Beyond BMD

E. Michael Lewiecki, MD
Director, New Mexico Clinical Research & Osteoporosis Center
Director, Bone Health TeleECHO
University of New Mexico Health Sciences Center
Albuquerque, NM, USA
Disclosure

• No direct compensation from potentially conflicting entities

• Employed by New Mexico Clinical Research & Osteoporosis Center, which has received the following in the past one year:
  – Research grant support from Amgen, Radius, Mereo
  – Consulting and scientific advisory board fees from Amgen, Radius, Alexion, Sandoz, Samsung Bioepis
  – Honoraria for speakers’ bureaus of Alexion, Radius
  – Support for project development with University of New Mexico
  – Royalties from UpToDate for sections on DXA, fracture risk assessment, and prevention of osteoporosis

• Board positions with the NOF, ISCD, OFNM

• Guideline committees with NOF, ISCD, AACE, NAMS
Objectives

• Describe the technology and potential clinical applications of Pulse-Echo UltraSonography (PEUS)

• Describe the technology and potential clinical applications of Radiofrequency Echographic Multi-Spectrometry (REMS)

• Describe the technology and potential clinical applications of Impact Microindentation (IMI)
Pulse-Echo UltraSonography (PEUS)
PEUS Device

- Non-invasive ultrasound technology
- Handheld transducer placed over proximal anterior tibia using ultrasound gel
- Signals transmitted to connected laptop/PC
- Cortical thickness is estimated by measuring lag time between ultrasound echoes from front and back surface of cortex

PEUS Technical

- Location on tibia is standardized to one-third the length from the proximal head of the tibia to the medical malleolus
- Transducer generates 3.0 MHz ultrasound waves
- 5 measurements, averaging total of 5 minutes
- Density Index (DI) calculated with input of cortical thickness, age, weight, and height to generate a value that is correlated with total hip BMD

ISCD Official Positions: QUS

- Can QUS be used to diagnose osteoporosis according to the WHO classification? – No

- However, thresholds could be defined to identify patients at high or low risk of having osteoporosis, as follows . . .
  - Upper threshold with 90% sensitivity for identifying patients with very low likelihood of having DXA T-score diagnosis of osteoporosis (10% false negative)
  - Lower threshold with 90% specificity for identifying patients with very high likelihood of having DXA T-score diagnosis (10% false positive)

- When DXA availability is limited, DXA might be recommended for patients between the thresholds for whom the diagnosis is uncertain

- When DXA is not available, treatment might be considered when QUS measurement is at or below the lower threshold and treatment might be avoided when at or above the upper threshold

Threshold analysis
- 448 Finnish women, mean age 69
- Proximal tibia DI and T-scores at TH and FN
- Upper threshold: 0.884 (90% sensitivity)
  - ≥ = very unlikely to have osteoporosis
- Lower threshold: 0.779 (90% specificity)
  - ≤ = very likely to have osteoporosis

Treatment analysis
- UK NOGG guidelines: DXA advised for women with intermediate risk by FRAX
- FRAX standard: 57% met criteria for DXA
- FRAX with PEUS: 16% required DXA

Note: Finnish subjects using GE Lunar DXA

# Proximal Tibia DI and Hip T-score

## Minnesota
- 555 postmenopausal women (mostly Caucasian) age 50-89
- Proximal tibia DI (average of 5 measures) detected hip osteoporosis (T-score ≤ -2.5 at FN or TH) with 80% sensitivity and 82% specificity
- DI > 0.844 upper threshold in 38%: DXA might have been avoided if PEUS had been used for pre-screening
- DI < 0.779 lower threshold in 32%
- DI association with hip T-score was weaker with BMI > 30 [soft tissue thickness over tibia does not influence PEUS measurement]
- Precision: CV 1.6%, 3.4% (2 staff)

## New Mexico
- 293 postmenopausal women (153 Caucasian, 140 Hispanic) age ≥ 50
- Proximal tibia DI (average of 5 measures) detected hip osteoporosis (T-score ≤ -2.5 at FN or TH) with 80% sensitivity and 86% specificity for Caucasians and 80%/91% for Hispanics
- Similar performance of PEUS in US Caucasians and Hispanics, suggesting same DI thresholds can be used for both
- 31% of combined groups were between DI thresholds of 0.844 and 0.779
- Precision: CV 1.8%, 2.0% (2 staff)
- Note: USA subjects and Hologic DXA for both

PEUS Printout

https://www.bindex.fi/en/use/
PEUS Potential Clinical Applications

• When DXA availability is limited or restricted according to national guidelines
  – Consider treatment when DI is ≤ lower threshold
  – Consider treatment according to FRAX with DI
  – Consider no treatment when DI is ≥ upper threshold
  – Consider DXA when DI is between upper and lower thresholds and FRAX shows intermediate level of risk

• When DXA is not available, consider PEUS as a substitute
  – Consider treatment when DI is ≤ lower threshold
  – Consider using DI as stand-in for FN BMD with FRAX and make treatment decisions accordingly

• Not known whether PEUS can be used to monitor treatment
Radiofrequency Echographic Multi-Spectrometry (REMS)
REMS Device

- Portable device using non-invasive ultrasound technology with transducer frequency 3.5 Mhz
- Software automatically eliminates calcifications, osteophytes, and other artifacts
- Generates REMS BMD, T-scores, and Z-scores for the spine and hip that are highly correlated with DXA values
- Uses proprietary reference data of ultrasound spectral models for REMS BMD and NHANES reference data for T-scores and Z-scores
REMS Measurements at Spine and Hip

Lumbar Spine

Femoral Neck

https://www.startupbusiness.it/echolight-soluzione-medtech-per-la-diagnosi-dellosteoporosi/96672/
Lumbar Spine REMS

- Transducer is placed under the sternum to visualize L1, then moved down to L4 with visual and audio guidance
- Total scan time 80 sec
- Followed by automatic processing time of about 1-2 minutes

Femoral Neck REMS

- Transducer is placed parallel to the femoral head-neck axis with visual and audio guidance
- Total scan time 40 sec
- Followed by automatic processing time of about 1 minute

https://www.youtube.com/watch?v=JYoPyR0U2T0
REMS Validation with DXA

- 1914 postmenopausal women age 51-70 in Italy (1)
- 4307 women age 30-90 in Italy, Belgium, UK, and Spain (2)
- High correlation between REMS and DXA for BMD and T-scores (1, left)
- Sensitivity and specificity of REMS to discriminate patients with and without osteoporosis was > 90% at LS and FN

<table>
<thead>
<tr>
<th>REMS (1)</th>
<th>Precision</th>
<th>LSC</th>
</tr>
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<tbody>
<tr>
<td>LS</td>
<td>0.38%</td>
<td>1.05%</td>
</tr>
<tr>
<td>FN</td>
<td>0.32%</td>
<td>0.88%</td>
</tr>
</tbody>
</table>

REMS T-score Predicts Fracture Risk

- 5-year prospective observational study in 1516 Italian women age 30-90
- Evaluation of REMS and DXA T-scores to discriminate women who fractured or did not fracture over 5 years
- 14% fracture incidence
  - 74.5% had REMS T-score ≤ -2.5
  - 64.5% had DXA T-score ≤ -2.5
- Fragility Score: TBS-like feature to assess bone quality and predict fracture risk independently of BMD

Scatterplot of Vertebral REMS and DXA T-scores in Women with and Without incident Fractures

REMS Potential Clinical Applications

• Population screening
• Patients with osteoarthritis and artifacts
• Pregnant women and children
• Short-term monitoring
• Fragility Score to assess bone quality
• Evaluation of cartilage and muscle mass
Impact Microindentation (IMI)

Formerly known as
Reference Point Indentation (RPI)
IMI Device: Clinical

- Novel technique for measuring tissue-level material properties of cortical bone

- Two devices
  - Osteoprobe: used in living humans with a handheld device that generates a single high force load of 40 N over 0.25 msec (impact microindentation - IMI)
  - BioDent: used in animals with cyclic low force loading and unloading of 0-10 N over several sec (cyclic reference point microindentation - CMI)

- Known force is applied

- Depth of penetration in the outer cortex is measured

- Output is Bone Material Strength index (BMSi)

http://research.activelifescientific.com/osteoprobe/
Step 1
The tip assembly is inserted through any soft tissue to the cortical bone surface.

Step 2
The user compresses the outer housing, pressing the tip lightly into the cortical bone surface.

Step 3
At maximum compression (~10N), the tip is pressed into the bone surface enough to set a reference point.

http://research.activelifescientific.com/how-does-osteoprobe-work/
Microindentation is Very Small

Local Anesthetic

8-10 Indentations (at least 5 must be valid)

8 Indentations of BMSi Reference Material

Scanning Electron Microscopy of IMI Indent

BMSi Clinical Correlations

BMSi Declines with Advancing Age

BMSi Increases with Some Medications

Lower BMSi with Type 2 Diabetes

- IMI in 30 postmenopausal women age 50-80 with T2D for > 10 years and 30 non-diabetic age-matched controls (1)
- BMSi was significantly lower in diabetics (-11.7%; P < 0.001) compared with non-diabetics (left, unadjusted) and when adjusted for BMI, age, hypertension, nephropathy, neuropathy, retinopathy, and vascular disease
- Diabetics also lower BTMs (P < 0.001) and tended to have greater cortical porosity at the distal radius with HRpQCT (NS)
- In another study of men with T2D compared with non-diabetic controls, BMSi and TBS were lower than controls despite no difference in BMD (2)

Lower BMSi in Women with PHPT

- Cross-sectional study of 37 women with PHPT, including 11 with fragility fractures, compared with 37 women controls who were euparathyroid matched for age and fragility fracture status

- BMSi was significantly lower in women with PHPT than controls (P < 0.001), despite no difference in BMD at LS and FN

- BMSi was significantly lower in the 11 PHPT patients with fractures vs the 26 PHPT patients without fractures (P = 0.015), with lower FN BMD and similar LS BMD in fracture patients

Schoeb M et al. J Clin Endocrinol Metab. 2021;Mar 29;dgab207.
IMI Potential Applications

• Research
  – Better understanding of the contribution of bone material properties to bone strength, independent of BMD

• Clinical
  – Assessment of bone strength for patients with discrepancies between BMD and fracture risk, such as those with T2D, PHPT, glucocorticoids, stress fractures, normal BMD and low trauma fractures, normal BMD and “soft bones” with orthopedic surgery
  – Complementary to conventional methods, not a replacement
FDA Approval vs. Clearance of Devices

Class III Devices are **Approved**
- Class III devices are ones that are implanted or may pose high risk (e.g., pacemakers, artificial heart valves)
- Manufacturer submits application and results of clinical testing
- FDA approval means the benefits of the product outweigh the known risks for the intended use

Class I and II Devices are **Cleared**
- Class I (low risk – electric toothbrush) and II (moderate risk – diagnostic ultrasound) devices are used externally are are considered safer than class III devices when use as intended
- Manufacturer submits premarket notification submission or 510(k)
- FDA clearance means the manufacturer has demonstrated that the product is substantially equivalent to another legally marketed device (“predicate device”) that already has FDA clearance or approval
- Once cleared, the device may be marketed and sold in the US
Regulatory

- **Bindex PEUS device**
  - Europe: approved for clinical use
  - US: FDA cleared, AMA CPT category III code 0508T [temporary code for emerging technologies], CMS approved coverage in the Ambulatory Surgical Center (ASC) setting

- **EchoS REMS device**
  - Europe: approved for clinical use
  - US: FDA cleared, unclassified ultrasound code 76999 has been used

- **Osteoprobe IMI device**
  - Europe: approved for clinical use
  - US: investigational

From websites of device manufacturers and contact with representatives
BEYOND BMD

DR. IRINEL STANCIU, MD, FACE, CCD, ECNU

FEEL BETTER. DO MORE.
DISCLOSURES:

- Member of speaker bureau for Radius Health and Alexion Pharmaceuticals
- Scientific advisory board for Ultragenyx
- Principal investigator for research trials with Radius and Ultragenyx (research funds received by Panorama)
OBJECTIVES

- Describe technology and clinical applications of the Trabecular Bone Score (TBS)
- Describe the technology and clinical applications of the Biomechanical Computed Tomography (BCT)
- Describe the technology and clinical applications of the HRpQCT
OSTEOPOROSIS = **LOW BONE MASS AND MICROARCHITECTURE DETERIORATION**

“A systemic skeletal disease characterized by low bone mass and microarchitectural deterioration of bone tissue with a consequent increase in bone fragility and susceptibility to fracture.”

BONE STRENGTH

BONE DENSITY

BONE QUALITY

BONE TURNOVER
BONE REMODELING
BONE GEOMETRY
MICROARCHITECTURE
MINERALIZATION
MICRODAMAGE
MATRIX AND MINERAL COMPOSITION
TRABECULAR BONE SCORE
A NEW BONE STRUCTURE ASSESSMENT TECHNIQUE ENHANCES IDENTIFICATION OF FRACTURE RISK

Discerns differences between DXA scans that show similar BMD measurements
WHAT IS TRABECULAR BONE SCORE (TBS)?

- Is a DXA software program that estimates bone texture information from the 2D LS DXA scan
  - Is a derived unitless index, not a direct physical measure
- TBS - highly correlated evaluation of trabecular microarchitecture and fracture risk
- TBS provides fracture risk information that is additive to BMD and clinical risk factors

*Silva et al. J Bone Miner Res. 2014 29:518–530 and White paper by Medimaps*
DIFFERENT BONE TEXTURE (TBS) DESPITE SAME L1-L4 BMD

Two patients with Same L1-L4 BMD

Normal trabecular Bone architecture

TBS L1-L4: 1.457

Degraded trabecular bone architecture

Homogeneous: High TBS

Heterogeneous: Low TBS

Adapted from Silva et al. J Bone Miner Res. 2014, 29:518–530
TRABECULAR BONE SCORE (TBS) REPORT

- TBS iNsight software Medimaps Group Geneva, Switzerland
- TBS report is obtained by one click
- Provides an indirect assessment of trabecular microarchitecture that is an independent predictor of fracture risk.
TBS Data Can be Used to Adjust FRAX
"Med-Imaps TBS iNsight is a software provided for use as a complement to a DXA analysis. … TBS is derived from the texture of the [AP spine] DXA image and has been shown to be related to bone microarchitecture and fracture risk … independent of BMD…”
TRABECULAR BONE SCORE (TBS)
2019 ISCD POSITIONS

- TBS is associated with vertebral, hip and major osteoporotic fracture risk in postmenopausal women.
- TBS is associated with major osteoporotic fracture risk in postmenopausal women with type II diabetes.
- TBS is associated with major osteoporotic fracture and hip fracture risk in men over the age of 50 years.
- TBS should not be used alone to determine treatment recommendations in clinical practice.
- TBS can be used in association with FRAX and BMD to adjust FRAX-probability of fracture in postmenopausal women and older men.

In patients receiving anti-fracture therapy:
- The role of TBS in monitoring anti-resorptive therapy is unclear.
- TBS is potentially useful for monitoring anabolic therapy.
Dual-energy X-ray Absorptiometry Monitoring with Trabecular Bone Score: 2019 ISCD Official Position

Kelly Krohn,¹ Elliott N. Schwartz,² Yoon-Sok Chung,³ and E. Michael Lewiecki⁴ *

¹ Department of Orthopedic Surgery, University of Arizona College of Medicine Phoenix, AZ, USA; ² Northern California Institute For Bone Health, Orinda, CA, USA; ³ Ajou University School of Medicine, Suwon, South Korea; and ⁴ New Mexico Clinical Research & Osteoporosis Center, Albuquerque, NM, USA
KEY QUESTIONS

1. Is TBS useful to monitor patients treated with antiresorptive agents?

2. Is TBS useful to monitor patients treated with teriparatide and abaloparatide?
The least significant change (LSC) for TBS can be estimated to be about $5.8\%$ (3.1-5.8\% in published data) or calculated by a dual-energy X-ray absorptiometry facility using the same methodology that is used for bone mineral density (BMD) precision assessment to calculate BMD LSC.

TBS precision is better when LS BMD precision is better - TBS LSC may be at the low end of this range at a facility with very low LS BMD LSC.

A significant decrease of TBS on treatment may represent a poor response to treatment and increasing fracture risk.
1. Is TBS useful to monitor patients treated with antiresorptive agents?
   - TBS does not appear to be clinically useful to monitor the skeletal effects of bisphosphonates and denosumab (unclear role)

2. Is TBS useful to monitor patients treated with teriparatide and abaloparatide?
   - TBS is potentially useful as a component of monitoring the skeletal effects of teriparatide and abaloparatide.
Cross-sectional study, 894 M and 682 F (24–98 years) enrolled in the Geelong Osteoporosis Study.

- TBS was assessed by analysis of lumbar spine DXA scans (Lunar Prodigy) using TBS iNsight software (Version 2.2).
- Bivariate and multivariable linear regression models

Low mobility and the use of antiresorptive medication were associated with lower TBS in both men and women.

Low childhood physical activity was associated with lower TBS in men.

Prior fracture, use of glucocorticosteroids, and total calcium intake were also associated with lower TBS in women.

# CLINICAL RISK FACTORS ASSOCIATED WITH TBS

<table>
<thead>
<tr>
<th>Clinical factors associated with higher TBS</th>
<th>Clinical factors associated with lower TBS</th>
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<tbody>
<tr>
<td>Non-Hispanic white ethnicity (women)</td>
<td>Older age</td>
</tr>
<tr>
<td>Recent osteoporosis therapy</td>
<td>Non-Hispanic black and Mexican-American ethnicity (women)</td>
</tr>
<tr>
<td>Higher BMD (spine or hip)</td>
<td>Recent glucocorticoid use</td>
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<tr>
<td></td>
<td>Prior major fracture</td>
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<tr>
<td></td>
<td>Type 2 diabetes</td>
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<tr>
<td></td>
<td>Rheumatoid arthritis</td>
</tr>
<tr>
<td></td>
<td>Chronic obstructive pulmonary disease</td>
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<td></td>
<td>High alcohol intake</td>
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<tr>
<td></td>
<td>Renal transplantation</td>
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<tr>
<td></td>
<td>Higher BMI and other measures of body size (weight, waist circumference, total body fat mass, trunk fat and lean mass)</td>
</tr>
</tbody>
</table>

BMD, bone mineral density; TBS, trabecular bone score.

*a* Dual-energy absorptiometry scanner and trabecular bone score software version dependent.

TBS HAS PARTICULAR ADVANTAGES OVER BMD FOR SPECIFIC CAUSES OF INCREASED FRACTURE RISK

- chronic corticosteroid use
- type-2 diabetes
- chronic kidney disease
- primary hyperparathyroidism
- patients being treated with aromatase inhibitors


BIOMECHANICAL CT (BCT)

- Quantitative computed tomography (QCT) uses conventional CT imaging of the lumbar vertebrae and proximal femur, concurrently with phantoms with known volumetric BMD values to convert image contrast into quantitative measures of volumetric BMD.

- QCT does not provide the resolution necessary to evaluate trabeculae.

- Finite element analysis (FEA) is a computer modeling technique that, when coupled with QCT, provides a non-invasive approach to estimate bone strength.

- QCT-based FEA extends interpretations of QCT to evaluate whole bone structure and shape as well as estimating the bone strength.
THE BIOMECHANICAL (BCT) CT

A fully reimbursed, zero radiation, patient-convenient, diagnostic service* for bone fragility

- Can utilize previously-acquired CT* scans taken for any medical indication — no need for a separate patient procedure
- Can include VFA analysis to detect existing vertebral fractures
- Offer to all CT patients w/o a recent DXA
- Well suited for pre-operative bone quality evaluation for ortho surgery patients

* Send hip- or spine-containing CT scan to OND; OND performs its VirtuOst BCT test and returns results
VirtuOst® BCT is Extensively Validated
Validated in > 7,000 patients, > 40 peer-reviewed journal articles

“Together, this body of evidence supports BCT as an accurate and convenient diagnostic test for osteoporosis in both sexes, particularly when used opportunistically for patients already with CT.”
The **VirtuOst test** measures both bone strength and BMD at the hip and/or spine, with FDA-cleared and validated interventional thresholds to facilitate clinical interpretation and decision making.

**Hip BMD:** *VirtuOst* provides DXA-equivalent BMD T-scores for the femoral neck and total hip regions. The T-scores utilize the NHANES III Caucasian reference database, assume the young-female reference values for both sexes, and can be used with the *FRAX® online calculator*.

**Spine BMD:** *VirtuOst* provides a "volumetric" trabecular BMD at the spine, for an elliptical region of trabecular bone within the central 8–10 mm of the vertebral body. As per clinical recommendations from the ACR and the ISCD, BMD ≤ 80 mg/cm³ indicates osteoporosis.

- **VirtuOst-VFA** identifies existing vertebral fractures.
THE SCIENCE BEHIND VIRTUOST® BCT

“Biomechanical CT” (BCT) harnesses advanced image processing of CT scans, AI, established biomechanical principles, and engineering-based, finite element analysis.

VirtuOst creates a personalized 3D model of a patient’s bone and subjects it to a virtual stress test.

VirtuOst-VFA identifies existing vertebral fractures.

See videos at https://ondiagnostics.com/physicians/overview/
BIOMECHANICAL COMPUTED TOMOGRAPHY (BCT)

Virtual stress testing

- Bone strength
- Bone density
- Fracture risk assessment
- Optionally also VFA (from CT)

- Can uniquely identify some patients with osteoporosis — compromised bone strength at high risk of fracture — who are missed by DXA

- Can utilize CT scans containing the hip or lower spine, previously taken for any medical indication
  - 8M patients/yr are BCT-eligible
  - No extra patient visit needed

Animations courtesy of O.N. Diagnostics
- BCT is now nationally covered and reimbursed as a BMM preventative services benefit
- Same coverage rules as for CT-bone density (diagnosis but not monitoring)
- BCT w/ or w/o a new CT

**Bone Mass Measurements (NCD 150.3)**

**HCPCS/CPT Codes**

- 0554T — Bone strength and fracture risk using finite element analysis of functional data, and bone-mineral density, utilizing data from a computed tomography scan; retrieval and transmission of the scan data, assessment of bone strength and fracture risk and bone mineral density, interpretation and report
- 0555T — Retrieval and transmission of the scan data
- 0556T — Assessment of bone strength and fracture risk and bone mineral density
- 0557T — Interpretation and report
- 0558T — Computed tomography scan taken for the purpose of biomechanical computed tomography analysis
- 76977 — Ultrasound bone density measurement and interpretation, peripheral site(s), any method
- 77078 — Computed tomography, bone mineral density study, 1 or more sites; axial skeleton (e.g., hips, pelvis, spine)
- 77080 — Dual-energy X-ray absorptiometry (DXA), bone density study, 1 or more sites; axial skeleton (e.g., hips, pelvis, spine)
- 77081 — Dual-energy X-ray absorptiometry (DXA), bone density study, 1 or more sites; appendicular skeleton (peripheral) (e.g., radius, wrist, heel)
- 77085 — Dual-energy X-ray absorptiometry (DXA), bone density study, 1 or more sites; axial skeleton (e.g., hips, pelvis, spine), including vertebral fracture assessment
- G0130 — Single energy x-ray absorptiometry (sexa) bone density study, 1 or more sites, appendicular skeleton (peripheral) (e.g., radius, wrist, heel)

**Logistics for BCT**

✓ Treating physician places order if a BMM is medically necessary for the patient
✓ Imaging facility sends CT scan to lab [CPT code 0555T]; lab performs BCT analysis [CPT code 0556T]
✓ Physician interprets BCT results [CPT code 0557T] and returns medical report to treating physician
HIGH RESOLUTION PERIPHERAL COMPUTED TOMOGRAPHY (HRPQCT)

- **Non-invasive 3-D** method to evaluate compartment-specific vBMD and bone microarchitecture in the peripheral skeleton (radius and tibia) at high resolutions (60-80 μ).
- First device ~ 2005
- Basic imaging principles are based on the interaction of ionizing radiation (X-rays) with matter.
- X-ray attenuation data is acquired at multiple projections around the specimen, which allows for a 3D image to be reconstructed
- **Low radiation:** standard HR-pQCT scan at the distal radius or tibia is 3– 5 μSv depending on the scanner generation
  - hip scan using DXA ~ 9 μSv
  - standard chest X-ray ~100 μSv
  - hip CT scan ~ 286–506 μSv

**XTREME CT - SCANCO**

- **Second-generation HR-pQCT** (XtremeCT II, Scanco Medical AG, Brütisellen, Switzerland)

- **First-generation HR-pQCT** (XtremeCT, Scanco Medical AG, Brütisellen, Switzerland) = standard

XtremeCT II
< 58 µm resolution, 30 s-2.1 min, < 5 uSv

XtremeCT I
82 µm resolution, 2.6 min, < 5 uSv

Increased our understanding of age-related changes and sex differences in bone microarchitecture, differences in bone structure across a wide range of bone metabolic disorders, fracture risk, and the response of bone to different osteoporosis therapies.

**Density Parameters:** Cortical and trabecular density

**Structural Parameters:** Trabecular Thickness, Trabecular Separation, Trabecular Number, Volume Fraction, Cortical Thickness, Cortical porosity, Arterial calcification

The decision of **which density and microarchitecture parameters** to report depends on the research question.

Difficult to implement - at this time - in clinical practice


XTREME CT II - SCANCO REPORT

TIBIA CROSS-SECTION

normal bone

BV/TV 16.1%
Tb.N. 2.0/mm
Tb.Th. 0.08 mm
Tb.Sp. 0.43 mm

osteopenia

BV/TV 11.3%
Tb.N. 1.3/mm
Tb.Th. 0.09 mm
Tb.Sp. 0.68 mm

osteoporosis

BV/TV 7.3%
Tb.N. 0.6/mm
Tb.Th. 0.11 mm
Tb.Sp. 1.47 mm

Courtesy of M.Dambacher - This device is not approved by all health authorities
For using HR-pQCT in clinical studies, a minimum set of parameters should be reported to appropriately characterize the trabecular and cortical bone.

Appropriate terminology is necessary, - certain parameters have different methods of measurement between scanner generations and thus cannot be directly compared.

Scan acquisition and analysis, reporting results, quality control and training needs to be standardized.

THE STRAX HR-PQCT DEVICE

- **High Resolution Images** – 75–80-micron voxel size (FDA, CE, TGA)
- **Negligible Levels of Radiation** – 3-6 microSieverts
- **Fast Scanning** - 1 min
- **Small Footprint** – The device footprint is 23X36 inches
- **Standard 115 V outlet and ‘Self Shielded Device’ (SSD)**- no additional cooling required
- **Consistent Images** – same quality scanning image globally – no manufacturer-to-manufacturer variations that can impact the performance of HR-pQCT images
- **Bone fragility assessment using an Artificial Intelligence solution and a deep learning framework** – With the new HR-pQCT device, Strax uses proprietary machine learning and deep learning algorithms, to automatically analyze scans with state-of-the-art accuracy and precision
  - **Flexibility** – can be used in imaging centers, hospitals, and even a primary care setting –
  - **Suitable for patients 50 to 400 lbs**
  - **FDA- cleared**

https://us.straxcorp.com/
Introducing Strax Micro CT plus SFS
STRAX FRAGILITY SCORE – PATENT PROTECTED AI ENGINE OVERVIEW

Step 3 is separately a blocking patent
The challenge is to set the ROI correctly for all patients all heights. A set distance back cannot be used, ROI would be different based on height of patient. So, the AI must calculate the length of the patient radius & assign a measure off 10% of the length of the radius back from the hand. Assures same region of interest for all patients, no manual measurement

• STEP 1 – scan takes 40 single scans wrist. The closer to the hand the bone (radius, ulna, metacarpal) is mainly trabecular (1), the further away from the hand it is mainly compact cortex of radius & ulna (3)
• STEP 2 – all bones 3D reconstructed - all tissue removed
• STEP 3 – Radius realigned & critical region of interest assigned
• STEP 4 – AI creates 3D region of interest of the radius
• STEP 5 – AI separates out compact cortex from transitional zone to trabecular bone for quantitation & Strax Fragility Score (SFS) reported

Step 3 is critical to the value of a bone diagnostic using bone microstructure – Region of Interest (ROI)
A 1% variation in correctly assigning the ROI can change the cortical bone to trabecular bone relationship by 20% (Seeman et al 2017)
Patient: Mary Smith
Date of Birth(Age): 1957/06/01(61)
Gender: Female

Scan Date: 2018/11/16
Processing Date: 2018/11/16
Prescribing Doctor: Dr. Ego Seeman

CT Slices

Distal Slice

Intermediate Slice

Proximal Slice

Doctor’s Notes:

3D Bone Reconstruction

Healthy Bone Reference

Patient

Decayed Bone Reference

Entire Bone

Cortical Bone

Trabecular Bone

Doctor’s Notes:
Excellence is the gradual result of always striving to do better.

Pat Riley