# ABSTRACTS

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Recipient of Best Clinician Abstract

001 - Integrating Fall Risk Assessment Into Routine Bone Density Testing
Kate Queen, Medical Director, Osteoporosis Center; Cherie Shaffer, Coordinator, Osteoporosis Center; Mary Underwood, Densitometrist, Osteoporosis Center; Robyn Duncan, Physical Therapist, Osteoporosis Center

BACKGROUND: Most serious fractures, including 90% of hip fractures, occur in association with a fall; yet fall risk assessment is not routinely included in the clinical evaluation of fracture risk. This study was undertaken to determine if fall risk assessment could be integrated into the evaluation performed during routine bone density testing, and to evaluate the characteristics of those community dwelling adults identified to be at increased fall risk.

METHODS: All individuals referred to the Osteoporosis Center at Medwest-Haywood for bone density testing between 4/19/10 and 8/31/11 were asked to perform Single Leg Stance, a validated tool for assessing risk of injurious falls in community dwelling older adults. Increased risk is associated with inability to stand unassisted on one foot for more than 5 seconds. History of falls over the prior 12 months based on recall was also obtained. Additional data obtained as part of routine bone density testing included: age, sex, height using stadiometer, peak height, weight, history of nonviolent fractures after the age of 40, current and prior osteoporosis medications, assessment of calcium and Vitamin D intake, risk factors for falls and VFA findings if performed.

RESULTS: 2932 individuals were evaluated. The 52 individuals for whom Z scores were reported were excluded from the analysis. Instruction in and performance of Single Leg Stance took no more than 2 minutes in this cohort of community dwelling older adults. 849 (29%) had ‘Poor Performance’ on Single Leg Stance with results < or equal to 5 secs and 73 (3%) were ‘Too Frail To Assess’. Only 31 (1%) ‘Refused’ to perform the test. Of those 32% identified to be at increased risk for falls, 48% had Osteopenia and 28% Osteoporosis on DXA testing. 57% met NOF guidelines for pharmacologic treatment. If History of Falls based on recall was used only 230 (25%) of those at risk using Single Leg Stance would have met the American Geriatric Society criteria for increased fall risk. In the 2880 individuals assessed, 60 had hip fractures and 235 had wrist fractures. Those with increased fall risk by Single Leg Stance had 42 of the 60 (70%) hip fractures; 152 of the 235 (65%) wrist fractures.

CONCLUSIONS: Standardized testing for fall risk using Single Leg Stance, can be successfully integrated into routine assessment at the time of bone density testing; and used to identify a subset of community dwelling adults who are at increased risk for falls, as well as fractures, and in need of interventions focused on fall prevention strategies, in addition to standard osteoporosis therapy.

Recipient of Best Technology Abstract

002 - Positioner and Clothing Artifact Can Affect One-third Radius BMD Measurement
Diane Krueger, University of Wisconsin; Nellie Vallarta-Ast, University of Wisconsin; Jessie Libber, University of Wisconsin; Mary Checovich, University of Wisconsin; Ronald Gangnon, University of Wisconsin; Neil Binkley, University of Wisconsin

Radius BMD is a valuable cortical bone measurement in clinical trials, patients with hyperparathyroidism and adults with spinal degenerative changes. However, we have observed substantial variability upon repeat of one-third radius BMD measurements. Here we identify a confounder to radius BMD measurement and propose a technical approach to avoid this inaccuracy.

Three technologists performed forearm BMD precision assessment in adults age = 65 following ISCD recommendations using a GE Lunar iDXA. Each technologist scanned 30 men and 30 women (total n = 180) twice with repositioning between scans. Mixed effects linear regression models were used to estimate least significant change (LSC). Upon demonstration of a larger than expected LSC and substantial difference between technologists, detailed visual examination of all 360 images, including bone, soft tissue, neutral and air point-typing was conducted. Potential causes of point-typing variability were explored. Upon identifying soft tissue point-typing errors, and potential causes of these errors, a second confirmatory cohort consisting of forearm scans from 62 postmenopausal women was similarly reviewed.

An almost two-fold difference in one-third radius BMD LSC (0.038 to 0.073 g/cm2; p < 0.001) was observed between technologists. Much of this appeared to result from automated soft tissue identification differences in scans from one technologist who often placed the forearm positioner with the long slots near the wrist instead of the elbow. Compared to the manufacturer’s ideal depiction, suboptimal soft tissue point-typing was present in 30/360 scans (8.3%) involving 27 individuals. The vast majority of these soft tissue point-typing errors appeared to result from inclusion of forearm positioner slots within the scan field; the others were due to clothing covering the forearm. In these 27 individuals, 24 had a paired scan correctly point-typed, thus allowing evaluation of the
effect on BMD. In those with long forearm positioner slots located at the distal corners of the scan field, the mean one-third radius BMD was ~7% higher (p < 0.01). In the confirmatory cohort, a comparable frequency of soft tissue point-typing anomalies was observed, being present in 7/62 (11%). In conclusion, substantial variability in one-third radius BMD measurement reproducibility was observed between technologists. Inaccuracies in automated soft tissue detection contribute to this variability. As soft tissue point-typing errors are not visually evident on the image used for interpretation, it is probable that clinicians will not appreciate these occurrences, thereby leading to an incorrect reading. Technologists must evaluate point typing as part of routine forearm DXA analysis and, when suboptimal, immediately reacquire the scan to produce a valid measurement. Finally, ensuring the positioner is placed as recommended, with the short slots at the distal forearm, reduces likelihood of producing this long slot error.

Invited Oral Presentation

003 - A comparison of the Australian FRAX and the Garvan hip fracture prediction models using a 10 prospective study of 1127 elderly Australian women

Mingxiang Yu, Shanghai Zhongshan Hospital & University of Western Australia; Satvinder Dhaliwal, Curtin University; Kun Zhu, University of Western Australia & Sir Charles Gairdner Hospital; Josh Lewis, University of Western Australia & Dept of Endocrinology and Diabetes; Richard Prince, University of Western Australia & Sir Charles Gairdner Hospital

Background: Fracture risk calculators have been developed to improve DXA aBMD structural measures as predictors of future fracture risk. We compared Australian FRAX and the Garvan hip fracture prediction models using a long running cohort study of older women. Methods: The study population used was the CAREES study, an ongoing population based cohort study of 1500 women with a mean age of 75 years at baseline in 1998. In this paper we report hip fracture risk prediction in a sub population of 1127 women who had a hip aBMD measurement in 1999 and in whom complete ascertainment of hip fracture incidence over 10 years is available.

Results: Hip fractures occurred in 68 (6%) participants. The median 10 year hip fracture risks were 4.1% for FRAX without BMD, 1.9% for FRAX with BMD, 5.6% for Garvan without BMD, and 3.9% for Garvan with BMD. The correlations of the predicted hip fracture rate of the two models were Pearson R = 0.721 and Spearman rank R = 0.890 for FRAX and Garvan without BMD, and Pearson R = 0.754; Spearman rank R = 0.913 for FRAX and Garvan with BMD (all P < 0.01). The kappa scores were FRAX and Garvan without aBMD 0.649, and FRAX and Garvan with aBMD 0.699. Conclusions: These data show that there is good agreement between the two calculators for 10-year hip fracture risk.

Invited Oral Presentation

004 - The Effects of 8 Years of Continuous Denosumab Treatment on Bone Mineral Density and Biochemical Markers of Bone Turnover in a Phase 2 Study

Michael McClung, Oregon Osteoporosis Center; E Michael Lewiecki, New Mexico Clinical Research & Osteoporosis Center; Michael Bolognese, Bethesda Health Research Center; Munro Peacock, Indiana University School of Medicine; Richard Weinstein, Diablo Clinical Research; Beiying Ding, Amgen Inc.; Michelle Geller, Amgen Inc.; Pei-Ran Ho, Amgen; Rachel Wagman, Amgen; Paul Miller, Colorado Center for Bone Research

Background: Denosumab, a fully human monoclonal antibody to RANK ligand, is an approved therapy for postmenopausal women with osteoporosis at high risk for fracture. Denosumab has been shown to reduce bone resorption, increase bone mineral density (BMD), and reduce the risk of new vertebral, hip, and nonvertebral fractures at 3 years compared with placebo. With its unique mechanism of action, long-term experience with denosumab therapy is of clinical interest. Here we report the longest evaluation of denosumab treatment to date and describe the effects of 8 years of continuous denosumab treatment on BMD and bone turnover markers (BTM) from a phase 2 study.

Methods: In the 4-year, phase 2 parent study, postmenopausal women with a BMD T-score between −1.8 and −4.0 (lumbar spine) and/or −1.8 and −3.5 (total hip or femoral neck) were randomized to receive placebo, open-label alendronate, or 1 of 7 different doses of denosumab. After 2 years on study, subjects were reallocated to continue, discontinue, or discontinue and reinstitute denosumab; discontinue alendronate; or 1 of 7 different doses of denosumab. After 2 years on study, subjects were reallocated to continue, discontinue, or discontinue and reinstitute denosumab; discontinue alendronate; or maintain placebo for an additional 2 years. The parent study was then extended for another 4 years. All subjects in the extension study received open-label denosumab 60 mg every 6 months (Q6M). Here our results focus on subjects who received denosumab treatment for 8 years total in the parent and extension studies, and those who
received placebo for 4 years in the parent study followed by denosumab for 4 years in the extension. **Results:** Of the 262 subjects who completed the parent study, 200 enrolled in the extension study and of these, 138 (69%) completed the 4-year extension study. For the 88 subjects who received 8 years of continuous denosumab treatment, BMD increased on average by 16.5% at the lumbar spine, 6.8% at the total hip, and 1.3% at the 1/3 radius compared with their parent study baseline, and by 5.7%, 1.8%, and 0.8%, respectively, compared with their extension study baseline. For the 12 subjects in the previous placebo group, 4 years of denosumab treatment resulted in gains in BMD comparable with those observed during the first 4 years of 60 mg Q6M in the parent study. Reductions in CTX and BSAP were sustained over the course of continuous denosumab treatment. At year 8, median reductions from parent study baseline in CTX and BSAP were −65% and −44%, respectively. Reductions in BTMs were also observed when the placebo group transitioned to denosumab treatment. The adverse event profile was consistent with an aging population and similar to previous reports. There were no atypical femur fractures or ONJ events. **Conclusion:** These data demonstrated that continuous denosumab treatment for up to 8 years was associated with continued gains in BMD and persistent reduction in markers of bone turnover, and was well tolerated.

**Recipient of Young Investigator Award; Invited Oral Presentation 005 - Opportunistic Screening for Osteoporosis During Abdominal CT Scanning**

D. Bryan Pooler, University of Wisconsin School of Medicine & Public Health; Perry Pickhardt, University of Wisconsin School of Medicine & Public Health; Travis Laudner, University of Wisconsin School of Medicine & Public Health; Alejandro Munoz del Rio, University of Wisconsin; Neil Binkley, University of Wisconsin School of Medicine & Public Health

**Background:** Osteoporosis is an important yet under-diagnosed public health concern. Our purpose is to evaluate a simple opportunistic screening method to identify individuals with osteoporosis using abdominal CT scans performed for other clinical indications (without a phantom).

**Methods:** Evaluation of 2,063 abdominal CT scans with correlative dual-energy x-ray absorptiometry (DXA) performed within six months in 1,867 adults (mean age ±SD 59.2±12.5 years, M:F 356:1511). Osteoporosis was defined as a DXA T-score = -2.5 or moderate-to-severe spinal compression fracture; remaining cases were either normal (T score =-1.0 or osteopenic (T-score between -2.5 and -1.0). CT region-of-interest (ROI) attenuation measurements were obtained at each vertebral level (T12-L5). Sagittal CT reconstructions were assessed for moderate-to-severe compression fractures using the Genant VSQ scale.

**Results:** Vertebral CT attenuation values were significantly different (p<0.0001) between osteoporotic, osteopenic, and normal cohorts at all levels (T12-L5). CT attenuation cut-off of 150 HU at L1 was 85% sensitive and 61% specific for osteoporosis with positive and negative predictive values (PPV and NPV) of 39% and 93%, respectively. Direct comparison of the osteoporotic and normal cohorts with a cut-off of 150 HU at L1 (excluding osteopenia) increases...
specificity and PPV to 80% and 75%, respectively, without affecting sensitivity. PPV for L1 at 100 HU was 68% for osteoporosis and 95% for combined osteoporosis/osteopenia; NPV for osteoporosis at L1 using a cut-off of 200 HU was 99%. Relative to the highest L1 attenuation quintile (>191 HU), the odds ratio for osteoporosis for the lowest L1 attenuation quintile (<112 HU) was 90.6 (95% CI: 41.83-196.40). Comparable performance was seen at all other vertebral levels. Among all patients with compression fractures seen at CT, 62/118 (52.5%) had T-scores = -2.5 (DXA false-negatives) while 95.1% had an L1 attenuation <150 HU. Among all patients with an L1 attenuation <150 HU, 96/1007 (9.5%) harbored a vertebral compression fracture. Presence or absence of IV contrast did not meaningfully impact results.

**Conclusion:** Simple lumbar attenuation measurement at CT (e.g., at L1 level) can effectively distinguish osteoporosis from normal, regardless of original study indication or technique. Moderate-to-severe compression fractures identified at CT are frequently associated with non-osteoporotic T-scores by DXA but have abnormally low vertebral attenuation values in the majority of cases. Osteoporosis screening can be performed concomitantly with abdominal CT. This opportunistic approach allows bone mass screening with no additional radiation exposure or cost.

![Mean CT attenuation by vertebral level](image)

**Figure 1:** Mean CT attenuation values of trabecular bone at each vertebral level (including standard deviations) according to BMD categories. Note separation between normal and osteoporotic patients at each vertebral level.

### Invited Oral Presentation

**006 - DXA-derived body shape indices as predictors of diabetes**

Joseph Wilson, University of California San Francisco; Bo Fan, University of California San Francisco; John Shepherd, University of California San Francisco

**Background:** Body mass index (BMI) has traditionally been used to characterize obesity and risk for conditions like diabetes and cardiovascular disease. Regional adiposity measures based on dual energy X-ray absorptiometry (DXA) provide additional risk information beyond BMI. In this project, we ask whether regional adiposity can be described by regional body volumes to provide more clinically-accessible biomarkers of risk, diagnosis, and treatment efficacy for a variety of weight-related conditions.

**Methods:** Using the results of the National Health and Nutrition Examination Survey (NHANES 1999-2004), regional body volumes (arms, legs, trunk) were estimated from whole body DXA scan results using a newly-derived calibration relationship between body compartmental masses (bone mineral, lean, fat) and their densities. Shape indices including volume ratios of regional to total volume and peripheral to trunk volumes were also derived. We investigated whether volume and shape indices provided additional risk assessment for self-reported diabetes status than traditional markers of diabetes using logistic regression (adjusted for age, gender, ethnicity, and BMI). BMI was stratified into three categories: Not Obese (BMI<25), Overweight (25 <= BMI <30), and Obese (BMI >=30).

**Results:** A total of 860 individuals reported having diabetes (compared to 8879 who reported not having diabetes). Regional percent trunk volume and trunk to leg volume ratio were significantly different by age, gender, ethnicity, and BMI. Mexican American males had the highest percent trunk volume (50.75%) and highest trunk to leg volume ratio (1.67). When trunk to leg volume ratio increased by one standard deviation, the odds of having...
BMD measurement by DXA is used to diagnose osteoporosis and assess fracture risk. However, DXA cannot currently evaluate trabecular microarchitecture. Assessing trabecular architecture should improve identification of those at high fracture risk. This study used a novel software program (TBS iNsight® v1.9, Med-Imaps, Pessac, FR), which utilizes grey-scale pixel assessment to estimate trabecular microarchitecture (Trabecular Bone Score [TBS]) from standard spine DXA images. We hypothesized that TBS assessment would differentiate women with low trauma fracture from those without. DXA lumbar spine (LS), proximal femur and vertebral fracture assessment (VFA) images were utilized from 445 women who participated in studies at the University of Wisconsin. All scans were acquired on Lunar Prodigy or iDXA densitometers (GE Healthcare–Madison, WI, USA) in routine clinical manner. VFAs were evaluated for fracture by a clinician experienced in this procedure (NB) who applied the Genant VSQ scale. TBS was assessed by the University of Lausanne (Switzerland) and blinded to fracture status. Mean participant age was 71.3 years (52.8 - 95.9) and BMI was 25.6 kg/m² (14.5 - 36.5). Their mean lowest T-score was -1.4 (-4.6 to +4.4) and 167 had fractures; vertebral (96) or other self-reported low trauma fracture. After confirming normal distribution, age, BMI and DXA device adjusted odds ratio (OR) per standard deviation decrease are reported for BMD and TBS. Covariate adjusted area under the curve (AUC) from ROC statistics were also performed. Correlation between LS BMD and TBS was calculated. Finally, on vertebral fracture patients and controls, a triage approach using TBS lowest tertile subsequent to the WHO classification on the lowest of hip or LS BMD was used to test the enhancement of identifying individuals at high vertebral fracture risk. As expected, correlation between LS BMD and TBS was low (r = 0.28) suggesting that these parameters reflect different bone properties. Adjusted ORs ranged from 1.48 to 1.55 (95% CI: 1.1 - 2.1; AUC 0.65) for LS and hip BMD and 1.91 (95% CI: 1.5 - 2.4; AUC 0.71) for spine TBS. TBS remained significant after adjustment for LS BMD (OR = 1.78; 95% CI 1.39 - 2.28, AUC: 0.72). When considering only vertebral fracture (VF) and non-fractured women, 74% of VF occurred in the non-osteoporotic zone; 41% of these women had a TBS score below the lowest tertile. 75% of non-fractured women were not osteoporotic and only 23% of them were below the lowest TBS tertile. In conclusion, TBS assessment enhances DXA by evaluating trabecular pattern and identifying individuals with vertebral or low trauma fracture. TBS identifies 41% of mis-classified fracture women when BMD alone was used. TBS may be a method to better target patients at higher fracture risk. As most fractures occur in those with osteopenia, identifying individuals most likely to fracture can facilitate more efficient utilization of health care dollars.

Recipient of Young Investigator Award

010 - Jumping Mechanography and Classic Muscle Function Tests: Effects of Age and Gender

Ellen Fidler, University of Wisconsin; Bjoern Buehring, University of Wisconsin; Jessie Libber, University of Wisconsin; Mary Checovich, University of Wisconsin; Diane Krueger, University of Wisconsin; Neil Binkley, University of Wisconsin

Background: Sarcopenia is a risk factor for falls and fractures. As muscle function predicts disability and mortality better than muscle mass, recent consensus sarcopenia definitions include both mass and function. Clinical trials of sarcopenia prevention/treatment require sensitive quantitative tools to evaluate muscle function; jumping mechanography (JM) is likely to be one such tool. However, prior to use of JM in prospective trials, it is necessary to evaluate comparability with existing functional tests in men and women. As such, the purpose of this study was to evaluate the impact of gender and age on classic muscle function tests and JM. We hypothesized...
that JM parameters of muscle function would be lower in older adults and in women. Methods: Community dwelling individuals age 70+ performed muscle function tests including JM, the short physical performance battery (SPPB) and grip strength. JM measures force and calculates body weight corrected peak power and jump height. Reaction time was collected as an exploratory parameter using a force plate; participants jumped as fast as they could in response to an auditory signal. Appendicular lean mass (ALM) was measured using a GE Lunar iDXA. T-tests and multivariate regression analyses were performed. Results: Participants included 49 females and 48 males (mean age 80.6 years, range 70 – 95) with and without osteoporosis and sarcopenia. Gender differences were present with men having higher grip strength [mean (SD) 32.4 (7.41) vs. 18.3 (4.76) kg], jump height [mean (SD) 20.0 (5.17) vs. 15.2 (4.81) cm], jump power [mean (SD) 22.7 (4.29) vs. 18.4 (4.44) W/kg] and ALM/ht2 [mean (SD) 7.75 (0.89) vs. 6.19 (0.800) kg/m²; all comparisons p<0.0001]. However, when adjusting jump height and jump power for a measure of muscle size, i.e., dividing by ALM/ht2, the sex difference disappeared. In contrast, even following adjustment in this manner, grip strength was higher in males. Age was negatively associated with performance in grip strength, total SPPB, jump height and jump power (p<0.05) with a trend in repeated chair rise and gait speed (p=0.06). No age correlation was observed in reaction time or ALM/ht2. Conclusion: In this cohort, men performed better than women in tests of muscle strength. This sex difference disappeared in JM parameters when correcting for ALM/ht2. No gender difference was observed in chair rise time or gait speed. Muscle function was poorer in older adults irrespective of gender for most tests. In summary, these data suggest that gender differences exist for tests of maximal muscle force but not tests measuring muscle power, i.e., those with a time component. JM parameters may integrate both strength and power. To improve utility of JM as a sarcopenia research tool, it would be helpful to establish normative ranges. Our data demonstrate that these ranges would need to be developed for men and women separately and adjusted for age.

Recipient of Young Investigator Award
011 - The Influence of Soft Tissue Recognition Errors on BMD Value - A case report
Jong Sook Choi, Asian Medical Center, Seoul, Korea

Purpose of This Study: DXA examines BMD using radiolucency differences between soft tissue and bone tissue. So soft tissue content is closely related with BMD. Because mostly soft tissue content is overlooked when people examine BMD or analysis the result, if there were soft tissue recognition errors, BMD value wouldn't be calculated correctly. This study will show you what kind of errors exist, how much these errors affect BMD value. Also we want to come up with an effective plan for dealing with it.

Method and Materials: Our subjects are the outpatients who have been tested BMD using Lunar Prodigy Verion 11.4 from January 2010 to December 2010. We drew samples from the total group who have had follow-up exams every year and have had more than 15% changes of BMD values only around the lumbar vertebrae or the femoral region. Four radiologists who have worked in BMD part for more than 4 years modified the soft tissue's shape that arose from errors for the same region that was tested last year. And they analyzed the differences between unadjusted BMD values and adjusted BMD values.

Results: We found out that there were 15 unusual cases about BMD-value differences among the 61 cases which had more than 15% BMD-value differences. Soft tissue recognition errors happened 8 times around the lumbar vertebrae and 7 times around the femoral region. We modified and analyzed soft tissues of 7 patients who made software problems. Among the 7 patients, some had operation on the lumbar vertebrae and others were patients with intestinal calcification. After adjusting, follow up test result that had changed more than 21.3 ± 10.1% in the absolute value because of soft tissue recognition errors was reduced to less than 2.9 ± 1.7%. The rest 8 errors happened because of being unprepared for the exam or accessories.

Conclusion: This study shows that software algorithm problem which didn't copy the soft tissue region like previous exam could happen to even normal patients. So it is important for us to check the soft tissue. The soft tissue recognition errors influence BMD value errors and cause incorrect diagnostic results. To prevent these errors, a radiologist should compare the lumbar vertebrae with the femoral region for a new patient. Also a radiologist should check the soft tissue contents for a follow up patient if there were a big difference with the latest exam. Among soft tissue recognition errors, in the case of software problems, a radiologist should suggest the correct results by modifying. And when unprepared patients make errors, a radiologist should conduct a exam with getting rid of accessories or with avoiding the exams that include a contrast medium or air-injection which could change the soft tissues.
### 100 - Relationship of Hip Geometric Properties and Bone Mineral Density in Male Athletes

**Chi Kei Li, Aspetar, Qatar Orthopaedic and Sports Medicine Hospital; Fuad Almudehki, Aspetar, Qatar Orthopaedic and Sports Medicine Hospital; Darren Paul, Aspetar, Qatar Orthopaedic and Sports Medicine Hospital; Olav Versloot, Aspetar, Qatar Orthopaedic and Sports Medicine Hospital; Dean Kenneally, Aspetar, Qatar Orthopaedic and Sports Medicine Hospital; Hakim Chalabi, Aspetar, Qatar Orthopaedic and Sports Medicine Hospital**

**Background:** Low bone mineral density (BMD) and geometric properties are major factors accounting for osteoporotic fractures especially hip fracture. Previous findings show significant correlation between BMD and bone strength in aged population. Whether this relation is present in male athlete population is still unknown. The purpose of this study is to investigate the relationship of hip geometric properties derived from advanced hip assessment (AHA) in Lunar iDXA program and BMD of spine (L1-L4) and hip in male athletes.

**Methods:** A total of 1562 male athletes aged 20 to 50y from 28 different sports performed Dual Energy X-ray Absorptiometry (DXA) scan with Lunar iDXA on their spine (L1 to L4) and right hip joint. The DXA machine was calibrated daily and all test and analysis were performed by a certified clinical technologist from International Society of Clinical Densitometry (ISCD). The bone mineral parameters - BMD and Z-score were compared with the AHA parameters - hip strength index (HSI), hip axis length (HAL), cross-sectional moment of inertia (CSMI), cross sectional area (CSA). Athletes were divided into 3 groups based on minimum Z-scores at any site < -2 (G1), -2 through -1 (G2) and > -1 (G3).

**Results:** Mean age, height and weight were 27.0±5.3y, 178.4±9.5cm and 77.2±14.5kg respectively. There was small to medium positive correlation of BMD parameters with HSI, HAL and CSA. CSMI was significantly associated (P<0.001) with high BMD at spine (r=0.64) and neck (r=0.52). HSI, HAL, CSMI and CAS were always higher in G3 compared to G1 and G2 (p<=0.033).

**Conclusions:** These data showed that athletes presenting a strong hip geometric property also displayed a high BMD. The information is important in the determination of bone fragility as the AHA program involves hip geometry analysis that describe the fracture risk in hip joint.

### 101 - Evaluation of Trabecular Micro-Architecture in Non-Osteoporotic Post-Menopausal Women With and Without Fracture

**Richard Kijowski, University of Wisconsin; Michael Tuite, University of Wisconsin; Diane Krueger, University of Wisconsin; Michael Kleerekoper, St. Joseph Mercy Reichert Health Center; Neil Binkley, University of Wisconsin**

**Background:** Microscopic magnetic resonance imaging (µMRI) has been used as a noninvasive method to assess trabecular micro-architecture. Various studies have been shown that µMRI parameters are superior to bone mineral density (BMD) measurements obtained using dual-energy x-ray absorptiometry (DXA) for distinguishing between osteoporotic women with and without fracture.

**Methods:**...
However, no previous study has investigated the ability of µMRI to assess fracture risk in individuals without a DXA-based diagnosis of osteoporosis. Thus, this study was performed to compare µMRI parameters between postmenopausal women with and without fracture who have normal or osteopenic BMD.

**Methods:** The study included 36 post-menopausal Caucasian women 50 years of age and older with normal or osteopenic BMD (T-scores better than -2.5 at the lumbar spine, proximal femur, and one-third radius on DXA). Eighteen women had a history of low-energy fracture, while 18 women had no history of fracture and served as an age, race, and ultra-distal radius BMD-matched control group. DEXA was performed on all women to measure BMD, while a routine blood chemistry panel was obtained to demonstrate absence of systemic conditions indicative of bone disease. A three-dimensional fast large-angle spin-echo sequence with 137 µm x 137 µm x 400 µm resolution was performed through the non-dominant wrist of all women using the same 1.5T scanner. The ultra-high resolution images were used to measure the micro-architecture parameters trabecular bone volume fraction, trabecular thickness, surface-to-curve ratio, and erosion index. Wilcoxon signed rank tests were used to compare differences in demographic variables, laboratory values, BMD measurements, and µMRI parameters between post-menopausal women with and without fracture.

**Results:** There was no significant difference in post-menopausal women with and without fracture in age (p=0.13), height (p=0.60), weight (p=0.68), body mass index (p=0.26), laboratory values (p=0.15-0.99), lumbar spine BMD (p=0.21), proximal femur BMD (p=0.19), one-third radius BMD (p=0.47), and ultra-distal radius BMD (p=0.90). However, post-menopausal women with fracture had significantly lower (p<0.05) trabecular bone volume fraction and surface-to-curve ratio and significantly higher (p<0.05) erosion index than post-menopausal women without fracture. There was no significant difference (p=0.80) between post-menopausal women with and without fracture in trabecular thickness.

**Conclusions:** Post-menopausal women with normal or osteopenic BMD who had a history of low energy fracture had significantly different (p<0.05) µMRI parameters than an age, race, and ultra-distal radius BMD-matched control group of post-menopausal women with no history of fracture. Our study suggests that µMRI can be used to identify individuals without a DXA-based diagnosis of osteoporosis who have impaired trabecular micro-architecture and thus a heretofore-unappreciated elevated fracture risk.

**102 - Correlation between constitution in Chinese medicine and bone stiffness index of calcaneum in Changfeng community of Shanghai**

Zhonghua Liu, Shanghai Changfeng Community Health Service Center; Xia Wu, Shanghai Changfeng Community Health Service Center; Yi Shun Hu, Shanghai Changfeng Community Health Service Center; Ling Shi, Shanghai Changfeng Community Health Service Center

**Aim:** According to the Traditional Chinese Medicine (TCM), there is some relation between occurrence and development of disease and different characteristics of bodily constitution. In this study, the Correlation between constitution in Chinese medicine and health-related bone stiffness index was explored so as to provide reference for traditional Chinese medicine to adjust biased constitution and enhance people’s bone stiffness index.

**Methods:** By using the Constitution in Chinese Medicine Questionnaire (CCMQ), 2,780 residents (including 1,187 men and 1,593 women) were surveyed with cross-section locale investigation from September 2009 to October 2011 with the informed consent. They were all over 45 years old and from the Changfeng Communities in Shanghai of China. The type of constitution in traditional Chinese medicine were evaluated with the Diagnosis standard of constitution classification in Chinese Medicine which published by China Association of Chinese Medicine (CACM). The bone mineral density was examined by SONOST-2000 supersonic bone density instrument to calculate the bone stiffness Index of right calcaneum (SI=0.67*BUA+0.28*SOS-420). And the Correlation between constitutional types and bone stiffness index was analysed with SPSS 11.5 software.

**Results:** The bone stiffness index was higher in males than that in females, and decreased with age increase (F=22.462 P=0.000). The constitutional types were in an order as, from high to low in bone stiffness index, damp-heat, phlegm-dampness, normal, qi stagnation, yin deficiency, special, qi deficiency, yang deficiency and blood stasis constitutions. The differences between constitutions was significant (F=5.776 P=0.000).

**Conclusion:** Constitutional type is one of significant influencing factors for bone stiffness index. Adjusting biased constitution could improve the bone stiffness index and promote the health. Particularly the constitution of Blood-stasis type adjustments should pay more attention.

**103 - Lead Exposure Decreases BMD as Measured by DXA and Micro CT in an in vivo Rat Model**

Catherine Muzytchuk, University of Rochester; Eric Beier, University of Rochester; J Edward Puzas, University of Rochester

**Background:** Lead (Pb) is a commonly occurring heavy metal and continues to be an environmental problem. A number of animal studies and human evaluations have suggested that lead exposure can induce an osteoporotic-like phenotype. However, there has never been a prospective direct test of this hypothesis. In this study we exposed a rodent model to levels of lead that would be found in the environment for their entire lifetime. We
then used DXA technology and micro CT to evaluate the status of their skeleton.

**Methods:** Rat dams were exposed to lead in their drinking water two months prior to conception. The exposure was continued throughout their lactation. The new born rat pups were continued on a lead dosing regimen (50 ppm lead in the drinking water) for over one year. The animals were sacrificed at 18 months and tissues (vertebrae, femur, tibia) collected for DXA and micro CT analysis. DXA bone mineral density (BMD) was measured using the small animal software mode in a GE Lunar Prodigy scanner. Bone volume and trabecular number was also determined on these specimens using a Scanco Viva CT-40 micro CT scanner.

**Results:** At the time of analysis the animals had a blood lead level of 9.16 µg/dl for the lead exposed group and 0.19 µg/dl for the control group. The bone lead levels were 30.9 µg/g and 0.2 µg/g for the exposed and control animals, respectively. These blood and bone values compare well with human levels (CDC safe threshold limit for blood lead levels is 10µg/dl). Our results show statistically significant decreases in BMD and bone quality parameters after a life long exposure to environmentally relevant lead levels (Figure 1). BMD as measured by DXA is decreased by 4.7% in the limbs and by 4.9% in the vertebrae. These results were corroborated with micro CT data indicating a 30% decrease in BV/TV and 23% decrease in Tb Number (Figure 1).

**Conclusion:** The results of our study indicate that lead exposure causes systemic bone loss and a decrease in bone quality in an adult rat model. This effect occurs at lead levels that are considered to be safe by human standards. This study is the first life-long exposure experiment characterizing the effect of environmentally relevant levels of lead on the skeleton of an animal model. Interestingly, in the past, investigators have suggested that heavy metals in bone could interfere with DXA measurements. We noted a smaller percent decrease in the DXA data as compared to the micro CT data. However, we could not attribute this to any artifact in the measurement by the DXA scanner.

**Figure 1:** Left Panel: DXA BMD data from the femur-tibia region of the rat. The white lines identify the region of interest where the measurements were made. Right Panel: Micro CT data of the metaphyseal region of the distal femur. The CT images are of control (H20) and Pb-treated animals.

**104 - BMD, micro-architecture estimation (TBS) and vertebral fracture assessment (VFA) extracted from a single DXA device in combination with clinical risk factors improve significantly the identification of women at high risk of fracture**

**Olivier Lamy, Bone Center Diseases; Marc-Antoine Krieg, Bone diseases Center; Marie Metzger, Bone diseases Center; Berengère Aubry-Roixer, Bone diseases Center; Delphine Stoll, Bone diseases Center; Didier Hans, Bone Diseases Center - Lausanne University Hospital**

**Introduction:** Osteoporosis (OP) is a systemic skeletal disease characterized by a low bone mineral density (BMD) and a micro-architectural (MA) deterioration. Clinical risk factors (CRF) are often used as a MA approximation. MA is yet evaluable in daily practice by the Trabecular Bone Score (TBS) measure. TBS is a novel grey-level texture measurement reflecting bone micro-architecture based on the use of experimental variograms of 2D projection images. TBS is very simple to obtain, by reanalyzing a lumbar DXA-scan. TBS has proven to have diagnosis and prognosis value, partially independent of CRF and BMD. The aim of the OsteoLaus cohort is to combine in daily practice the CRF and the information given by DXA (BMD, TBS and vertebral fracture assessment (VFA)) to better identify women at high fracture risk.

**Method:** The OsteoLaus cohort (1400 women 50 to 80 years living in Lausanne, Switzerland) started in 2010. This study is derived from the cohort COLAUS who started in Lausanne in 2003. The main goals of COLAUS is to obtain information on the epidemiology and genetic determinants of cardiovascular risk in 6700 men and women. CRF for OP, bone ultrasound of the heel, lumbar spine and hip BMD, VFA by DXA and MA evaluation by TBS are recorded in OsteoLaus. Preliminary results are reported.

**Results:** We included 631 women: mean age 67.4±6.7 y, BMI 26.1±4.6, mean lumbar spine BMD 0.943±0.168 (T-score -1.4 SD), TBS 1.271±0.103. As expected, correlation between BMD and site matched TBS is low (r=0.16). Prevalence of VFx grade 2/3, major OP Fx and all OP Fx is 8.4%, 17.0% and 26.0% respectively. Age- and BMI-adjusted ORs (per SD decrease) are 1.8 (1.2-2.5), 1.6 (1.2-2.1), 1.3 (1.1-1.6) for BMD for the different categories of fractures and 2.0 (1.4-3.0), 1.9 (1.4-2.5), 1.4 (1.1-1.7) for TBS respectively. Only 32 to 37% of women with OP Fx have a BMD < -2.5 SD or a TBS <1.200. If we combine a BMD < -2.5 SD or a TBS <1.200, 54 to 60% of women with an osteoporotic Fx are identified.

**Conclusion:** As in the already published studies, these preliminary results confirm the partial independence between BMD and TBS. More importantly, a combination of TBS subsequent to BMD increases significantly the identification of women with prevalent OP Fx which would have been miss-classified by BMD alone. For the first time we are able to have complementary information about fracture (VFA), density (BMD), micro- and macro architecture (TBS & HAS) from a simple, low ionizing
radiation and cheap device: DXA. Such complementary information is very useful for the patient in the daily practice and moreover will likely have an impact on cost effectiveness analysis.

105 – Microdensity of humeral head and clinical implications
Sophie Abrassart, Hospital Universitaire de Genève; Pierre Hoffmeyer, Hospital Universitaire de Genève

Objective: The goal of this study is to analyze human humeri, and characterize trabecular parameters. One parameter of interest is the volume fraction of bone through the humeral head. Other parameters are trabecular number, trabecular thickness and trabecular spacing. Another important parameter is the trabecular orientation.

Material and Methods: 15 fresh humeral heads were collected mostly from women 10/5 (mean age 75). Each bone dissected free of all soft tissue. Bones with arthritis, previous surgery and rotator cuff diseases were excluded. High-resolution micro-CT imaging (µCT 40, Scanco Medical), was used to evaluate each specimen Cortical shell was excluded first. Subvolume of the original image was determined as 4 parts outlining of the contour of cancellous bone an cortical bone was done manually. The analysis of each ROI represented a volume of 900 cubic microns. Measurements made included bone volume fraction (BV/TV), architectural parameters [trabecular thickness (Tb.Th), number (Tb.N) separation (Tb.Sp)].

Results: Many potential factors can affect the stability of the component, including the bone quality. Shoulder arthroplasty offers good results in terms of pain relief, motion, and level of activity, even in osteoarthritis. However, loosening prosthesis and fractures regarding screws and plates component ruptures, are continued areas of concern Micro-CT provides a quantifiable analysis of the cancellous bone and cortical bone. The f study had showed the higher density in the cephalic area. The lesser tuberosity has a higher density than greater tuberosity. There’s much more trabeculae in cephalic area. The thickness of trabeculae are all the same. There’s a lot of space between trabeculae in centre and greater tuberosity.

<table>
<thead>
<tr>
<th>Humeral head</th>
<th>BV/TV mm³</th>
<th>TB nb1/ mm</th>
<th>TB th mm</th>
<th>TB sp mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articular area</td>
<td>0.3</td>
<td>1.4</td>
<td>0.3</td>
<td>0.9</td>
</tr>
<tr>
<td>Center</td>
<td>0.1</td>
<td>0.6</td>
<td>0.3</td>
<td>1.7</td>
</tr>
<tr>
<td>Lesser Tuberosity</td>
<td>0.2</td>
<td>1</td>
<td>0.3</td>
<td>1</td>
</tr>
<tr>
<td>Greater tuberosity</td>
<td>0.1</td>
<td>0.6</td>
<td>0.3</td>
<td>1.7</td>
</tr>
</tbody>
</table>

Conclusions: The fragility of the greater tuberosity may explain some failure of rotator cuff suture. The poor bone quality in the cephalic area may be a factor of screws cut-off. These ones have to be long, oriented in the posterior and anterior areas and with the extremities in the subchondral bone. Plates osteosynthesis failure could be improved by the multi direction screws in the trabeculae in the external part of humeral head. On the other way, this bone densitometry study explains the cartography of humeral head fractures. These informations could equally improve material positioning and material design decreasing surgical complications.

Central Measurements: Bone Density and Other

106 - Could BMD Reflect the Real Change in Human Bone Mineral?
Sung Hwa Seo, Department of Biomedical Sciences, Kyungpook National University; Hyung Tae So, Department of Orthopaedic surgery, Kyungpook National University; Hyemi Jeong, Department of Statistics, Kyungpook Nation University; Sang ho Cheon, Department of Orthopaedic Surgery, Kyungpook National University; Il Hyung Park, Professor of Orthopaedic surgery, Kyungpook National University, Korea

Background: Bone mineral density (BMD) is an important index in diagnosing osteoporosis and other metabolic bone diseases, predicting fractures, and monitoring treatment. Dual-energy X-ray absorptiometry (DXA) is most widely used technique for assessments of BMD and considered as the gold standard for the minimum exposure to radiation, low cost, high reproducibility, and ease of use. Author performed an experimental study to determine the relationship between the change in BMD measured by DXA and real change in mineral of human long bone.

Material and Method: A pair of humeri and femora from one male cadaver was cut into specimen about half in length. Three specimens from a pair of humerus and 4 specimens from a pair of femur were immersed into 1N HCl from 10 minutes to maximum 70 minutes with 10 minutes’ interval for different level of demineralization. All 7 specimens were checked with BMD using by DXA (GE-Lunar Prodigy) and analysed respectively. The amount of calcium and phosphorus both from demineralized and normal area were measured and expressed in percentage of demineralization.

Result: As demineralization was going on with time of immersion into HCl, there was statistically significant correlation between the change of BMD and real change of calcium amount (r=0.65) in humerus, and also in femur (r=0.63). There was statistically significant correlation only in femur between BMD and phosphorus (r=0.77), and not
in humerus (?=0.42). In summary, there was a high linear regression between BMD and real bone mineral with minimum of 89% and maximum of 97% as coefficient of determination (R-Square; R²) (p<0.05). Through correlation analysis, correlation coefficient (?) between BMD measured by DXA and mineral of human long bone showed a high correlation as maximum of 0.84(p<0.05).

**Conclusion:** Our study showed a statistically significant high relationship between BMD measured by DXA and mineral of human long bone. Therefore, the measurement of DXA is considered to reflect the real change of mineral in human long bone as well as that of BMD. The limitation of this study was that it was based on artificially induced demineralization only one pair of cadaveric humerus and femur so that vertebrae were excluded.

### 107 - A Case of Abnormal DXA and Spontaneous Fractures: Primary Osteoporosis?

**Sara Puening, MS3, Wright State University, Dayton, OH; Susan Williams, Cleveland Clinic**

**Introduction:** An abnormal DXA can be indicative of bone problems other than osteoporosis. Recognizing abnormal results at specific anatomical sites can help guide the clinician in making an accurate diagnosis.

**Case:** M.Y. is a 78-year-old Caucasian female who was referred to the Bone Clinic by her PCP due to abnormal DXA, multiple fractures and chronic bone pain. Her history is significant for five ‘fragility’ fractures within the past five years, loss of three inches of height, lifelong low calcium intake, and weight of less than 127 pounds. The patient denied a history of renal stones, headaches, or psychiatric disturbances on her initial visit, but later reported feelings of “brain fog” on follow up. She is a lifelong nonsmoker and has no history of taking anticonvulsants, steroids, antiestrogen drugs or antiresorptive (bone) medications. The physical exam was notable for diffuse back pain, point tenderness of the left hip, kyphosis, and proximal weakness. Blood tests showed elevated alkaline phosphatase 246 U/L (40-150 U/L) and elevated parathyroid hormone 112 pg/mL (10-60 pg/mL) with normal calcium 10.1 mg/dL (8.5-10.5 mg/dL) and vitamin D 40.6 ng/mL (31.0-80.0 ng/mL). Imaging revealed diffuse osteopenia and multiple osteoporotic fractures of the pelvis and femur. DXA revealed abnormal T- and Z-scores, the lowest of which was in the distal third of the radius. A Tc-99m sestamibi scan of the neck and chest was subsequently ordered but failed to reveal parathyroid adenoma or ectopic parathyroid tissue.

**Discussion:** At first, our patient’s low BMD, history of fractures, and post-menopausal state appeared to indicate a diagnosis of osteoporosis, but a closer look at DXA imaging showed that a metabolic disorder was more likely the cause of her bone disease. Her DXA scan revealed an overall decrease in T and Z scores, but the scores were worst in the distal third of the left radius, a site that is predominantly cortical bone. This is an important finding in differentiating post-menopausal bone disease from hyperparathyroidism. Elevated PTH has a catabolic effect on cortical bone and was evident in our patient whose bone density was lowest at the distal third of the radius. Our patient does not currently meet criteria for parathyroid surgery. Non-surgical management of her metabolic bone disease includes optimizing calcium and Vitamin D, physical therapy, annual zolendronic acid, and repeat labs every six months.

**Conclusion:** Not all abnormal DXA results are due to osteoporosis. When interpreting a DXA scan it is important to not only look at the severity of the T and Z scores but to also compare the scores between measured regions of interest. In our patient, the T-scores were significantly abnormal, painting a picture of severe osteoporosis to the untrained observer. Recognizing that the distal radius was most severely affected gave us the clue we needed to look further for the correct diagnosis.

<table>
<thead>
<tr>
<th>Region</th>
<th>BMD (g/cm²)</th>
<th>T-Score</th>
<th>Z-Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lumbar Spine</td>
<td>0.782</td>
<td>-3.3</td>
<td>-1.2</td>
</tr>
<tr>
<td>L1-L4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right Femoral</td>
<td>0.507</td>
<td>-3.8</td>
<td>-1.5</td>
</tr>
<tr>
<td>Neck</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right Total Hip:</td>
<td>0.442</td>
<td>-4.5</td>
<td>-2.4</td>
</tr>
<tr>
<td>Left Femoral</td>
<td>0.504</td>
<td>-3.8</td>
<td>-1.6</td>
</tr>
<tr>
<td>Neck</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left Total Hip:</td>
<td>0.481</td>
<td>-4.2</td>
<td>-2.0</td>
</tr>
<tr>
<td>Left Forearm</td>
<td>0.411</td>
<td>-5.4</td>
<td>-2.8</td>
</tr>
<tr>
<td>Distal 1/3 Radius</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### 108 - Artifacts and pitfalls in DXA scan images and interpretation

**Violeta Boinca, Lecturer Sf. Maria Hospital, Bucharest, Romania; Daniela Opris, Sf. Maria Hospital; Mihai Bojinca, Ion Cantacuzino Hospital**

**Background:** Osteoporosis is an important health problem due to known consequences of various types of fractures(suffering, back pain, deformity, immobilization, poor quality of life, premature death etc). Bone densitometry remains the gold standard for the diagnosis of osteoporosis, prognosis (fracture risk assessment) and monitoring of the disease. Densitometric measurements need appropriate technique and analysis for accurate results with minimal errors and avoidance of pitfalls.

**Objectives:** The analysis of the DXA-determination database in the department of Internal Medicine and Rheumatology of “Sfanta Maria” Hospital, Bucharest, Romania.

**Methods:** We reviewed the DXA-scans performed between 2007-2011 at “Sfanta Maria” Hospital. Measurements were obtained using a central DXA Lexxos scanner with a pyramidal beam. Measurements were made at the lumbar spine and both hips, where possible. Results: We searched for bad positioning (tilted spine, improper rotation of the leg, angled femoral shaft),
common artifacts (spinal degenerative disease, osteoarthritis of the hip), vertebral compression fractures, metal devices – surgical clips. Other internal artifacts found were aortic calcification, gastrointestinal contrast, gallstones, renal stones, laminectomy defects, Paget’s disease, obesity and fat panniculus. External artifacts consisted of zippers, bra clips and buttons. Discussion and Conclusions: For a correct evaluation of bone mineral density and for the reproducibility follow-up scans we need consistent patient positioning, consistent scan analysis and exclusion of artifacts.

109 - Cross calibration of bone mineral density values among three dual energy x-ray absorptiometry systems

Sasithorn Amnuaywattakorn, Faculty of Graduate Studies, Mahidol University; Sasivimol Promma, Ramathibodi Hospital, Mahidol University; Kanungnij Thammirat, Nuclear Medicine Unit; Chiraporn Tocharoenchai, Faculty of Medical Technology, Mahidol University; Chanika Sritara, Ramathibodi Hospital, Mahidol University

Introduction: Monitoring BMD with different DXA systems is sometimes unavoidable. The manufacturer may provide a cross-calibration equation to convert BMD from one system to another. However, ISCD recommends the use of Generalize Least Significant Change (GLSC), 95% confidence interval of precision error between the two DXA systems.

Aims: To generate the GLSC values among three DXA machines (Lunar Prodigy, Hologic Discovery A and Hologic Discovery W) and to compare these values with the errors from the cross-calibration equations provided by the manufacturer.

Methods: The IRB approved the study protocol. The patients sent for BMD measurement who signed a consent form underwent BMD measurement at Nuclear Medicine Unit, Faculty of Medicine Ramathibodi Hospital, Bangkok, Thailand were included. The measurement was performed on the same day with all 3 DXA machines at L1-L4 vertebrae, femoral neck, and total hip. Each measurement was performed twice with repositioning in between. The analysis was performed with the ISCD cross-calibration calculating tool. Using the manufacturer’s cross-calibration equation provided by Hologic, the predicted BMD values at each site were calculated.

Results: Thirty female patients with mean ± s.d. of age, weight and height of 55.2 ± 8.6 years, 59.6 ± 8.5 kg and 152.8 ± 6.1 cm, respectively. The GLSCs for L1-L4 vertebrae, femoral neck, and total hip were 0.020 - 0.088 (Table 1). Most of the measurement sites had moderate to high percentages of patients with prediction errors less than the site-specific GLSC values (Table 2), suggesting that the predictions were reasonable. However, only 23% of the patients had their predicted L1-L4 BMD errors less than the site-specific BMD due to relatively small GLSC at this site.

Conclusions: The GLSC values among three DXA machines were presented. These values were greater than the conversion errors from the manufacturer’s equations. The results suggest that, if performing a cross-calibration study is not at all possible, the conversion equations may still provide some useful information for patient monitoring.

Table 1: GLSCs for L1-L4 vertebrae, femoral neck, and total hip among 3 DXA machines

<table>
<thead>
<tr>
<th>GLSC (g/cm^2)</th>
<th>L1-L4</th>
<th>Femoral neck</th>
<th>Total hip</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hologic Discovery A vs. Lunar Prodigy</td>
<td>0.066</td>
<td>0.088</td>
<td>0.066</td>
</tr>
<tr>
<td>Hologic Discovery W vs. Lunar Prodigy</td>
<td>0.064</td>
<td>0.076</td>
<td>0.070</td>
</tr>
<tr>
<td>Hologic Discovery W vs. Hologic Discovery A</td>
<td>0.020</td>
<td>0.074</td>
<td>0.062</td>
</tr>
</tbody>
</table>

Table 2: Prediction errors % Patient with prediction error <

<table>
<thead>
<tr>
<th>Prediction errors</th>
<th>95% CI (g/cm^2)</th>
<th>GLSC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hologic Discovery A BMD predicted from Lunar Prodigy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1-L4</td>
<td>-0.025 - (-0.006)</td>
<td>96.7</td>
</tr>
<tr>
<td>Femoral neck</td>
<td>-0.003 - 0.027</td>
<td>93.3</td>
</tr>
<tr>
<td>Total hip</td>
<td>-0.048 - (-0.025)</td>
<td>76.7</td>
</tr>
<tr>
<td>Hologic Discovery W BMD predicted from Lunar Prodigy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1-L4</td>
<td>-0.055 - (-0.035)</td>
<td>83.3</td>
</tr>
<tr>
<td>Femoral neck</td>
<td>-0.002 - 0.024</td>
<td>96.7</td>
</tr>
<tr>
<td>Total hip</td>
<td>-0.036 - (-0.013)</td>
<td>90.0</td>
</tr>
<tr>
<td>Hologic Discovery W BMD predicted from Hologic Discovery A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1-L4</td>
<td>-0.035 - (-0.023)</td>
<td>23.3</td>
</tr>
<tr>
<td>Femoral neck</td>
<td>-0.011 - 0.009</td>
<td>96.7</td>
</tr>
<tr>
<td>Total hip</td>
<td>-0.001 - (-0.023)</td>
<td>96.7</td>
</tr>
</tbody>
</table>

110 - Cross-calibration of bone mineral density values among three dual energy x-ray absorptiometry systems: Comparison between center-derived and manufacturer's equations

Sasithorn Amnuaywattakorn, Faculty of Graduate Studies (Medical Physics), Mahidol University; Suchawadee Musikarat, Ramathibodi Hospital, Mahidol University; Sasivimol Promma, Ramathibodi Hospital, Mahidol University; Chirawut Utamakul, Ramathibodi Hospital, Mahidol University; Chiraporn Tocharoenchai, Faculty of Medical Technology, Mahidol University; Chanika Sritara, Ramathibodi Hospital, Mahidol University

Introduction: When the replacement of the old DXA system with a new one is unplanned as in the case of the system with a new one is unplanned as in the case of
irreparable of the old system, Generalized Least Significant Change (GLSC) cannot be obtained because it requires that the duplicate or triplicate BMD monitoring with the old system. BMD monitoring may have to rely on a cross-calibration equation, which is provided by the manufacturer.

**Aims:** The aims were to derive cross-calibration equations among three DXA machines (Lunar Prodigy, Hologic Discovery A and Hologic Discovery W) and to compare the BMD prediction errors from these equations with those from the manufacturer.

**Methods:** The study protocol was approved by the IRB. The female patients sent for BMD measurement were invited. Thirty patients who gave written informed consent underwent BMD measurements using all 3 DXA machines at L1-L4 vertebrae, femoral neck, and total hip on the same day. Each measurement was performed twice with in-between repositioning. Cross-calibration equations were derived using linear regression analysis. The predicted BMDs were calculated from both our and manufacturer’s equations and the difference between the observed and the predicted BMDs were compared using pair t-test.

**Results:** The means ± SDs of the 30 female patients’ age, weight and height were 55.2±8.6 years, 59.6±8.5 kg and 152.8±6.1 cm, respectively. As shown in Table 1, the derived cross-calibration equations were fitted the BMD data relatively well (R² 0.89-1.0). Table 1. Cross-calibration equations for L1-L4 vertebrae, femoral neck, and total hip among 3 DXA machines. The differences between the predicted and the observed BMD (Table 2) were statistically significant at L1-L4 vertebrae and total hip (p<.05), where the manufacturer’s equations tended to overestimate the BMD more than ours. Table 2. Difference between observed and predicted BMD.

**Conclusions:** Our cross-calibration equations fit the BMD data relatively well and appear to be better as a means for BMD monitoring than those provided by the manufacturer.

**Table 1.** Cross-calibration equations for L1-L4 vertebrae, femoral neck, and total hip among 3 DXA machines

<table>
<thead>
<tr>
<th></th>
<th>Lunar Prodigy vs. Hologic Discovery A</th>
<th>Hologic Discovery W vs. Hologic Discovery A</th>
<th>Hologic Discovery A vs. Hologic Discovery W</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1-L4</td>
<td>Hologic Discovery A = -0.008 + (0.875 x Lunar Prodigy)</td>
<td>Hologic Discovery W = -0.029 + (1 x Hologic Discovery A)</td>
<td>Hologic Discovery W = -0.029 + (1 x Hologic Discovery A)</td>
</tr>
<tr>
<td>Femoral neck</td>
<td>Hologic Discovery A = -0.018 + (0.848 x Lunar Prodigy)</td>
<td>Hologic Discovery W = 0.003 + (1.003 x Hologic Discovery A)</td>
<td>Hologic Discovery W = 0.003 + (1.003 x Hologic Discovery A)</td>
</tr>
<tr>
<td>Total hip</td>
<td>Hologic Discovery A = 0.043 + (0.848 x Lunar Prodigy)</td>
<td>Hologic Discovery W = -0.057 + (1.086 x Hologic Discovery A)</td>
<td>Hologic Discovery W = -0.057 + (1.086 x Hologic Discovery A)</td>
</tr>
</tbody>
</table>

**Table 2.** Difference between observed and predicted BMD

<table>
<thead>
<tr>
<th></th>
<th>Ours</th>
<th>Manufacturer’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predict Hologic Discovery A BMD from Lunar Prodigy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1-L4</td>
<td>-0.010 - 0.008</td>
<td>-0.025 - (-0.006)*</td>
</tr>
<tr>
<td>Femoral neck</td>
<td>-0.011 - 0.019</td>
<td>-0.003 - 0.027</td>
</tr>
<tr>
<td>Total hip</td>
<td>-0.012 - 0.008</td>
<td>-0.048 - (-0.025)*</td>
</tr>
<tr>
<td>Predict Hologic Discovery W BMD from Lunar Prodigy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1-L4</td>
<td>-0.010 - 0.009</td>
<td>-0.055 - (-0.035)*</td>
</tr>
<tr>
<td>Femoral neck</td>
<td>-0.015 - 0.010</td>
<td>-0.002 - 0.024</td>
</tr>
<tr>
<td>Total hip</td>
<td>-0.015 - 0.007</td>
<td>-0.036 - (-0.013)*</td>
</tr>
<tr>
<td>Predict Hologic Discovery W BMD from Hologic Discovery A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L1-L4</td>
<td>-0.006 - 0.006</td>
<td>-0.035 - (-0.023)*</td>
</tr>
<tr>
<td>Femoral neck</td>
<td>-0.017 - 0.004</td>
<td>-0.011 - 0.009</td>
</tr>
<tr>
<td>Total hip</td>
<td>-0.013 - 0.008</td>
<td>-0.001 - (-0.023)</td>
</tr>
</tbody>
</table>

*, P value <0.05
111 - Association of Bone Mineral Density and Pelvic Floor Symptoms in Women Presenting for Bone Mineral Density Evaluation

Sarah Morgan, The University of Alabama at Birmingham; Jonathan Gleason, The University of Alabama at Birmingham; Ligong Chen, The University of Alabama at Birmingham; Kathryn Burgio, The University of Alabama at Birmingham; Patricia Goode, The University of Alabama at Birmingham; Alice Howell, The University of Alabama at Birmingham; Holly Richter, The University of Alabama at Birmingham.

BACKGROUND: Low bone mineral density (BMD) reflects deficits in bone connective tissue qualities including mass, matrix and microarchitectural abnormalities. Connective tissue and other extracellular matrix abnormalities are also associated with the development of pelvic floor disorders including incontinence and pelvic organ prolapse in women. Pelvic floor symptoms were characterized in postmenopausal women presenting for dual-energy x-ray absorptiometry scans.

METHODS: Validated pelvic floor symptom questionnaires were mailed to patients in an IRB-approved osteoporosis database (January, 2007-October, 2010). Questions assessed urinary incontinence (UI) in the past 3 months, UI frequency and severity, incontinence of liquid/solid stool over the past month, and bothersome prolapse symptoms. Multivariable logistic regression models controlling for age, race, body mass index, and COPD were performed to compare symptoms in women with osteopenia (T-score: < -1, referent) and osteoporosis at any site (T-score: < -2.5) and osteoporosis at any site (T-score: < -2.5) to women with normal BMD (T-score: > -1, referent).

RESULTS: 1774/4026 (44%) questionnaires were returned. 1655 postmenopausal women with BMD diagnoses were included in the analyses (423 normal BMD, 870 osteopenia, 362 osteoporosis). Mean (±SD) age was 63(±9) years. Overall prevalence of UI was 1226 (75%) with UI frequency >2.3 times/week in 699 (58%), fecal incontinence in 247 (16%), and bothersome prolapse symptoms in 162 (10%). Prevalence of prolapse symptoms did not differ by BMD group (p=0.87). Multivariable analyses revealed that women with osteoporosis had increased risk of incontinence of solid stool (OR: 1.8, 95% CI: 1.2-2.8) as compared to women with normal BMD. Risk of UI >2.3 times/week was not increased in women with osteoporosis (OR: 0.9, 95% CI: 0.6, 1.3) and was lower in women with osteopenia (OR: 0.7, 95% CI: 0.5-0.9).

CONCLUSIONS: In a cohort of women undergoing BMD evaluation, those with osteoporosis were at increased risk of solid stool incontinence, but not UI. Women with osteoporosis and very low T-scores were at increased risk of moderate/large volume UI. Further studies should target the evaluation of connective tissue markers and pathological mechanisms linking low BMD and pelvic floor symptoms. Grant Support: Protective Life Clinical Initiative award program through the UAB School of Medicine.

112 - Race- and sex-specific whole body reference data for GE-Lunar DXA scanner

Bo Fan, UCSF; John Shepherd, UCSF; Michael Levine, Children’s Hospital of Philadelphia and University of Pennsylvania; Xing Ping Wu, University of Zhong Nan

Background: The National Health and Nutrition Examination Survey (NHANES 1999-2004) includes adult and pediatric comparisons for total body bone and body composition results. Because DXA measures from different manufacturers are not standardized, NHANES reference values are only currently applicable to a single make and model of Hologic DXA system. The purpose of this study was to derive body composition reference curves for GE Healthcare Lunar DXA systems.

Methods: Published values from the NHANES 1999-2004 survey were acquired from the CDC website. Using previously reported cross-calibration equations between Hologic and Lunar, the total body and regional bone and soft tissue measurements from NHANES 1999-2004 were converted to Lunar values. The LMS (LmsChartMaker Pro Version 3.5) curve fitting method was used to generate Lunar reference curves. Separate curves were generated for each gender and ethnicity. The reference curves were also divided into pediatric (<20 years old) and adult (>20 years old) groups. Adult reference curves were derived as a function of age. Additional relationships of pediatric DXA values were derived as a function of height, lean mass, and bone area. Robustness was tested between Hologic and Lunar Z-score values.

Results: The NHANES 1999-2004 survey included a sample of 19,900 subjects (9662 female). 7128 subjects were less than 20 years old and were included in the pediatric reference data set. Subjects enrolled in the study who weighed more than 136 kg (over scanner table limit) were excluded. The average Z-Scores comparing the new Lunar reference curves are close to zero and the standard deviation of the Z-Scores are close to one for all variables. As expected, all measurements on the Lunar reference curves for subjects less than 20 years old increase monotonically with age. In the adult population, most of the curves are constant at younger age and drop moderately as age increases.

Conclusions: We have presented NHANES reference curves for applicable to DXA whole body scans acquired on GE Healthcare Lunar systems by age, sex and ethnicity. Users of GE Healthcare Lunar DXA systems can now benefit from the large body composition reference data set collected in the NHANES 1999-2004 study.

Other Density and Morphometric Measurements:

Contemporary Management of Skeletal Health: Partnering to Image, Diagnose & Treat
Los Angeles, CA USA
Body Composition, Vertebral Fracture Analysis, Other

113 – Bone Density and Body Composition in healthy Greek Women: A comparison with the Standard Database NHANES
Stavroura Theodorou, UHI; Daphne Theodorou, GHI; John Kalef-Ezra, UHI; Andreas Fotopoulos, UHI; Anastasios Korobilas, UHI; Agathoklis Tsatsoulis, UHI; Epaminondas Tsianos, ; Konstantinos Tsampoulas, UHI

Background: The use and correct interpretation of bone densitometry data relies on the availability of appropriate reference data. In most cases, manufacturer-specific reference data are used; however, locally derived data that are sex- and ethnicity-specific should be used, instead.

Methods: Bone mineral density (BMD) and body composition of total body and subregions were measured in 300 Caucasian Greek, healthy women aged 20-85 years using a Hologic QDR Discovery W DXA scanner. Reference values for BMD and body composition were determined and age-related changes were analyzed. These data were then compared with data from the National Health and Nutrition Examination Survey (NHANES) database.

Results: The peak BMD and bone mineral content (BMC) was 1.114 g/cm2 and 2178 g respectively in the total body and was achieved at 37-39 and 33-36 years, respectively. In the NHANES database corresponding values were 1.122 g/cm2 (p= 0.5) and 2198 g (p= 0.6) and were achieved at 40-44 years. The peak %fat in the total body and the peak ratios %fat trunk to %fat legs and fat trunk to fat limbs were 41.8%, 1.6, and 1.1 and were all achieved at 61-70 years. Accordingly, the NHANES values were 43% (p= 0.17), 0.906 (p= 0), and 1.011 (p= 0.001) and were achieved at 65-70 years. The peak ratio lean to height2 in the total body was 18.29 kg/m2 at 61-70 years, whereas in the NHANES the peak was 16.36 kg/m2 (p= 0.000) at 45-49 years.

Conclusions: An ethnicity-specific reference database for total body measures in 20-85-year-old Caucasian Greek women for the Hologic Discovery W DXA scanner using software V.12.3 is presented. The reference values for the peak BMD and BMC in the total body derived from the adult female population in Greece were very similar to those recorded in the NHANES. Although there was no accountable difference in the percentage of fat in the total body between women in Greece and women in the NHANES, there was statistically significant difference in the distribution of fat in the body. Reference values for lean mass divided by height2 were higher in Greek women than in the NHANES. To our knowledge these are the first Greek reference data with regards to total body measures. These data are intended to assist clinicians in the interpretation and monitoring of bone densitometry results in Greek women. Without appropriate reference data, the clinical care of patients with bone diseases and/or altered body composition can be inadequate, and may lead to suboptimal management.

114 – Bone Scintigraphy vs Conventional Radiography in Early Diagnosis of Compressive Vertebral Fractures in Osteoporosis
Sanja Dugonjic, Nuclear medicine specialist, Military Medical Academy; Boris Ajdinovic, professor, Military Medical Academy, Belgrade, Serbia; Milan Cirkovic, Rheumatologist; Gorica Ristic, Rheumatologist

Most difficult and very frequent complications of osteoporosis are compressive vertebral fractures. Bone scintigraphy with Tc99m-phosphonates enable early detection of compressive vertebral fracture in first 72 hours of occurring. Typical scintigraphic finding of vertebral compressive fracture is markedly increased radiotracer uptake in the linear pattern, throughout of collapsed vertebral body. Bone scintigraphy is useful in follow up of vertebral fracture healing, showing reduction of radiotracer uptake in fractured vertebra.

Aim: In patients with osteoporosis and suspicion of compressive vertebral fracture to detect compressive vertebral fracture by bone scintigraphy and compare it with conventional radiography findings.

Patients and Methods: Bone scintigraphy was done in 40 patients with osteoporosis and suspicion of compressive vertebral fracture, 32 women and 8 men, mean age, 71 year. Three hours after iv. injection of 740 MBq of Tc99m-DPD to patient, whole body scintigraphy was done.

Results: Radiography finding was positive for compressive vertebral fracture in 28 patients (70%). In 36 patients (90%) scintigraphy diagnosed compressive fracture of one or more vertebrae. In three patients bone scintigraphy diagnosed bone metastasis. In one patient with positive radiographic finding for compressive fracture, scintigraphy was negative, with no intensive uptake in vertebra. This showed that this compressive vertebral fracture was healed.

Conclusion: Bone scintigraphy is diagnostic method with very high sensitivity for detection of compressive fractures in osteoporosis. Conventional radiography showed lower sensitivity and couldn’t distinct recent from old vertebral fracture. Bone scintigraphy have to be used in early diagnosis and in follow up of compressive vertebral fracture healing.
115 - Distal Femur DXA Measurements in Healthy Controls and Patient Populations: Preliminary Data

Jay Shapiro, Kennedy Krieger Institute; Cristina Sadowsky, Kennedy Krieger Institute; Feng-Shu Brennen, Kennedy Krieger Institute

Background: Conventional DXA scans record bone mineral density at the lumbar spine, total hip, femur neck and radius. Total hip and femur neck are clinically used to assess fracture risk. However, in patients who are non-weight bearing (spinal cord injury (SCI) and cerebral palsy (CP)), 80% of fractures occur at the distal femur, frequently with minimal trauma. SCI and CP patients and those with Osteogenesis imperfecta (OI) are at high fracture risk. Studies by Henderson and Hartke (1998) suggest that DXA bone density measurements at the distal femur may be more reliable indicators of the extent bone demineralization and fracture risk compared to conventional measurements. Although BMD data at the distal femur have been reported for children (Zemel, 2009), there is no comparable adult data. We hypothesize that the distal femur is: a) more sensitive than femur neck in reflecting BMD status, and b) is more reflective of bone loss with age and non-weight bearing status than is the femur neck.

Methods: We employed the reported scan procedure for measuring distal femur BMD developed by Henderson and Hartke (1998). The distal femur is divided into three zones (R1, R-2, R-3) of which R-1, largely trabecular bone, is the most distal region abutting the growth plate. Proximally, the R-2 and R-3 zones contain an increasing amount of cortical bone. Four groups, ages 18-65 years were studied: healthy individuals (n=35; M=18, F=17), individuals with SCI (n=29; M=18, F=11), CP (n=16; M=8, F=8) and OI (n=35; M=17, F=18).

Results: In four groups, mean distal femur R-3 site BMD was higher than mean distal femur R-2 site BMD due to the presence of more cortical bone, which in turn, was higher than mean distal femur R-1 BMD (Data not shown). Each patient group has lower distal femur BMD at the R-1 site when compared to control (p< 0.05). Within the control group for R1, females on average have a BMD 0.174 less than males, and this difference is statistically significant. Female and Male ages are comparable. For males at R1 site, the OI group on average has a BMD 0.56 less than the control group and this difference is statistically significant. CP and SCI R-1 BMD values were significantly lower than control values. The ratio of femur neck (FN) BMD to R-1 site BMD in the control and the 3 grouped -patient populations was examined. The FN/R-1 ratio is increased in patient groups compared to control (p< 0.05) suggesting a relative decrease in R-1 BMD values compared to FN. Changes in distal femur BMD as related to age is not shown.

Conclusions: This preliminary data with a small number of observations suggests that the R-1 distal femur site may be a more sensitive index of bone mineralization when compared to femur neck BMD.

Table 1 lists the grouped populations studied (including males and females and grouped OI types), and the mean ±SD values for BMD at the distal femur R-1 site and the femur neck (FN).

<table>
<thead>
<tr>
<th>Population</th>
<th>N (R1)</th>
<th>BMD g/cm² Mean±SD (R1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>34</td>
<td>1.06±0.18</td>
</tr>
<tr>
<td>OI</td>
<td>31</td>
<td>0.61±0.18</td>
</tr>
<tr>
<td>SCI</td>
<td>28</td>
<td>0.66±0.19</td>
</tr>
<tr>
<td>CP</td>
<td>16</td>
<td>0.58±0.21</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Population</th>
<th>N (FN)</th>
<th>BMD g/cm² Mean±SD (FN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>34</td>
<td>1.27±0.19</td>
</tr>
<tr>
<td>OI</td>
<td>31</td>
<td>0.86±0.25</td>
</tr>
<tr>
<td>SCI</td>
<td>28</td>
<td>0.97±0.19</td>
</tr>
<tr>
<td>CP</td>
<td>16</td>
<td>0.80±0.18</td>
</tr>
</tbody>
</table>
116 - Total body DXA scanning in a study of Sarcopenia, Disability and Fracture risk in a cohort of inflammatory arthritis patients attending the North-West Rheumatology unit-Ireland.

Sharon Cowley, Sligo General Hospital, Sligo, Ireland; John Doherty, Sligo General Hospital, Sligo, Ireland; Mohamed Ahmed, Sligo General Hospital, Sligo, Ireland; Mohamed Hussein, Our Lady’s Hospital, Manorhamilton Co. Leitrim; Aoife McPartland, Our Lady’s Hospital, Manorhamilton Co. Leitrim; Bryan Whelan, Our Lady’s Hospital, Manorhamilton Co. Leitrim; Carmel Silke, Our Lady’s Hospital, Manorhamilton Co. Leitrim

Background: Sarcopenia is defined as a progressive and generalised loss of skeletal muscle and strength either age or disease activity related or both. The aim of this study was to assess sarcopenia in inflammatory arthritis (IA) by whole body DXA studies and measurement of muscle function and strength.

Materials and Methods: Patients attending the North Western Rheumatology Unit were invited to participate in a study consisting of total body composition analysis via DXA scanning (GE Lunar Prodigy®), muscle function and quality of life assessment. Sarcopenia was quantified as appendicular skeletal mass divided by height squared (ASM/H²) and considered present if the figure was two standard deviations below the mean for a population of young adults as based on the Rosetta study.2 Upper limb grip strength was measured using a hand held dynamometer and muscle function was assessed with the ‘Get Up and Go Test’, based on the American protocol.

Results: 44 subjects were studied (24 inflammatory arthritis patients and 20 controls). There were no significant differences between patients and control group means concerning age, gender, weight, height and BMI. The mean age of the study group was 65.21 (±10.75) years and the mean of the control group was 61.95(±11.06) years. 20% of patients in the IA group had Sarcopenia compared to none of the controls. Muscle function was also considerably reduced in those with IA. The mean maximum dominant arm grip strength for IA patients was 7.96kg while the mean for the controls was 11.45kg (p=0.002). Health Assessment Questionnaire score (a measure of quality of life) was much lower in the IA group and reduced ASM/H² and grip strength correlate to a reduced HAQ score; (p=0.006 and 0.001). 20.8% of the IA patients had a previous fracture compared to 5% of the control group (p=0.001) despite there being no significant difference in bone mineral density (BMD) between the groups. The mean FRAX® major osteoporotic fracture risk for the IA group was 16.1 compared to 7.28 for the control group (p= 0.004). There were no differences in mean Vitamin D levels (40.05, 43.5) in the IA vs. control groups.

Conclusions: Sarcopenia is more prevalent in inflammatory arthritis patients and is associated with reduced muscle strength and quality of life in these patients. Patients with IA have an increased incidence of fractures compared to healthy individuals despite similar bone mineral density profile.

117 - There is awareness for those people having a normal body mass index by DXA

Yi-Shi Hwu, Central Taiwan University of Science and Technology, Taiwan; Li-Feng Lin, Central Taiwan University of Science and Technology, Taiwan, R.O.C.; Asphodel Yang, Central Taiwan University of Science and Technology, Taiwan, R.O.C.

The predictive power of waist circumference and body compositions measured from dual energy X-ray absorptiometry (DXA) for identifying the risk of metabolic syndrome in Taiwanese. BMI, WC and percent fat, measured by DXA, were evaluated in 102 healthy Taiwanese men (21) and women (81) [age, 38.5 ± 18.8 (SD) years; BMI, 22.4 ± 3.5 kg/m²]. 39 females (39/82) and 6 males (6/21) with a normal body mass index (BMI 18.5-24) had an increased percent body fat (BF%). 12 females (12/39) and 1 male (1/6) of those people having a normal BMI also had an increased waist circumference (greater than 35 inches in men and 31 inches in women). All the obese subjects (4 males and 6 females) (BMI 27-32) and most overweight females (10/14) (BMI 24-27) both had an enhanced BF% and WC. The combination of DXA-derived body component measures and waist circumference might be suitable for clinical application in identifying the metabolic syndrome status.

118 - Long term precision of dual-energy X-ray absorptiometry total and regional body composition measurements and their associations.

Cassidy Powers, University of California, San Francisco; Bo Fan, University of California, San Francisco; John Shepherd, University of California, San Francisco

Background: Few studies have neither studied long-term repeatability nor had enough participants to describe precision in terms of covariates such as body weight, sex, and body mass index (BMI). We previously reported total body values and trends with respect to age, BMI and time. However our objective was to further investigate the repeatability of both total body and subregional body composition measurements and their covariates in a large prospective self-selected sample.

Methods: We recruited 651 participants of the National Health and Nutrition Examination Survey (NHANES) to receive two DXA scans. Participants varied in ethnicity and gender, with age ranging from 16 to 69 years (mean, 39.2 ± 17.5), and BMI from 14.1 to 43.5 (mean, 26.5 ± 5.0). Time between scans ranged from 1 to 30 days (mean, 15.1 ± 8.8). Participants with avoidable scan artifacts were excluded. Precision estimates for whole body, and subregional measures, including android, gynoid, trunk,
arm, leg and appendicular (arm+leg), were calculated as root mean square coefficients of variation (RMS-%CV) and standard deviations (RMS-SD). Pearson correlation coefficients and stepwise regression analysis was used to determine the influence of participant descriptors (Sex, BMI, time, age, BMD, BMC, fat, lean mass, total mass, %fat) on the precision of BMD, BMC, fat mass, lean mass, total mass, and %fat for each region.

**Results:** The subregional precision values were worse than the total body values (CV and RMSE, 1.12 and 0.01g/cm2, 1.17 and 27.5g, 1.83 and 471g, 1.39 and 710g, 1.04 and 796g, and 1.62 and 0.53 for BMD, BMC, fat mass, lean mass, total mass, and %fat, respectively). The precision of the subregions vary with Android region having the worst overall (CV and RMSE, 3.44 and 73.7g, 3.02 and 108g, 2.97 and 1.06 for fat mass, lean mass and %fat, respectively). The precision of the android-gynoid percent fat ratio (CV and RMSE, 2.98 and 0.03) was also worse than the total body percent fat value, but similar to the trunk-percent fat ratio (CV and RMSE, 3.08 and 0.03). Fat mass was consistently measured with the worst precision in each region, with the arms having the highest value of 4.05 and 126g (CV and RMSE). Time between scans was not associated with any of the precision measures. Total body precision values were only associated with BMI, ?BMI, or sex, but subregional measures were associated with almost all other covariates.

**Conclusion:** We conclude that long-term precision values for whole body DXA scan measures are better than subregional precision values and confirm that precision values are unique my type of measure and region of interest.

**119 - Relationship Between Total Body Bone Mineral Content and Total Body, Appendicular or Abdominal Lean or Fat Mass**

Jingmei Wang, Norland—CooperSurgical Company; Kathy Dudzek, Norland—CooperSurgical Company; Chad Dudzek, Norland—CooperSurgical Company; Tom Sanchez, Norland—CooperSurgical Company

A strong and positive relationship has been noted between total body lean mass and total body bone mineral in both male and female subjects by DXA. The same studies have demonstrated a significant relationship between total body fat mass and total body bone mineral in female subjects but not in male subjects. If the relationship between bone and lean relies on skeletal muscle a stronger relationship might be seen with appendicular lean mass. The present study examines if those relationships are strengthened or weakened when regional (appendicular or abdominal) lean or fat mass are examined. A population of 100 children between 7 and 19 years old (50 boys and 50 girls) underwent whole body studies to assess bone, lean and fat mass using a Norland XR-46 fitted with Illuminatus software. Regional results for lean and fat were obtained for total body, appendicular (left leg + right leg + left arm + right arm) and abdominal (midriff + pelvis) regions. A strong linear relationship was seen between appendicular lean mass and total body bone mass in the boys (y = 0.1093x + 437.5, r = 0.9774, RMSE = 172.0) and girls (y = 0.1133x + 500.2, r = 0.9475, RMSE = 202.1). Similar relationships were seen between abdominal lean mass and total body bone mass in the boys (y = 0.2722x + 506.3, r = 0.9656, RMSE = 211.5) and girls (y = 0.2672x + 579.6, r = 0.9420, RMSE = 212.1). As expected from earlier studies, a weaker relationship was seen between appendicular fat mass and total body bone mass in boys (y = 0.0278x + 2280.9, r = 0.1169, RMSE = 808.0) with a relatively better relationship being seen in girls (y = 0.0735x + 1207.9, r = 0.5026, RMSE = 546.4). Similar findings were seen between abdominal fat mass and total body bone mass in boys (y = -0.0243x + 2122.3, r = -0.0517, RMSE = 812.5) and girls (y = 0.1253x + 1429.6, r = 0.4580, RMSE = 561.8). Those results compare to a strong linear relationship between total body lean mass and total body bone in boys (y = 0.0531x + 336.1, r = 0.9795, RMSE = 163.8) and girls (y = 0.0560x + 371.7, r = 0.9430, RMSE = 210.3) and weaker relationship between total body fat and total body bone in boys (y = -0.0098x + 2211.8, r = -0.0869, RMSE = 810.5) and girls (y = 0.0322x + 1300.0, r = 0.4649, RMSE = 559.5). Results show very similar relationships between total body bone and total body, appendicular or abdominal region lean or fat mass suggesting that the relationship is not necessarily tied to regional lean or fat mass in boys or girls.

**120 - Change in Serum 25(OH)D Following Vitamin D Supplementation is Unrelated to Body Composition**

Jessie Libber, University of Wisconsin Osteoporosis Clinical Research Program; Bjoern Buehring, University of Wisconsin Osteoporosis Clinical Research Program; Diane Krueger, University of Wisconsin Osteoporosis Clinical Research Program; Neil Binkley, University of Wisconsin Osteoporosis Clinical Research Program

The recent Endocrine Society guidelines recommend higher dose vitamin D supplementation (at least 3,000-6,000 IU daily) for individuals with a BMI > 30 kg/m2. This recommendation is based on the established association of higher BMI with lower serum 25-hydroxyvitamin D [25(OH)D]. It is logical that this association reflects greater vitamin D storage by larger amounts of fat in those with higher BMI. Consequently we hypothesized that change in 25(OH)D following supplementation would be inversely associated with total body or visceral fat mass as measured by DXA. To test this hypothesis, we conducted a double blind placebo controlled randomized trial of vitamin D supplementation. Ninety-nine women age 18 or greater (mean 55.7, SD ± 2.3 years; BMI mean 26.0, SD ± 0.6 kg/m2) were randomly assigned to receive either vitamin D3 2,300 IU or matching placebo daily for four weeks. Results show very similar relationships between total body bone and total body, appendicular or abdominal region lean or fat mass suggesting that the relationship is not necessarily tied to regional lean or fat mass in boys or girls.
months. Total body scans were obtained on all participants at baseline utilizing a GE Lunar iDXA. These scans were analyzed with enCORE software version 13.4 including the visceral adipose tissue feature. Serum 25(OH)D was measured by reverse phase HPLC. Change in serum 25(OH)D was assessed by repeated measures ANOVA. Relationships between body composition parameters and change in serum 25(OH)D were evaluated by simple and multiple regression analyses performed using Statview or Analyze-it software. No baseline differences between the vitamin D supplemented and placebo group were observed in BMI, age, 25(OH)D or serum chemistries. Consistent with published data, lower baseline 25(OH)D (p < 0.01) was observed in those with higher total body mass, higher total body fat mass and higher visceral fat mass. After four months of supplementation, serum 25(OH)D increased (p < 0.01) in the treatment group by an average of 14.2 ng/mL. Supplement compliance was > 90%. No association was observed between 25(OH)D change and total body fat mass, total body percent fat or visceral fat mass. Similarly, after correction for baseline 25(OH)D, no relationship between fat mass and 25(OH)D change was observed. Given these findings, we explored potential relationships of total body mass and lean mass with 25(OH)D change; again no relationship was observed. Finally, 25(OH)D change was unrelated to the daily vitamin D dose received. In conclusion, these data do not support the concept that a higher vitamin D dose is required for those with greater body mass or fat mass. It seems likely that the factors(s) explaining the relationship of high BMI with lower 25(OH)D are more complex than simply fat mass amount. Further delineation of body composition status with other circulating vitamin D parameters, (e.g. 3-epi 25(OH)D and 24, 25 OH2D), and direct tissue measurement of these and potentially other vitamin D metabolites may enhance the understanding of this complex system.

121 - Is bone mass associated with functional or total lean soft tissue mass?
Jennifer Sherman, UCSF; Joseph Wilson, University of California San Francisco; John Shepherd, University of California San Francisco; Kathy Mulligan, University of San Francisco; Neil Binkley, University of Wisconsin-Madison; Ellen Fidler, University of Wisconsin; Jessie Libber, University of Wisconsin; Mary Checovich, University of Wisconsin; Diane Krueger, University of Wisconsin; Bjoern Buehring, University of Wisconsin; John Shepherd, University of San Francisco

Background: Bone mineral density and bone mineral content are strongly associated with lean body mass and weight. The association is thought to be due to mechanostat stimulation. Lean soft tissue mass is mostly water found in both adipose and muscle. We ask the question, are there other measures of functional mass, such as total body protein, that drive bone density more than just weight alone?

Methods: Whole body DXA scans were taken of 25 subjects (14 female, mean age 37.8) using a Hologic QDR4500W (Hologic, Bedford, MA). Twenty-two participants were healthy and three had amyotrophic lateral sclerosis (ALS). Total body volume was estimated from the DXA scans using density estimates of the lean, fat, and bone masses. Total body water (TBW) was measured using deuterium dilution techniques and taking saliva samples at baseline, 3 and 4 hours. Total body protein (TBP) as well as arms, legs, and trunk protein indices were calculated using a validated 4C model. Associations of the protein and other body composition measures to BMD and BMC were investigated using SAS program 9.2 (SAS Institute Inc., Cary, NC) and correlation measures derived.

Results: BMC was highly correlated to TBW, LSTM, and TBP (r = 0.90, 0.88, and 0.72 respectively.) BMD was correlated to the same variables to a lesser degree (r = 0.78, 0.64, and 0.68 respectively.) The highest correlation between lean variables was LSTM to TBW and then to a lesser degree TBP (r = 0.98 and 0.77 respectively.) Weight was less correlated to both BMC and BMD than any of the lean mass measures (r=0.71 and 0.52 respectively.)

Conclusion: In a mostly healthy adults, bone mass and density are most highly correlated to lean mass measures with the highest correlation to TBW. We also found that LSTM is essentially just a measure of water mass. Future work will explore if these associations are the same in disease states and aged populations where protein and water mass are less coupled.

122 - Potential Utility of a DXA-Measured Lower Extremity Lean Mass / Fat Mass Ratio
Bjoern Buehring, University of Wisconsin-Madison; Ellen Fidler, University of Wisconsin; Jessie Libber, University of Wisconsin; Mary Checovich, University of Wisconsin; Diane Krueger, University of Wisconsin; Neil Binkley, University of Wisconsin

Background: Adiposity and intramuscular fat are associated with poorer physical function. Currently, clinical assessment of intramuscular (IM) fat measurements is limited, as it requires MRI or CT. Although DXA body composition is currently unable to evaluate IM fat, it is able to regionally determine lean and fat mass. DXA measured appendicular lean mass (AML) is part of consensus sarcopenia definitions, but lean mass is imperfectly correlated with muscle function and outcomes. Including fat measurement in sarcopenia evaluation likely will enhance diagnosis validity as high amounts of adipose tissue may contribute to muscle loss and increase risk for disability. This study aimed to examine whether a simple DXA body composition derived ratio of lower extremity fat/lean mass differs between young and old adults and correlated this ratio and the standard ALM/height2 ratio, with different classic muscle function tests and jumping mechanography (JM) parameters.

Methods: 60 collegiate athletes (30 females, 30 males) participating in various sports (hockey, golf, wrestling, basketball) and 97 community dwelling older adults were studied. Body composition was determined in all...
Peripheral Measurements: 
Bone Density and Other

123 - The Axial Dependence of Bone Density and Ultrasound at the Radius
Grant Nagaki, CyberLogic, Inc.; Mark Lieberman, Computerized Diagnostic Scanning Associates; Gangming Luo, CyberLogic, Inc.; Jonathan Kaufman, CyberLogic, Inc.; Stanley Rosenfeld, Computerized Diagnostic Scanning Associates; Alfred Rosenbaum, Computerized Diagnostic Scanning Associates; Robert Siffert, The Mount Sinai School of Medicine

Methods: Nine subjects with no history of fragility fracture were measured at the forearm (all except two had both forearms measured) using DXA (QDR-4500, Hologic) to obtain their BMDs. The BMD of the radius was measured from the 1/3rd (33%) location to the 10% percent location in 5 mm steps, using a rectangle of 5 mm constant height and a length that varied with the width of the radius. Three of the 9 subjects were also measured using a through-transmission ultrasound device (UltraScan 650, CyberLogic, Inc., NY, NY). The left and right forearms of each of the three subjects were measured starting at the 1/3rd location (Fig. 1) in steps distal to 3.33 mm, ending at the 10% location. The received ultrasound signals were processed to obtain two net time delay (NTD) parameters.

A relatively constant rate of decrease for most subjects. In particular, BMD decreases at an average rate of 0.01 g/(cm^2•%) from the 1/3rd (mean BMD = 0.75 g/cm^2) to the 10% (mean BMD = 0.58 g/cm^2) locations. The ultrasound data (consisting of 98 points) is shown in Fig. 3, and there is excellent correlation between the actual BMD and the ultrasound estimate, BMDUS, (r = 0.9, P<0.001).

Discussion: This study showed that there is a relatively constant rate of decrease in BMD along the radius, from the 1/3rd to about the 10% locations. Prior studies have generally reported BMD at either the 1/3rd or the ultrasound estimate, BMDUS, (r = 0.9, P<0.001).

Conclusion: An easily obtainable leg fat/lean mass ratio differs between young athletes and older individuals and also between genders. More importantly these data suggest that this ratio correlates with muscle function measures in older individuals and might be superior to the widely used ALM/height^2 ratio. Further studies are needed to evaluate whether the fat/lean mass ratio correlates with outcomes, e.g., falls and fracture, and whether it can be used as a surrogate marker for IM fat and/or sarcopenic obesity.
124 – Bone Loss in the Axial and Appendicular Skeleton in Ehlers-Danlos Syndrome
Stavrula Theodorou, UHI; Daphne Theodorou, GHI; Judith Adams, University of Manchester

**Background:** Ehlers-Danlos syndrome (EDS) comprises a distinct group of many inherited connective tissue disorders that are characterized by hyperelasticity and fragility of the skin, hyperlaxity of joints, bleeding diathesis, and decreased bone mass. We present the BMD measures and illustrate the imaging findings of EDS on dual energy X-ray absorptiometry (DXA), quantitative computed tomography (QCT), and peripheral pQCT images of the lumbar spine and distal forearm.

**Case Report:** A 14-year-old female with a history of type III EDS was referred to an orthopaedist regarding osteoporosis. She was short and light for her age (height 115 cm, weight 18 kg; which both lie way below the 0.4th centile), and she had reduced muscle bulk. The patient was wheelchair bound. On general examination, the girl had lax skin and joints, bilateral pes planus, and bruised easily. Bone densitometry by DXA revealed lumbar density of 0.464 g/cm² (T-score –5.3, Z-score –4.23). BMD measured in the distal forearm was 0.230 g/cm² (T-score –4.5) and in the ultradistal forearm 0.181 g/cm² (T-score –4.1) using SXA. Accordingly, she was treated with teriparatide. Over the next four years, the patient consistently gained bone density at the distal radius. Total BMD was 458 mg/cm³ (T-score 1.2, Z-score 1.4) at the radius 4% distal site using pQCT. Trabecular BMD was 220.5 mg/cm³ (T-score 0.5, Z-score 0.6) at the same site. Volumetric BMD was 71.2 mg/cm³ (T-score –3.74, Z-score –4.51) in the lumbar spine using QCT.

**Discussion:** Musculoskeletal manifestations of EDS include recurrent joint subluxations and dislocations, subcutaneous calcifications, persistent joint effusion or hemarthrosis, and precocious osteoarthrosis. Other findings may include kyphoscoliosis, spondylolysis, spondylolisthesis, thorax deformities, deformities of the radius and/or ulna, and pes planus. Osteoporosis is an additional feature of EDS whose etiology is complex and includes abnormal collagen synthesis, immobility, or reduced exercise.

**Conclusion:** Normal quality collagen is required to form normally mineralized bone. The abnormal collagen framework present in EDS may lead to defective deposition of bone mineral, with resultant decreased bone mass and fractures. In EDS, bone mass diminution is multifactorial due to faulty formation of bone matrix that is accentuated by lack of mobility. Careful monitoring by regular bone densitometry is invaluable in the assessment of treatment, in those patients with EDS.
125 - Comparison of normative reference QUS data derived from healthy Thai workers with manufacturer’s standards
Chanika Sritara, Ramathibodi Hospital, Mahidol University; Suchawadee Muskarat, Ramathibodi Hospital, Mahidol University; Sasithorn Amnuaywattakorn, Ramathibodi Hospital, Mahidol University; Kanokon Poonak, Ramathibodi Hospital, Mahidol University; Piyamitr Sritara, Faculty of Medicine Ramathibodi Hospital, Mahidol University

Introduction: Quantitative ultrasound (QUS) is a method widely available used for assessing bone health in terms of stiffness index (SI). The result is commonly classified by T-score, the number of standard deviation of the difference from the mean SI of race- and gender-specific young adults. However, normative reference data needed for the calculation of T-score for Thai population have not been reported. The database provided by the manufacturer may differ from ours.

Aim: To explore the bone health of healthy working male and female employees of the Electricity Generating Authority of Thailand (EGAT) using a QUS normative reference database for Thai population and to provide this dataset as an urban counterpart of Thai population.

Methods: The IRB approved the study protocol. It was part of the EGAT Cardiovascular Risk Factor Survey in the employees aged 25-54 years. Health workers who agreed to sign informed consent forms were enrolled. Each volunteer underwent QUS measurement at the left calcaneus with a Lunar Achilles ultrasound machine. The volunteers of each gender were divided to form 6 age groups of 5-year interval. The mean and standard deviation (SD) of stiffness index (SI) were calculated for each age group; those of the young adults, volunteers aged 25-29 years, were used for T-score calculation. These T-scores were compared with the T-scores derived from the manufacturer database using paired t-test.

Results: 1,921 healthy working volunteers (male 72.9%) participated in the survey. The male SI was 113.5 ± 18.4, 108.0 ± 17.8, 103.1 ± 16.4, 102.1 ± 17.8, and 97.2 ± 17.0 for group 1-6, respectively; and was 106.8 ± 21.1, 102.8 ± 16.5, 102.5 ± 16.1, 101.4 ± 17.1, 98.0 ± 17.0, and 97.2 ± 17.0 for the corresponding female group. The difference between the T-scores derived from our reference dataset and those from the manufacturer’s was statistically significant (p < 0.001) for both male (-0.64 ± 0.97 vs. -0.04 ± 1.54) and female (-0.27 ± 0.79 vs. 0.97 ± 1.65).

Conclusion: The QUS normative reference data for the urban counterpart of the Thai population were presented. Both male and female Thai healthy working populations have higher T-score than the reference dataset provided by the manufacturer.

126 - Bone Mass Density, Z-Score and Stiffness Index correlations based on age groups in post menopause women
Mara Carsote, UMPH Carol Davila, Bucharest,Romania; V. Radoi, UMPH Carol Davila; Gabi Voicu, Parhon Institute; Andreea Geleriu, Parhon Institute; Cristina Ene, Parhon Institute; M. Cuculescu, UMPH Carol Davila, Parhon Institute; Catalina Poiana, UMPH Carol Davila, Parhon Institute

Introduction: The heel QUS (quantitative ultrasound) is a useful tool to assess the fragility fracture risk. The analyze is differentiated based on clinical risk factors as age but a specific correlation index with results based on DXA is difficult to reveal.

Aim: We analyze SI (QUS) and BMD, respective Z-Score (DXA) based on decades of life. Patients 311 women in menopause were investigated between January 2010 and
August 2011. The patients already treated with anti-
resorptives were not included. Method We performed DXA
and QUS (with an Achilles device). The informed consent
was obtained. The statistical analyze EpiInfo/Pearson was
performed.

Results: We included the patients in 4 groups depending
on their age: group 1 between 40 and 49 yrs - 45 patients
(p), group 2 between 50 and 59 yrs - 157 p, group 3
between 60-69 yrs - 80p, group 4 over 70 yrs- 29 p. The
correlations were established between BMD and left, right
and average SI. For the group 1, the r values were: -0.19,
0.4, respective 0.42 (p<0.001). For the group 2, the r
values were: 0.31, 0.36, respective 0.34 (p<0.001). For the
group 3, the r values were: 0.03, 0.17, respective 0.11
(p<0.001). For the group 4, the r values were: 0.31, 0.34,
respective 0.36 (p<0.001). For all the groups, the r values
were: 0.31, 0.36, respective 0.35 (p<0.001). The corre-
lations were established between left, right, av. SI
and Z-Score. The correlations regarding for the entire
studied population were r 0.34 / 0.36 / 0.36 (p<0.001).
The first group, the correlations were: 0.54, 0.44,
respective 0.5 (p<0.001). The second group, the values
were: 0.42, 0.42, respective 0.43 (p<0.001). The third
group, the r values were: -0.01, 0.11, respective 0.05
(p<0.001). The forth group, the correlation values were:
0.39, 0.52, respective 0.5 (p<0.001).

Conclusions: The relatively good positive correlation was
revealed to all the patients from the studied group, and
also for the decades, except for the 60-69 yrs group.
Similar results were obtained for each or average values
of the Stiffness Index. Except for the third group, our data
showed a statistically significant positive correlation
between the data based on stiffness index and DXA Z-
score.

127 - QUS analyze (Achilles and Chrono Sonost) in
patients diagnosed with osteopenia
Mara Carsote, UMPh Carol Davila,
Bucharest,Romania; Gabi Voicu, Parhon Institute;
Adriana Gruiu, Medlife; V. Radoi, UMPh Carol Davila;
Cristina Ene, Parhon Institute; Catalina Poiana,
UMPh Carol Davila, Parhon Institute; M. Cociulescu,
UMPh Carol Davila, Parhon Institute

Introduction: Osteopenia is a very important category of
people diagnosed by DXA, important because most of the
frailty fractures are associated with it rather than
ostoporosis not due to the higher risk but due to the
more population diagnosed with osteopenia compare to
ostoporosis.

Aim: We analyze QUS (Quantitative Ultrasound)
parameters in patients diagnosed by DXA with osteopenia.
Patients 306 postmenopausal women were included. The
exclusion criteria were pre-therapy with antiresorptives
drugs.

Method: We performed DXA and QUS exam (Achilles and
Sonost Chrono). The informed consent was obtained. The
statistical analyze was performed by student t test.

Results: The DXA diagnosis categories included: group 1
=153 patients (p) with osteopenia (50%), group 2=103
patients with normal DXA (34%), group 3=50 patients
(16%) with osteoporosis. The av. age was for the 3 groups:
58.07 yrs, 54.07, 60.62 yrs. The mean stiffness index (SI)
revealed by Achilles for the groups was: 75.44±14.74U,
88.09±18.73U, 68.7±14.03U. The statistically significant
difference (p<0.001) was between osteopenia and normal,
respective osteoporosis group. The percent of patients
with SI = 54 U (high risk category), SI between 55 and 79 U
(medium risk category), SI = 79U (low risk category) was for
osteopenia group: 7.18 / 56.2 / 36.6%, for normal DXA
group: 3.88 / 31 / 65.04%, for osteoporosis group: 12 / 72/
16%. The mean BQI (U) revealed by Sonost Chrono for the
1 to 3 DXA groups was: 72±14.38U, 81.05±17.24U,
62.69±10.74U. The high/medium/low risk QUS category
patients were: for patients diagnosed with osteopenia,
normal DXA, respective osteoporosis: 11.11 / 63.3
25.49%, 7.76 / 37.86 / 54.36%, 22 / 66 / 8%. The corre-
lation coefficient between the two QUS devices was
0.76 (p<0.001). Conclusion: Based on the both ultrasound
devices revealed the fact than almost 10% of patients
diagnosed with osteopenia have high risk of fragility
fractures, so an anti-osteoporotic therapy may be
initiated, and almost 25% of patients have low risk QUS
profile, so follow up is enough.

128 - CTXA Hip - An Extension of Classical DXA
Measurements Using QCT
Alan Brett, Mindways Software Inc; Keenan Brown,
Mindways Software Inc; Chris Cann, Mindways
Software Inc; Judy Adams, Central Manchester
University Hospitals NHS Foundation Trust

Introduction: Bone mineral density (BMD) estimates for
the proximal femur using DXA are currently considered the
standard for making a diagnosis of osteoporosis in an
individual patient using BMD alone. We have compared
BMD results from a commercial QCT BMD analysis system,
CTXA Hip (see Figure 1), which provides clinical data for
the proximal femur, to results from DXA. We have also
used CTXA Hip to determine cortical and trabecular
contributions to total BMD.

Material and Methods: Sixty-nine patients were scanned
using 3D QCT and DXA. CTXA Hip BMD measurements for
Total Hip and Femoral Neck were compared to DXA
results. Twenty-two women were scanned at 0,1,2 years
and CTXA Hip and DXA results analyzed for long term
reproducibility.

Results: Reproducibility was 0.011 g/cm2 for CTXA Total
Hip and 0.012 g/cm2 for CTXA Femoral Neck compared to
0.012 g/cm2 and 0.013 g/cm2 respectively for DXA (see
Table 1). The correlation of Total Hip BMD CTXA vs. DXA
was R=0.97, and for Femoral Neck (see Figure 2) was
R=0.95 (SEE 0.044 g/cm2 in both cases). Cortical bone

Contemporary Management of Skeletal Health: Partnering to Image, Diagnose & Treat
Los Angeles, CA USA
comprised 62 ± 5% (mean ± SD) of total hip bone mass in osteoporotic women. 

**Conclusion:** CTXA Hip provides substantially the same clinical information as conventional DXA, and in addition provides estimates of volume-derived parameters which may be useful in evaluation of bone strength.

<table>
<thead>
<tr>
<th>Total Hip</th>
<th>Femoral Neck</th>
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</thead>
<tbody>
<tr>
<td>CTXA</td>
<td>DXA</td>
</tr>
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<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Areal Density (g/cm²)</th>
<th>0.645</th>
<th>0.700</th>
<th>0.551</th>
<th>0.598</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precision (g/cm²)</td>
<td>0.011</td>
<td>0.012</td>
<td>0.012</td>
<td>0.013</td>
</tr>
<tr>
<td>CV (%)</td>
<td>1.7</td>
<td>1.7</td>
<td>2.1</td>
<td>2.1</td>
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</table>

### Prevention and Treatment: Osteoporosis and Other Conditions

**129 - Osteoporosis Education in the Digital Age**

*Jay Ginther, Cedar Valley Bone Health Institute of Iowa*

Communicating full information about osteoporosis prevention and treatment to patients and their families during the limited time of an office visit is virtually impossible. They will seek further information outside the office setting. The abundance of information aimed at the lay public available on the internet is impressive. Its accuracy is not. The challenge is to supply abundant scientifically accurate information, written for the lay public, to our patients. This poster presentation will detail the mix of paper handouts, office video, office double screens, website, blog, CD, YouTube, and magazine articles used by Cedar Valley Bone Health Institute of Iowa.

**130 - Efficacy of Denosumab in Increasing Hip Bone Mineral Density in Older Versus Younger Women with Postmenopausal Osteoporosis**

*Paul Miller, University of Colorado Health Sciences Center; E. Lewiecki, University of New Mexico School of Medicine; Maria Luisa Brandi, University of Florence; Jonathan Adachi, McMaster University; Christopher Recknor, United Osteoporosis Centers; Andrea Wang, Amgen Inc; Jesse Hall, Amgen Inc; Steven Boonen, Leuven University*

**Background:** Denosumab (DMAb), a RANKL inhibitor indicated for the treatment of postmenopausal women with osteoporosis at high risk for fracture, has been shown to significantly decrease bone resorption, increase bone mineral density (BMD), and reduce new vertebral, nonvertebral, and hip fractures in women with postmenopausal osteoporosis (PMO) (Cummings et al., NEJM 2009). In addition, DMAb results in significant improvements in both BMD and bone mineral content across total, cortical, subcortical, and trabecular hip compartments (Genant et al., ASBMR 2010). The current posthoc analysis was conducted to assess the efficacy of DMAb on hip BMD in subjects aged ≥75 yrs compared with subjects aged <75 yrs in randomized clinical trials where subjects who were naïve to PMO treatment or previously received alendronate (ALN) were switched to DMAb treatment.

**Methods:** This analysis was based on 3 randomized controlled studies in which postmenopausal women with low BMD who were either naïve to PMO treatment (FREEDOM, Cummings, et al., NEJM 2009; DECIDE, Brown, et al., JBMR 2009) or previously received ALN (STAND, Kendler, et al., 2010) were randomized to 60 mg DMAb every 6 months, or either placebo or 70 mg weekly ALN. Percentage change from baseline to 12 months in subjects’ total hip (TH) BMD (determined by DXA) was analyzed by age group (<75 and ≥75 yrs).

**Results:** A total of 6779 and 2722 subjects aged <75 and ≥75, respectively, were randomized in all 3 studies. Mean age of subjects for the 3 studies, respectively, were: 70, 62, and 64 for subjects <75; and 78, 79, and 79, for subjects ≥75. Percentage change in BMD and comparison between age groups are shown in the figure below. For both age groups across all 3 studies, treatment with DMAb resulted in a statistically significant increase in TH BMD from baseline to month 12 relative to either placebo or ALN (interaction p>0.05), which were consistent with the overall results from each individual study. Among subjects ≥75 yrs of age who were previously treated with ALN, switching to DMAb treatment resulted in a significant improvement from baseline in TH BMD at month 12 (1.5%, 95%CI: 0.8%, 2.2%)
while continuation of ALN had no further impact on BMD (0.1%, 95%CI: -0.6%, 0.7%).

**Conclusions:** DMAB is associated with significant BMD increases at the TH regardless of age (<75 or ≥75 yrs) and independent of prior ALN treatment. While older subjects previously treated with ALN showed significant improvement in TH BMD when switched to DMAB treatment, those who continued with ALN treatment for 12 months did not show additional BMD improvement at the TH.

### 131 - Effects of Denosumab on 1/3 Radius Bone Mineral Density in Postmenopausal Women Across Randomized Controlled Clinical Trials

**E Lewiecki, New Mexico Clinical Research & Osteoporosis Center; Richard Prince, Sir Charles Gairdner Hospital; David Kendler, Clinical Research Centre; Edward Franek, Central Clinical Hospital MSWiA; Jose Zanchetta, Instituto de Investigaciones Metabolicas and University of Salvador; Carol Zapalowski, Amgen Inc.; Irene Ferreira, Amgen Inc.; Rachel Wagman, Amgen**

**Background:** Cortical bone as well as trabecular bone makes a substantial contribution to bone strength. The 1/3 radius is an almost entirely cortical site, thus it provides an excellent site to study the effects of pharmaceutical agents on the cortical bone compartment. Denosumab is a RANKL inhibitor that decreases bone resorption through a novel mechanism of action. Denosumab reduces cortical porosity as measured by pQCT at the distal radius (Seeman, ASBMR 2011) and increases bone strength as assessed by polar moment of inertia (Seeman, JBMR 2010). In the pivotal fracture study, denosumab reduced the risk of wrist fracture in higher risk women (Simon, ASBMR 2011). The effects of denosumab on bone mineral density (BMD) have been studied in numerous clinical trials of postmenopausal women with varying baseline BMD characteristics. We examined the consistency of denosumab’s effect on BMD at the 1/3 radius across these studies.

**Methods:** The effects of denosumab 60 mg Q6M compared with placebo and/or alendronate on 1/3 radius BMD at 12 months were evaluated in 6 randomized, double-blind, multicenter clinical trials involving postmenopausal women with low bone mass or osteoporosis. BMD changes as measured by DXA were evaluated from baseline to 12 months in studies which included placebo and/or alendronate as comparators (Table).

**Results:** Across studies, subjects in the denosumab group had significant gains in mean 1/3 radius BMD of 0.8% to 1.4% at 12 months (Figure). In comparison, the placebo groups in these studies largely exhibited reductions in BMD. Alendronate groups either had no changes or smaller increases in 1/3 radius BMD compared with denosumab. For trials that included subjects with baseline BMD T-scores above and below ~2.5, similar effects of denosumab on 1/3 radius BMD vs comparator(s) were seen when subjects were grouped according to baseline lumbar spine or total hip BMD T-scores that were ~2.5 or >~2.5 (P>0.1 for the treatment-by-subgroup interaction in each study).

**Conclusions:** Denosumab consistently increased BMD at the 1/3 radius at 12 months in postmenopausal women independent of baseline BMD T-scores and in those with or without prior treatment with alendronate. The mechanism by which denosumab contributes to increases in cortical bone density and strength compared with placebo and other interventions and the potential clinical benefit of these unique effects on cortical bone with respect to reduction in non-vertebral fractures continues to be evaluated.

### Table. Summary of Randomized Clinical Trials of Denosumab With 1/3 Radius BMD Determinations

<table>
<thead>
<tr>
<th>Study</th>
<th>Subjects</th>
<th>Enrolment Criteria</th>
<th>Comparator(s)</th>
</tr>
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<tbody>
<tr>
<td>Phase 1 Fracture study</td>
<td>151 placebo</td>
<td>T-score &lt;-2.5 and &gt;-4.0 at lumbar spine or total hip</td>
<td>placebo</td>
</tr>
<tr>
<td>Phase 3 low BMD study</td>
<td>155 placebo</td>
<td>T-score &gt;-1.0 and &gt;-2.5 at lumbar spine</td>
<td>placebo</td>
</tr>
<tr>
<td>Phase 2 study (60 mg Q6M denosumab opted)</td>
<td>55 placebo</td>
<td>T-score &gt;-1.8 to &gt;-4.0 at lumbar spine or ≤-1.8 to ≤-3.5 at proximal femur</td>
<td>placebo, open-labeled alendronate</td>
</tr>
<tr>
<td>Phase 2 wrist HoPqCT study</td>
<td>79 placebo</td>
<td>T-score ≤-2.0 to &gt;-3.0 at lumbar spine or total hip</td>
<td>placebo, alendronate</td>
</tr>
<tr>
<td>Phase 2 head-to-head study in treatment naïve women</td>
<td>573 denosumab 569 alendronate</td>
<td>T-score &gt;-2.0 at lumbar spine or total hip</td>
<td>alendronate</td>
</tr>
<tr>
<td>Phase 3 head-to-head study in women with prior alendronate treatment</td>
<td>245 denosumab 245 alendronate</td>
<td>T-score ≤-2.0 and ≤-4.0 and remaining alendronate therapy for at least 6 months</td>
<td>alendronate</td>
</tr>
</tbody>
</table>

* N indicates the number of subjects with 1/3 radius BMD measurements at baseline and month 12. *P*<0.05 study.
Anne Lake, RPJ Connections; Mary Nichols, Frontier Nursing University; Laura Hollywood, Frontier Nursing University

**Background:** To promote the role of the fracture liaison specialist in the care of the post fracture patient over 50 with osteoporosis in an effort to reduce the risk of future fractures in this patient population.

**Purpose:** The purpose of this research is to advocate the fracture liaison specialist in caring for the post fracture patient over 50 at risk for future fracture. The fracture liaison specialist is identified as critical member of the collaborative care team in bridging the gap in care between admission for fracture care and the treatment of osteoporosis in the immediate post fracture period.

**Rational:** Based on a comprehensive literature review, the research evidence indicates a gap in current practice standards regarding bone health evaluation and treatment in the post fracture patient with a history of osteopenia or osteoporosis. The research further identifies specialty care provider as playing a key role in closing this gap in the post fracture care of men and women over the age of 50 who are diagnosed with osteopenia or osteoporosis when evidenced based bone health protocols are initiated soon before or after fracture diagnosis.

**Project Description:** The program will include assessment by the fracture liaison specialist of the post fracture patient over the age of 50 either while in the acute care setting or as an outpatient in the orthopedic clinic. The assessment will include a bone health evaluation for men and women age 50 or older with a diagnosis of osteopenia or osteoporosis. The protocol includes three measures. The first measure is a comprehensive bone health consultation on any patient over 50 admitted to the acute care facility with a diagnosis of a fracture. This will include starting the patient on calcium and vitamin D on admission and obtaining appropriate labs. Prior to discharge the patient will be given an appointment or an order for Bone Density Testing and a follow-up with the fracture liaison specialist. The second measure captures the patient seen in the emergency department for fracture care but not admitted for surgery. Emergency room discharge instructions will include the recommendation to follow up with the fracture liaison specialist for bone density testing. The third measure includes an outpatient visit to include an educational opportunity for the patient with the fracture liaison specialist to discuss current bone health, recommended lifestyle changes and the need for bone density testing.

**Expected Outcomes:** The expected outcomes of this program will include improved quality of care for the patient with osteoporosis by reducing the risk of future fracture and promoting health through education on falls prevention and safety. Early intervention will capture the patient at the “teachable moment” for screening and treatment recommendations. This early intervention will improve the bone health of the patient and promote prevention of future fractures.

**133 - Calcium and Vitamin D Improve Bone Mineral Density in Patients with Epilepsy taking Anti-Epileptic drugs (AEDs) but do not Prevent Vertebral Fractures**

Antonio Lazzari, Boston Division NE VA Health Care System; Philip Dussault, Boston Division VA New England Health Care System; Samuel Davis, Boston Division VA New England Health Care System; Manisha Thakore, Boston Division New England VA Health Care System

**Purpose:** It is has been known that long term use of AEDs is associated with an increased rate of bone loss, in addition, it is well accepted that individuals with epilepsy have an increased risk of vertebral or non-vertebral fractures as compared to the general population. The objective of the Anti-Epileptic Drug Osteoporosis Prevention Trial (ADOPT) was to evaluate whether the use of an oral bisphosphonate supplemented with calcium (Ca+) and vitamin D (Vit D) compared to a placebo also supplemented with Ca+ and Vit D would help in preventing bone loss in an epileptic population treated with phenytoin, phenobarbital, sodium valproate or carbamazepine.

**Method:** ADOPT is an investigator initiated phase IV, prospective, randomized, placebo controlled study, double-blind study involving 80 male veterans with epilepsy who were being treated with AEDs for at least 2 years. Patients who were found to be osteoporotic according to WHO criteria (BMD T-score < -2.5 at spine or hip) or were found to be vitamin D deficient were excluded from initial randomization. Patients who had a T score > -2.5 were randomized into one of two possible arms. A bisphosphonate group (B group) received 35 mgs of risedronate weekly and a placebo group (P) received an identical placebo tablet weekly both groups received Ca+ and Vit D supplementation. Enrolled patients BMDs of bilateral proximal femura, LVA, A-P lumbar spine, total body and forearm were evaluated utilizing a GE Lunar Bone Densitometer or an iDXA instrument and had measurements of 25-OH Vit D, urinary NTX, serum calcium and blood chemistries.

**Results:** A total of 80 patients were randomly enrolled in either the B or P groups. Baseline characteristics of both groups were similar. Average age was 60 +/-13 years. Baseline average bilateral total proximal femura mean BMD was 0.990 +/-0.124 g/cm2 for the B group and 1.018 +/- 0.144 g/cm2 for the P group. Lumbar spine baseline BMD was 1.246 +/-0.189 for the B group and 1.244 +/- 0.162 g/cm2 for the P group. In the B group 27 patients completed the study, there was 1 death and 12 withdrew for variable reasons. In the P group, 26 patients completed the study, there were 2 deaths and 12 withdrew for multiple reasons. At the end of the study 10 out 27 patients from group B and 8 out 28 patients from group P had a significant increase of BMD as determined at the total proximal bilateral femura which was above the LSC for our site; further, 5 out 27 of group B and 1 out of 26 on group P demonstrated a significant increase of total body BMD. Five new vertebral fractures occurred in the
placebo group but none was observed in the active drug group.

**Conclusion**: Supplementation with Ca+ and Vit D or use of Ca+, Vit D and a bisphosphonate decreased the rate of bone loss and increased bone mass in our cohort of seizure patients chronically treated with AEDs. Prevention of vertebral fractures was not observed in the placebo group taking Ca+ and Vit D.

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**134 - Treatment with the Cathepsin K Inhibitor Odanacatib in Postmenopausal Women with Low BMD: 5 Year Results of a Phase 2 Trial**

*Nelson Watts, University of Cincinnati Bone Health and Osteoporosis Center; Neil Binkley, University of Wisconsin; Henry Bone, Michigan Bone and Mineral Clinic; Nigel Gilchrist, Princess Margaret Hospital; Bente Langdahl, Aarhus University Hospital; Heinrich Resch, Medical University Vienna; Andrew Denker, Merck Sharp, and Dohme*

**Background**: The selective cathepsin K inhibitor odanacatib (ODN) progressively increased BMD at the spine and hip over the course of a 2-year trial and its 2-year extension. Here we are reporting the results of an additional extension year.

**Methods**: Postmenopausal women, mean age 63 years, with BMD T-scores initially between -2.0 and -3.5 at the lumbar spine or hip, received weekly placebo or ODN 3, 10, 25, or 50 mg for 2 years in addition to vitamin D3 and calcium if needed. In year 3, women in each treatment group were re-randomized to ODN 50 mg or placebo. For years 4-5, women receiving placebo or ODN 3 mg in years 1-2 and placebo in year 3 were switched to ODN 50 mg; all others continued with their year 3 treatments. BMD at the lumbar spine (primary endpoint), femoral neck, trochanter, and 1/3 radius; bone turnover markers; and safety were assessed.

**Results**: Women entering the year 4-5 extension receiving placebo (n=41) or ODN 50 mg (n=100) had similar baseline characteristics. After 5 years, for women who received ODN 50 mg continuously from year 1 (n=13), mean % changes (SE) in BMD from baseline were: lumbar spine 11.9 (2.1) (Figure), femoral neck 9.8 (1.9), trochanter 10.9 (1.4), total hip 8.5 (1.0), and 1/3 radius -1.0 (1.3). In women who were switched from ODN 50 mg to placebo after 2 years (n=14), BMD mean % changes (SE) from baseline were: lumbar spine -0.4 (1.3) (Figure), femoral neck -1.6 (1.0), trochanter -1.0 (0.8), total hip -1.8 (0.8), and 1/3 radius -4.7 (1.7). After 5 years, for women continuously receiving ODN 50 mg (n=9-10), geometric mean % changes from baseline (SE) were -67.4 (10.1) for urine NTX/creatinine, but only -15.3 (5.9) for serum BSAP, whereas for women switched from ODN 50 mg to placebo after 2 years (n=10) these changes were 6.0 (7.6) and -11.9 (3.9), respectively. The administration of ODN over 5 years compared to placebo was generally well-tolerated.

**Conclusions**: Women who received ODN 50 mg for 5 years had gains in spine and hip BMD over 5 years and showed a sustained reduction in urine NTX/creatinine and a smaller reduction in serum BSAP. As previously reported, discontinuation of odanacatib resulted in reversal of BMD gains.
135 - To identify the inadequate risk stratification, prevention and treatment of osteoporosis/osteopenia among premenopausal females on prolactin raising antipsychotics.

Sobia Khan, Women's Health fellow, Cleveland Clinic Foundation, Cleveland, Ohio; Adele Viguera, Neurology Institute-Psychiatry and Psychology, CCF, Ohio

Background: Osteoporosis is prevalent among schizophrenic patients for obscure reasons. It could be partly explained by hyperprolactinemia associated with most conventional antipsychotics and among atypical antipsychotics, commonly caused by the use of risperidone. High prolactin levels are associated with hypogonadism and subsequent osteopenia/osteoporosis. It is known that psychiatric patient population often does not receive adequate preventive care and screening as compared to general population. A retrospective study conducted in three of Midwest VA medical centers and clinics in US, concluded that fewer postmenopausal schizophrenic females received a clinical service for osteoporosis as compared to their control group. We hypothesized that neither the psychiatrists nor the primary care physicians, taking care of schizophrenic premenopausal female patient population on risperidone, screen them adequately for hyperprolactinemia, osteoporosis/osteopenia or provide education on bone health.

Methods: This is a retrospective cross sectional study conducted by electronic medical record review at Cleveland Clinic Foundation, Ohio. The knowledge project data base was utilized to retrieve the medical record numbers of the 101 premenopausal female ages 18-45 on risperidone, evaluated at the outpatient psychiatric department of Cleveland Clinic Foundation from January 1st, 2008 through January 1st, 2011. Electronic medical chart review of these patients was conducted to identify the percentage of females counseled and screened for potential bone mineral density loss, hyperprolactinemia and vitamin D deficiency.

Results: A detailed chart review of the 101 premenopausal female ages 18-45, demonstrated no documentation of relevant bone health counseling or screening for potential bone loss while on risperidone by their psychiatrist or primary care physician. 42 patients out of the study group were =30 years old (not even yet reached the age to have achieved peak bone mineral density). Out of this subgroup, only 33.3% were at least once screened for hyperprolactinemia and only 36% screened for vitamin D deficiency.

Conclusion: The results of this study demonstrate that premenopausal women on prolactin raising antipsychotics are inadequately risk stratified, screened and managed for potential bone mineral density loss. The results of this preliminary study are important because despite of known adverse metabolic bone consequences of prolactin raising antipsychotics, little is projected to have specific guidelines for its prevention and establishing it as a risk factor for osteoporosis/osteopenia. Health care professionals need to be educated to use alternative medications or else monitor this side effect of prolactin raising antipsychotics, to prevent the silent bone mineral density loss among very young females suffering from schizophrenia.

136 - Recurrent Pleural Effusion After Zoledronic Acid In A Patient With Fibrous Dysplasia

Tulsi Sharma, SUNY Upstate Medical University; Jennifer Kelly, SUNY Upstate Medical University

Introduction: Bisphosphonates are used in a wide variety of bone disorders. Multiple serious adverse effects have been attributed to their use; some having resulted from off-label uses, but others seen with recommended indications, dosage and infusion time.

Case: We present the case of a 41 year-old male with a history of polyostotic fibrous dysplasia since 1986. He had increasing bone pain for which he received IV zoledronic acid 5mg infusion in April 2011. Within a few days after the infusion, he experienced progressive dyspnea. This worsened over the next few weeks and he was found to have large bilateral pleural effusions. Thoracentesis revealed an exudative effusion and a left drain was placed and removed after 2 days. His symptoms recurred the following month, he was again found to have massive pleural effusions. He had a repeat thoracentesis and more than 1800ml of exudative fluid was removed. Since that time, his effusions have been recurrent requiring repeated thoracentesis. His course over the last few months has been complicated by development of pleural fibrosis and trapped lung as a result of his effusions. He has recently undergone a right sided VATS (video-assisted thoracic surgery) with parietal pleurectomy and pulmonary decortication in July 2011 for the pleural thickening. Pleural biopsy showed evidence of fibrosis with adhesions. Rib lesion biopsy showed fibrous dysplasia without any evidence of malignancy. Despite a complete and exhaustive work-up, no specific cause has been identified for this effusion. Is this related to the use of zoledronic acid?

Discussion: Exudative pleural effusion usually has a cause but the differential is wide and thinking out of the ordinary can sometimes help if no obvious cause is found. Although uncommon, a number of medications have been reported to cause exudative pleural effusions. Our patient has a history of polyostotic fibrous dysplasia for the past 25 years. He did not have any prior history of effusions. The occurrence of recurrent effusions with a history of recent use of zoledronic acid points to a diagnosis of this being a rare medication side-effect. A detailed search of literature shows that a few cases have been reported to the FDA after use of zoledronic acid but none have been published. Dyspnea is a listed side effect occurring in 22-27% patients but the etiology is not elucidated. This case highlights the importance of having a high index of clinical suspicion to make a diagnosis of drug induced lung disease. This is especially the case for newer drugs with which we do not have long term data and experience. As the clinical indications for bisphosphonate use continues to expand, it is important for clinicians to prevent, recognize, and manage any possible complications.
effectively and expeditiously. It also raises awareness to be vigilant for the possibility of a pleural effusion after the use of zoledronic acid as dyspnea is a frequently reported complication.

137 - The correlation of body mass index, plasma Ct

telopeptidase, and synovial fluid leptin in osteoarthritis, before and after exercise. A study in explaining role of leptin and exercise in osteoarthritis with obesity and osteoporosis

Christiana Wahjuni, Indonesian Orthopedic Association; Norman Zainal, Indonesian Orthopedic Association

The most common type of joint inflammation found worldwide is Osteoarthritis (OA). It symptom of pain due to the progressive degenerative process. The progressivism of the symptom increase if accompanied by the condition of obesity and osteoporosis. Leptin, an anti-obesity hormone, acts on regulating energy balance, and also play a role on chondrocyte and bone metabolism. The purpose of the research is to identify a correlation between BMI (body mass index) , the C-telopeptidase(CTX-I) plasma and the synovial fluid leptin on OA patient who has obesity and osteoporosis before and after 12 weeks physical training treatment. The before and after interventional design used for 34 subject, consist of 23 postmenopause female between the age of 51-71 years and male 57-80 years of age. The assessment towards the leptin content level of the synovial fluid knee and the CTX-I plasma content level were conducted before and after 12 weeks of physical training. The result of the pair t-test between BMI, the CTX-I plasma, and the leptin of synovial fluid, before and after the physical training treatment, shows a significant decrease after the physical training. The correlation analysis result between BMI, the CTX-I plasma and the leptin of synovial fluid, before and after the physical training intervention, shows a lower correlation between variable. But after physical training shows a slight increase of the correlation coefficient. The analysis between BMI and the leptin with BMI as a control, after physical training, shows an increase of the correlation coefficient 0.001. The analysis between BMI and CTX-I with leptin as a control, after physical training shows an increase of the correlation coefficient 0.130. The analysis between BMI and leptin with CTX-I as a control, after physical training shows an increase of the correlation coefficient 0.017. Its verify the fact that after 12 weeks of physical training program obtained which, intensify the connection between variables.

Conclusion: A well-structured physical training program is proven to enable the body to regain ability of BMI, CTX-I and leptin toward a normal level. There is a leptin pathway that connects the occurrence of OA condition, obesity and osteoporosis simultaneously in one patient. Key words: OA, obesity, osteoporosis, leptin, physical training.

138 - VFA Performed in Clinical Practice Influences Physician Prescribing Behavior

John Schousboe, Park Nicollet Institute for Research and Education; Fergus McKiernan, Marshfield Clinic; Neil Binkley, University of Wisconsin Osteoporosis Clinical Research Program

VFA Performed in Clinical Practice Influences Physician Prescribing BehaviorJT Schousboe, FE McKiernan, N Binkley

Background/Purpose: Vertebral fracture is itself an indication for pharmacologic therapy to reduce fracture risk. VFA identifies substantial numbers of individuals with previously unappreciated vertebral fracture. However, it is not known whether physician prescribing behavior is actually influenced by use of, or results from, VFA. The purpose of this study was to determine whether VFA performance VFA influences physician fracture prevention prescribing behavior.

Method: This is a retrospective study performed at a US multispecialty clinic where VFA is performed when the worst BMD T-score is = -1.5 PLUS age =65 years OR current glucocorticoid use OR height loss = 1.5 inches. All individuals who had a DXA with/without VFA between 7/1/2005 and 6/31/2010 were identified and these results were merged with electronic health record and prescription medication data. Previous fracture was identified electronically as one or more clinic encounters with a primary or secondary diagnosis for a clinical vertebral, hip, wrist, humerus, or pelvis fracture. Use of a fracture prevention medication within 150 days following the DXA test was compared between subjects with an indication for a VFA who had this
139 - A Significant Minority of Patients Prescribed Fracture Prevention Medication Lose Significant BMD on Repeat Testing

John Schousboe, Park Nicollet Institute for Research and Education

Background: The timing and indications to perform repeat bone densitometry (DXA) following initiation of fracture prevention medication is controversial. A recent post-hoc analysis of the Fracture Intervention Trial (FIT) showed that BMD loss following initiation of alendronate therapy was so uncommon that repeat DXA testing was unjustified. However, the FIT population may not be representative of the high fracture risk population treated with medication in clinical practice. The objective of this study was to estimate the proportion of individuals prescribed a fracture prevention medication after a DXA test that lost > 0.03 gram/cm^2 (the least significant change in our institution) or > 0.06 gm/cm^2 at either the lumbar spine or total hip on follow-up DXA.

Methods: Between 7/1/2005 and 6/30/2010, 8,024 individuals were identified from the Bone Density database of a large urban health care delivery organization who had 1 baseline and at least 1 repeat DXA test. Bone density results from both tests were merged with medication data from the electronic health record. Previously untreated patients who initiated fracture prevention medication within 150 days of their first DXA test and remained on medication at the time of their follow-up DXA constituted the study population.

Results: 1,181 individuals with two or more DXAs in this five year time period NOT on fracture prevention medication at the time of their first DXA were prescribed medication after their first DXA (84% alendronate, 7% ibandronate, 4% risedronate, and 5% other) and still had an active prescription for medication at the time of their second DXA (mean 2.3 years later). The distributions of absolute BMD change at the lumbar spine and total hip between the two tests were as follows (figure); 13.5 % subjects lost >0.03 gm/cm^2 BMD at either the lumbar spine or total hip. 4.3% lost >0.06 gm/cm^2 BMD at either the lumbar spine or total hip.

Conclusion: Significant BMD loss occurs in a significant minority of individuals prescribed fracture prevention medication. A study limitation is of the absence of medication persistence or compliance information. These results indicate that repeat DXA two years after initiation of fracture prevention medication may detect, noncompliance, nonpersistance or nonresponders.1 Bell, KJ et. al. BMJ 2009; 338: b2266
Risk Assessment and Epidemiology: Osteoporosis and Other Conditions

140 - Assessment of Protective and Risk Factors of The Second Contralateral Hip Fracture in The Elderly
Jui-Kuo Hung, Changhua Christian Hospital; Ing-Lin Chang, Changhua Christian Hospital; Chen-Tung Yu, Changhua Christian Hospital

Background: Among osteoporotic fractures in the elderly, hip fracture is the most destructive and costly event. In these patients with a hip fracture, some will suffer from a second contralateral hip fracture. We attempt to identify a cohort with a high risk suffering a second hip fracture and notice the protective and risk factors to prevent the second hip fracture and decrease the resulting disability.

Methods: A total of 1185 patients (426 men and 759 women) aged over 60 years with a first hip fracture, treated at our institute between 2003 and 2006, were included. The data of Taiwan Health Insurance Information Bank was connected for evaluation. The patients' characters, medical behaviors, accompanied comorbidity, Elixhuaser Comorbidity Index, and accompanied musculoskeletal diseases were investigated to identify the relationship with the second contralateral hip fracture.

Results: Among these patients, 40 patients developed a second contralateral hip fracture with an incidence of 3.375%. There was significant difference in the incidence of second contralateral hip fracture by age difference, congestive heart failure, rheumatoid arthritis, osteoporotic distal radial fracture, and visual problems via Chi-Square and Logistic regression analysis.

Conclusion: The incidence of second contralateral hip fracture after a first one was 3.375% in this study. Increased risk of a second contralateral hip fracture was associated with age older than 80 years, congestive heart failure, rheumatoid arthritis, osteoporotic distal radial fracture, and visual problems.

141 - Can The Trabecular Bone Score (TBS) Be Considered As a Major Clinical Risk Factor (CRF) of Osteoporotic Fractures?
Renaud Winzenrieth, Bone and Joint Department

To have an added value over BMD, a CRF of osteoporotic fracture must be predictable of the fracture, independent of BMD, reversible and quantifiable. Many major recognized CRF exist. Out of these factors many of them are indirect factor of bone quality. TBS predicts fracture independently of BMD as demonstrated from previous studies. The aim of the study is to verify if TBS can be considered as a major CRF of osteoporotic fracture. Existing validated datasets of Caucasian women were analyzed. These datasets stem from different studies performed by the authors of this report or provided to our group. However, the level of evidence of these studies will vary. Thus, the different datasets were weighted differently according to their design. This meta-like analysis involves more than 32,000 women (=50years) with 2,000 osteoporotic fractures from two prospective studies (OFELY&MANITOBA) and 7 cross-sectional studies. Weighted relative risk (RR) for TBS was expressed for each decrease of one standard deviation as well as per tertile difference (TBS=1.300 and 1.200) and compared with those obtained for the major CRF included in FRAX®. Overall TBS RR obtained (adjusted for age) was 1.79 [95%CI-1.37–2.37]. For all women combined, RR for fracture for the lowest compared with the middle TBS tertile was 1.55[1.46-1.68] and for the lowest compared with the highest TBS tertile was 2.8[2.70-3.00]. TBS is comparable to most of the major CRF (Fig 1) and thus could be used as one of them. Further studies have to be conducted to confirm these first findings.

142 - Prevalence of underlying medical disorders in pediatric patients undergoing bone mass evaluation
Laura Parks, resident physician, University of Mississippi, Jackson, MS; Vikas Majithia, associate professor, University of Mississippi, Jackson, MS

Background: Dual-emission X-ray absorptiometry (DEXA) is the standard measurement of bone mineral density (BMD). Z-scores can be matched for age, sex, race, and weight, but limited data supports normal pediatric values. Multiple pediatric disorders are associated with decreased bone density. Without well-studied epidemiology, there is little data for evaluation and treatment guidelines for a population in which intervention may have the greatest
effect. Our objective was to determine the association of bone density with various chronic pediatric diseases. **Methods:** The charts of pediatric patients (less than or equal to 21 years old), who had a DEXA scan performed from July 1997 to July 2011 were retrospectively reviewed. Age, race, sex, height, weight, body mass index, diagnoses, and medications were recorded. The absolute bone densities, T-scores, and Z-scores for the femoral neck, total femur, and lumbar spine were calculated. The Z-scores were used to sort patients into three groups: normal bone mass (Z > -1 SD), reduced bone mass (Z = -1), and severely reduced bone mass (Z = -2.5).

**Results:** Fifty-four subjects were available for analysis. Mean ages were 15.8 and 15.25 years in the low and normal bone mass groups, respectively. Reduced BMD was noted in 30/54 (56%) and normal BMD in 24/54 (44%) patients. Low BMD was measured in 19/26 (73%) males and 11/28 (39%) females. Reduced BMD was more common in Caucasians 19/26 (73%) compared to African Americans (40%). Low bone mass was associated with neurological diseases such as cerebral palsy, muscular dystrophy, and myasthenia gravis. Other diseases in patients with reduced BMD were cystic fibrosis, asthma, gastroparesis, Crohns, leukemia/lymphoma, systemic lupus erythematosus, rheumatoid arthritis, spina bifida, celiac disease, and spinal muscular atrophy. None of the patients who were referred because of multiple fractures, celiac disease, endometriosis, or depot medroxyprogesterone acetate had abnormal Z-scores.

**Conclusions:** The findings suggest that low bone mass may be a consequence of some pediatric conditions. Low BMD was more prevalent among patients in this cohort than would be expected for the general population, likely due to sampling bias. Of all patients with reduced BMD, those with neurological diseases were most predominant. Interestingly, a higher number of males had a low bone mass as compared to females. This may be a reflection of low overall numbers in this cohort, which included a disproportionately high number of patients with muscular dystrophy. We are currently reviewing more charts and including other variables such as risk factors and medication doses to further evaluate these preliminary findings.

**143 - Australian FRAX and the Garvan hip fracture prediction models do not improve hip fracture prediction compared to model using hip DXA aBMD T score alone**

Satvinder Dhaliwal, Curtin University; Mingxiang Yu, Shanghai Zhongshan Hospital & University of Western Australia; Kun Zhu, University of Western Australia & Sir Charles Gairdner Hospital; Josh Lewis, University of Western Australia & Sir Charles Gairdner Hospital; Richard Prince, University of Western Australia & Sir Charles Gairdner Hospital

**Background:** Fracture risk calculators have been developed to improve DXA aBMD structural measures as predictors of future fracture risk. We compared Australian FRAX and the Garvan hip fracture prediction models with a simple hip aBMD T score model using a 10-year cohort study of older women. **Methods:** The study population was the CAREES cohort, an ongoing population based cohort study of 1500 women mean age 75 years in 1998. In this analysis we report hip fracture risk prediction in a sub population of 1127 women who had a hip aBMD measurement in 1999, and in whom complete ascertainment of hip fracture incidence over 10 years is available.

**Results:** The median 10-year hip fracture risk in the in the 68 participants who sustained a hip fracture compare to the 1059 who did not were: FRAX without BMD 4.9% vs 4.1%; FRAX with BMD 2.9% vs 1.9%; Garvan without BMD 6.6% vs 5.6% and Garvan with BMD 6.5% vs 3.9%. The total Hip aBMD T score in the in the 68 participants who sustained a hip fracture compared to the 1059 who did not were -1.65± 0.97 and -1.04 ± 1.01 (p<0.001). The table below shows the ROC areas under the curve (AUC) and diagnostic measures for each risk model. The Youden index was used to determine the best sensitivity and specificity cut off for each ROC.

**Conclusions:** These data show that neither calculator improves on the hip fracture prediction compared to the model using the total hip or femoral neck T score alone.

<table>
<thead>
<tr>
<th>Variable</th>
<th>ROC AUC (95% CI)</th>
<th>Cut-off</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Likelihood Ratio (+)</th>
<th>Youden Index</th>
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</thead>
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<tr>
<td>FRAX + BMD</td>
<td>0.64 (0.57 - 0.71)</td>
<td>2.65%</td>
<td>55.9%</td>
<td>68.3%</td>
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<td>GARVAN + BMD</td>
<td>0.64 (0.57 - 0.71)</td>
<td>6.65%</td>
<td>50.0%</td>
<td>73.8%</td>
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<td>4.45%</td>
<td>60.3%</td>
<td>56.2%</td>
<td>1.38</td>
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<tr>
<td>GARVAN - BMD</td>
<td>0.55 (0.47 - 0.63)</td>
<td>7.35%</td>
<td>48.5%</td>
<td>66.3%</td>
<td>1.44</td>
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<tr>
<td>Total Hip T-score</td>
<td>0.67 (0.60 - 0.73)</td>
<td>-1.60</td>
<td>57.4%</td>
<td>69.4%</td>
<td>1.88</td>
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<tr>
<td>Femoral Neck T-score</td>
<td>0.65 (0.58 - 0.72)</td>
<td>-1.55</td>
<td>69.1%</td>
<td>53.8%</td>
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<td>0.23</td>
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<tr>
<td>Age</td>
<td>0.58 (0.50 - 0.66)</td>
<td>77.5 yrs</td>
<td>38.2%</td>
<td>81.3%</td>
<td>2.04</td>
<td>0.20</td>
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</table>

**144 - Muscle Function, but Not Muscle Mass, is Related to Balance Confidence in Older Adults**

Bjoern Buehring, University of Wisconsin-Madison; Ellen Fidler, University of Wisconsin; Jessie Libber, University of Wisconsin; Mary Checovich, University of Wisconsin; Diane Krueger, University of Wisconsin; Neil Binkley, University of Wisconsin

**Background:** Both impaired muscle function and low muscle mass are included in recent consensus sarcopenia definitions. Sarcopenia is associated with increased risk of falls and fear of falling. Self-reported health is a falls risk factor that predicts hip fracture. However, how self-reported balance confidence relates to objective measures of muscle function and mass has received only limited...
evaluation. As such, this study examined the relationship of balance confidence with jumping mechanography (JM) parameters, classical muscle function tests, and appendicular lean mass (ALM) as measured by DXA.

**Methods:** Community dwelling individuals age 70+ completed the Activities-specific Balance Confidence (ABC) scale to assess balance confidence. This scale is reliable and able to distinguish fallers from non-fallers. Additionally, all volunteers performed several muscle function tests including the short physical performance battery (SPPB), grip strength, and JM. JM assesses muscle function using countermovement jumps to calculate body weight corrected peak power and jump height. Total body DXA was used to assess ALM. Statistical testing included correlation of ABC scores with muscle function tests and ALM/height2. Based on their ABC score, participants were divided into groups of high, moderate, and low balance confidence. Receiver-Operator Curves (ROC) and their area under curve (AUC) for the three defined confidence groups were calculated for the different muscle parameters.

**Results:** 97 individuals (49 females and 48 males, mean age 80.6, range 70 – 95 years) with and without osteoporosis and sarcopenia were studied. Participants had high balance confidence with only 10 individuals having ABC scores in the moderate range and none in the low range. Correlations from various regression analyses were statistically significant but small and ranged from 0.05 for grip strength to 0.28 for total SPPB score (P-values all <0.05 or lower). ALM/height2 was not associated with ABC score (P=0.625). ROC analysis revealed highest AUCs for gait speed and total SPPB score (~0.83). Jump power/height and chair rise time had lower AUCs (~0.75).

**Conclusion:** Tests of muscle function, including JM, but not simple lean mass measurement, are associated with balance confidence. These data support the need to include both measures of muscle mass and muscle “quality” in clinical definitions of sarcopenia. This study is limited by the generally high balance confidence in the study cohort. Further studies are needed to develop a sarcopenia test battery that is able to identify individuals at high falls risk. Subsequent implementation of such a testing approach may well increase accuracy of fracture estimation.

**145 - Screening of Osteoporosis by Different Methods in Old Males Lived in a Rural Community**

Chih-Hsing Wu, National Cheng Kung University Medical Center; Hong-Yu Chen, College of Medicine, National Cheng Kung University; Yin-Fan Chang, National Cheng Kung University Hospital; Chin-Sung Chang, National Cheng Kung University Hospital; Chuan-Yu Chen, Public Health Center, Tainiao District, Kaohsiung City; Mei-Wen Wang, Tainan Hospital Xinhua Branch, Department of Health; Yi-Ching Yang, National Cheng Kung University Hospital

**Objectives:** Male osteoporosis is not uncommon, but underestimated unintentionally. This study aimed to disclose the influence of different methods on the screening of osteoporosis among elderly males living in a rural community in Taiwan.

**Methods:** In 2010, an epidemiological survey using the whole-community screening method was performed for 1033 elderly males living in Tainiao District, Kaohsiung City in southern Taiwan. A total of 414 subjects (age:74.6 ± 6.2 y/o, response rate=60.8%) completed the structured questionnaires via a face-to-face interview by a well-trained investigator. Lumbar (L1-4) and hip (total and neck) bone mineral density was measured by mobile dual energy X-ray absorptiometry (DXA, Hologic Explorer QDR). Diagnosis of osteoporosis (T-score <=-2.5, young Asian reference) was confirmed by either the 1994 WHO criteria or history of non-traumatic fracture. Thoraco-lumbar X-ray was measured by mobile X-ray (Daeyoung DC-325R).The compression fracture was confirmed as >= 20% reduction of vertebral body height (Genant HK et al. 1993). The 10-year probability of major osteoporotic fracture was assessed by the FRAX® algorithms developed by WHO.

**Results:** Of 413 subjects completed questionnaires, 51 (12.3%) mentioned history of osteoporosis, while 18 (4.4%) had history of non-traumatic fracture. Of the 406 subjects scanned by DXA, 70 (17.2%) reached the diagnostic criteria of osteoporosis. Of 401 subjects with thoracolumbar X-ray, 234(58.4%) were diagnosed with compression fracture. Considering all combinations of four diagnostic criteria above, the prevalence of osteoporosis was ranged from 4.4% up to 70.2% (fig 1)?Using the X-ray as the golden standard of compression fracture, the DXA, FRAX, history of osteoporosis or history of non-traumatic fracture all showed no discriminative ability in ROC curve. Using the DXA as the golden standard of osteoporosis, the cut-off of 10-year hip fracture probability at either 3%, 4%, or 5% had acceptable discriminative ability.

**Conclusions:** In elderly male living in rural community in Taiwan, osteoporosis is not uncommon, and the prevalence of compression fracture is extremely high. As a result, thoracolumbar X-ray should be included to avoid the underestimation of the osteoporotic prevalence. Hip FRAX without bone mass density at 3-5% cut-offs have high negative predictive value and is appropriate for initial screening of osteoporosis in old males living in rural community.

**146 - The Effect of Competing Mortality on Fracture Risk Assessment**

William Leslie, University of Manitoba; Lisa Lix, University of Saskatchewan; Xiaojing Wu, University of Saskatchewan

**Objective:** A unique feature of FRAX is that the estimation of fracture probability accounts for the competing risk of mortality. A standard Kaplan-Meier (KM) method for time-to-event analysis does not adjust for competing mortality. Therefore we compared non-parametric and parametric methods that do and do not account for competing
mortality, and propose a new approach based on a modified KM method.  

**Methods:** The Manitoba BMD database was used to identify men and women age ≥50y with FRAX probabilities calculated using femoral neck BMD (N=39,063). Fractures were assessed from administrative data (N=2,543 with a major osteoporotic fracture, N=549 with a hip fracture during mean 5.3y follow-up). Results were stratified by variables for which competing mortality is expected to exert a differential effect: sex, age, major osteoporotic fracture probability, and presence of diabetes. In the modified KM method, death before a defining fracture was not censored at the time of death as in standard KM analysis. Instead, this was assigned a final follow up equal to the end of the observation period and a final status of being fracture-free. Censoring only occurred for loss to follow up from migration.  

**Results:** There was significantly higher mortality in the subgroups of interest. Estimates of fracture probability that did not consider competing mortality risk were consistently higher than estimates with adjustment for competing mortality risk. Ten-year major osteoporotic fracture probabilities were greater for men than women when no adjustment was made for mortality risk. When estimated with competing mortality, this was reversed with lower 10-year fracture probability in men than women. In the subgroups of interest (men, diabetics, high FRAX probability, age >80y), failure to account for competing mortality overestimated fracture risk by 16-56% with the standard KM method (non-parametric) and 15-29% with the Cox model (parametric). Similar findings were seen when the outcome was hip fractures: failure to account for competing mortality overestimated hip fracture probability in the high mortality groups by 18-36% using the standard KM method and by 17-35% in the Cox model. The modified KM method showed very close agreement with the non-parametric method that adjusted for competing mortality (within 2% in all subgroups).  

**Conclusions:** Failure to account for competing mortality risk gives considerably higher estimates of 10-year fracture probability than if adjustment is made for this competing risk. This effect is stronger among groups with higher mortality. A modified KM method is relatively easy to implement and provides an alternative approach to other estimation methods that have been proposed for competing mortality risk adjustment.  

### Table. Ratios of observed 10-year fracture probability estimated without versus with adjustment for competing mortality.  

<table>
<thead>
<tr>
<th>Sex</th>
<th>Death</th>
<th>Major osteoporotic fracture</th>
<th>Hip fracture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard KM model</td>
<td>Cox Model</td>
<td>Modified KM model</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>7.4%</td>
<td>1.06</td>
<td>1.06</td>
</tr>
<tr>
<td>Men</td>
<td>19.7%</td>
<td>1.56</td>
<td>1.23</td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50-59</td>
<td>3.0%</td>
<td>1.03</td>
<td>1.03</td>
</tr>
<tr>
<td>60-69</td>
<td>6.1%</td>
<td>1.05</td>
<td>1.05</td>
</tr>
<tr>
<td>70-79</td>
<td>13.0%</td>
<td>1.13</td>
<td>1.13</td>
</tr>
<tr>
<td>&gt;80</td>
<td>22.5%</td>
<td>1.28</td>
<td>1.29</td>
</tr>
<tr>
<td>FRAX category</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>0.3%</td>
<td>1.04</td>
<td>1.04</td>
</tr>
<tr>
<td>Moderate</td>
<td>1.8%</td>
<td>1.11</td>
<td>1.10</td>
</tr>
<tr>
<td>High</td>
<td>5.9%</td>
<td>1.19</td>
<td>1.20</td>
</tr>
<tr>
<td>Diabetes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>6.2%</td>
<td>1.07</td>
<td>1.07</td>
</tr>
<tr>
<td>Yes</td>
<td>8.2%</td>
<td>1.16</td>
<td>1.15</td>
</tr>
</tbody>
</table>

A ratio of 1.00 indicates perfect agreement with the corresponding method adjusting for competing mortality.  

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**147 - Vitamin D, Fractures, and Human Skeletal Health**  
Sunil Wimalawansa, UMDNJ-RWJMS  
**Introduction:** Vitamin D deficiency is increasing worldwide. Ultraviolet rays provide more than 80% of our vitamin D requirement; diet and supplements can augment it. Rickets in childhood and osteomalacia in adults are classic manifestations of severe vitamin D deficiency. An additional 1,000 IU of vitamin D/day is generally sufficient for lighter-skinned individuals, whereas older people and dark-skinned individuals may need extra 2,000 IU/day to maintain normal serum 25-hydroxyvitamin D [25(OH)D] levels; over 30 ng/mL (50 nmol/L). Measurement of serum 25(OH)D is the most reliable way to evaluate vitamin D status. Low vitamin D levels may aggravate a variety of non-skeletal disorders including cancer, diabetes, metabolic syndrome, infectious diseases, and autoimmune disorders.  

**Method and Results:** A meta-analysis of 8 randomized trials involving 2,426 older patients demonstrated that daily doses of vitamin D (700–1,000 IU) lowered the risk by 19%. Women’s Health Initiative study suggested, every 10 ng/mL decrease in serum vitamin D levels doubles the risk of hip fractures. Another meta-analysis consisted of 5 randomized clinical trials (RCTs) (n = 9,294) of hip fracture and 7 RCTs (n = 9,820) of non-vertebral fractures with vitamin D with or without calcium reported a significant reduction of fractures. Vitamin D in doses in excess of 800 IU/day reduced the risk of hip and non-vertebral fracture by 26%, compared with calcium alone or placebo, or 400 IU of vitamin D. A Cochrane review also reported that vitamin D3 reduced hip fractures, and suggested that higher doses of vitamin D are more effective in fracture prevention.  

**Conclusion:** Low vitamin D status is common in vulnerable groups and elderly. This is due to several factors, but predominantly due to inadequate sun-exposure. Most vitamin D deficient patients are not provided with inadequate doses, and long-term adherence to is poor. Better compliance seems to occur with supplementation with 50,000 or 100,000 IU doses administered once a
148 - Increased Risk for Bone Loss and Fractures in Persons with Disability
Sunil Wimalawansa, UMDNJ-RWJMS; Patricia Graham, University Medical Center Princeton

Background: In 2006, 15.7% of Americans reported disability. Despite this, Persons with Disability (PWD) are under-represented in osteoporosis screening, treatment, and research. Decreased non-ambulatory status and less out-of-home activity, dysmobility, and increased falls put adult and pediatric PWD at much higher risk for low BMD and fracture than non-disabled peers.

Method: Literature review: PWD, children/adults; EMR use

Results: Adult with PWD is grossly under-represented in published BMD and osteoporosis research, not evaluated as thoroughly or frequently for low BMD. PWD have lower serum vitamin D levels and BMD, and earlier onset of low BMD than non-disabled peers do. Onset of disability and mobility status are independent predictors of BMD (hip and spine). Children with disabilities also have lower BMD and increased fractures, relative to age- and sex-matched peers. PWD with high risk include spina bifida, SCI, CP, MS, CVA, amputees, COPD, and RA. Adults with intellectual disabilities also show lower BMD, decreased ambulation and higher fracture risks. Falls are a significant cause of fracture and hospitalization in PWD, and at a younger age, and for 90% of hip fractures in the elderly. Fall risk factors are well documented, include fear of falling, but are rarely addressed in medical preventive care models. The Garvan nomogram includes fall risk in 10-year hip fracture risk and medication need. Early medication use in acute SCI patients can reduce BMD loss. EMR capture of patients at low BMD risk improves screening and treatment efficiency, and reduces cost of care.

Conclusion: More research is needed to define the demographics/etiology of low BMD, falls, and fracture risk in PWD, and to establish uniform Best Practice Parameters, including safe exercise parameters, timing of medication, and usefulness of Garvan nomogram. EHR-driven interdisciplinary models including rehabilitation medicine strategies together with traditional care should improve morbidity and mortality of PWD. These should in hand-in-hand with focus on minimizing disparity in health care delivery, optimizes early screening for falls, better management of pain and disability, and providing safe exercise strategies, home safety and psychosocial support. Electronic Health Record Systems are essential to targeting PWD for this care. Ref: P. May, H. Chahal, A. Warusawithana, R. May, S. Wimalawansa. Prevalence of Low BMD and vitamin D deficiency in patients with developmental disabilities, ISCD 2011, Abstract, 122.

149 - Risk Factors for Bone Loss in a University Based Lupus Cohort
Saru Sachdeva, Loma Linda University Medical Center; Ioana Moldovan, LLUMC; Emmanuel Katsaros, LLUMC

The purpose of this study was to study risk factors associated with low bone density in a lupus cohort from our university clinic. The charts of 160 patients that fulfilled the American College of Rheumatology criteria for SLE (systemic lupus erythematosus) were reviewed. Fifty one had bone mineral density (BMD) assessed by dual absorptiometry scan (DXA) and their charts were reviewed in detail. Age, body mass index (BMI) and disease duration were recorded. Disease activity was assessed by the SLEDAI (SLE disease activity index) score. Laboratory test results were reviewed, including erythrocyte sedimentation rate (ESR), presence of double stranded DNA antibodies (DsDNA), complement levels, complete blood counts and presence of proteinuria. Vitamin D levels were included when available. Medications were recorded, including glucocorticoids, immunosuppressants, osteoporosis medications, calcium and vitamin D. The patients’ age ranged from 21 to 76, with a median of 44 years. 33 patients (64.7%) were premenopausal and 18 (35.3%) were postmenopausal. In the premenopausal group, the patients had moderate disease activity, as opposed to the postmenopausal group, where the disease activity was low. There were 11 (21.5%) patients with osteoporosis, 23 (45%) patients with osteopenia and 17 (33.3%) patients had normal bone density. The majority of patients were on chronic low dose glucocorticoids, however only approximately half were taking osteoporosis-preventing medications. The patients with BMD within normal and osteopenic ranges were younger and had moderate disease activity scores. A higher prevalence of fragility fractures was observed in the osteoporotic group. The patients with osteoporosis were older, had longer disease duration and low disease activity scores. ESR and vitamin D levels were not significantly different in the three groups. Body mass index was higher, in the overweight range, for the patients with normal BMD, and normal in the osteoporotic and osteopenic groups. In conclusion, in our study, the main determinants for osteoporosis were disease duration and menopausal status. Disease activity and inflammation at the time of obtaining the DXA did not seem to play a major role in bone density. Higher BMI seemed to have a protective effect. Fragility
fractures increased in the osteoporotic group but did not correlate with the disease activity or vitamin D level. Larger, prospective trials are needed to establish definite risk factors associated with bone loss in lupus patients.

150 - A Vertebral Fracture Assessment (VFA) Performance Algorithm Improves Appropriate Utilization Among Those Referred for DXA

John Schousboe, Park Nicollet Institute for Research and Education; Fergus McKiernan, Marshfield Clinic; Neil Binkley, University of Wisconsin Osteoporosis Clinical Research Program; Jay Fuehrer, Marshfield Clinic Research Foundation; Derek Fuerbringer, University of Wisconsin

Background: Vertebral fracture assessment (VFA) identifies prevalent vertebral fracture and improves fracture risk estimation. However, VFA is under-utilized in clinical practice. VFA should be performed in those with sufficient pre-test probability of finding a prevalent vertebral fracture to warrant the additional resource utilization. A performance algorithm implemented by DXA technologists at one of our three institutions (Park Nicollet) for the last 7 years has increased appropriate VFA utilization. The objectives of this study are to a) assess how well DXA technologists implemented a performance algorithm over a five year period and b) assess VFA utilization following similar implementation of this performance algorithm at a large rural multispecialty community health care organization and a university academic health center.

Methods: We devised a physician order option simplified from the ISCD 2007 Position Statement for VFA indications to specify that VFA is appropriate for those patients whose worst T-score (lumbar spine, femoral neck, total hip) is ≤-1.5 and PLUS age = 65 years OR height loss = 1.5 inches OR current glucocorticoid use. The association between indications for VFA and actual utilization of VFA at Park Nicollet was assessed by cross tabulation and chi2 statistic. The order option was introduced at the other two institutions in January 2011 with slight revision in that the T-score criterion was changed to ≤-1.5 and > = -2.5. VFA utilization among those with these bone density and age/height loss/glucocorticoid use for the 8-month period following introduction of this order option was compared to the three preceding 8 month periods by chi2 statistic.

Results: At Park Nicollet, 72% of those referred for DXA who meet criteria for a VFA had the test, whereas 92% of those who lack the indication noted above do not have the test done. Following introduction of the order option, 23% and 44%, respectively, of those meeting the criteria at the other two institutions had VFA performed (Figure).

Conclusions: Using a performance algorithm for VFA, DXA technologists successfully can identify those for whom VFA is indicated and perform the test. This performance algorithm can be successfully introduced in a variety of health care delivery organizations. However, uptake of the algorithm is likely to be a gradual process requiring sustained effort for full success.

151 - Two methods to predict fractures clavicle: 3D modelisation and bone densitometry

Sophie Abrassart, Hopital Universitaire de Genève; Christophe Barea, HUG; Pierre Hoffmeyer, HUG

Introduccion: Fractures of clavicles account for 5 to 10 % off all fractures, with injuries of the middle third of the clavicle accounting for 80 % of these cases. The aim of this study was to compare one 3D finite element model of clavicle with mCT analysis. One finite element model of a normal clavicle was created. Six paired clavicles were analyzed with normal CT and with mCT. Changes in stress distribution were visualized in the bone in order to quantify the stress shielding effect compared to real bone quality.

Material and Method: 1) CT-images of a normal clavicle were processed in order to build the clavicle geometry and to get bone properties with Mimics (Materialise, BE). In ABAQUS-Pre software (HKS, Inc., Pawtucket, RI, USA), the 3D finite element model of the bone (including cortical and cancellous bone) was generated. The model consisted of 113’135 hexahedral elements Axial loads of 800N and boundary conditions reproduced the main forces acting on the shoulder with the arm at 90° of abduction. The transverse isotropic mechanical properties of bone were integrated into the model.2) mCT (X trem Ct from Scanco ) with High-resolution peripheral quantitative CT resolution of 41 - 246 μm nominal isotropic (pixel size) and slices of 80 microns was performed on the clavicles. The results were obtained with Scanco software.Bone volume, trabecular space, trabecular number, trabecular thickness and the structure model index were calculated .3) Both CT scans methods and results were compared to the the 3D finite element model.

Results and Discussion: Stresses visualization showed the load transmission trough the bone. Clavicle is like a bow with the two edges as fixed points. Tension and compression were shown on the clavicle Respectively, the lateral part worked in traction and the medial part in compression. Distal translation of the load transfer was observed at the larger part of the clavicle. The medial sterna part was a rigid...
Maximum stress compression occurs in this area. Lateral-posterior part was more sensitive to fracture and underwent maximum stresses in traction according with the finite elements results. These results were supported by the microdensitometric analysis. The most constrained areas of the 3D model were these where the bone density was the highest. The centre of the clavicle receives a lot of stresses and has the highest density with large trabeculae.

**Conclusion:** This study revealed the changes in bone density in the clavicle due to different stress distribution. Potential fractures problems seemed to occur in the external part. Superior and posterior cortical bone had the best quality as they had much more trabeculae with very few space between them. These informations may help to understand fractures and to conceive new material.

**Acromial part of clavicle**