Quantitative Ultrasound and the Management of Osteoporosis

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Osteoporosis

• Prevalence in USA: 10 million

• Osteoporosis Drugs
  – Calcitonin (Miacalcin) 1991
  – Alendronate (Fosamax) 1995
  – Raloxifene (Evista) 1997
  – Risedronate (Actonel) 1998
  – Teriparatide (Forteo) 2002
  – Ibandronate (Boniva) 2005
  – Zoledronic acid (Reclast) 2007
  – Denosumab (Prolia, Xgeva) 2011

• High prevalence + multiple treatment options → high demand for diagnostic methods.

• Gold Standard: DXA (Dual Energy X-ray Absorptiometry)

Quantitative Ultrasound (QUS)

- QUS devices transmit and monitor ultrasound waves in bone.
- Because osteoporosis is a systemic disorder, measurements at the heel can indicate fracture risk throughout the skeleton.
- QUS devices can measure ultrasound properties that correlate with material and micro-architectural properties of bone\(^1\) and bone-mimicking phantoms\(^2,3\).


• “Heel QUS measures are related to global fracture risk with similar relative risk as other central bone density ROI for postmenopausal women.” – ISCD.¹

• “Quantitative ultrasonography of the calcaneus predicts fractures of the femoral neck, hip, and spine as effectively as DXA.”²

Non-Calcaneal Methods of QUS

Yamamoto et al., Osteo. Int., 20, 1215-1224, 2009

Backscatter Method of QUS


http://www.boneindex.fi/en/page/2
Expansion of Bone Testing

• Ultrasound devices have benefits over DXA with regard to expansion of screening / diagnostic testing to a much wider population:
  – Less expensive
  – More compact
  – More portable
  – No ionizing radiation

• Unlike DXA, ultrasound devices are practical for primary care settings.
Current BMD Testing Guidelines\textsuperscript{1,2}

- BMD testing is recommended for
  - all women $\geq 65$ years old (NOF, WHO, ACOG, ISCD, USPSTF)
  - postmenopausal women with risk factors (e.g. low body weight, prior fracture, high-risk medication use) (NOF, ACOG, ISCD, USPSTF)

\textsuperscript{2} http://www.iscd.org/official-positions/2007-iscd-official-positions-adult/

NOF: National Osteoporosis Foundation
WHO: World Health Organization
ACOG: American College of Obstetricians and Gynecologists
ISCD: International Society of Clinical Densitometry
USPSTF: United States Preventive Services Task Force
Bone Mass in Girls

- Osteoporosis in the elderly woman is determined by:
  - Amount of peak bone mass in adolescence,
  - Premenopausal maintenance of such peak bone mass
  - Rate of postmenopausal bone mass loss
- “For the prevention of osteoporosis, the importance of bone gain early in life, i.e., during a period of relatively high plasticity of the skeleton to physical forces, has become an accepted axiom.”


Panel Session: Nutrition/Exercise

Is Osteoporosis a Pediatric Disease? Peak Bone Mass Attainment in the Adolescent Female

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Synopsis

Osteoporosis in the elderly woman is determined by the amount of peak bone mass in adolescence, the...
Bone Accrual vs. Age


Looker *et al.*, *Osteo Int.*, 20, 1141-1149, 2009
Factors for Low Bone Mass in Adolescents

• Diet – e.g. low calcium intake¹
• Physical Inactivity²
• Low Weight²
• Anorexia Nervosa³,⁴
• Athletic Energy Deficit⁵,⁶
• Smoking⁷
• Use of injectable contraceptive, DMPA⁸

6. [Link to document](http://americanbonehealth.org/images/About_AED_Symposium_Press_Release__FINAL.pdf)
Promotion of Bone Mass in Adolescents

- Diet – e.g., calcium intake\(^1\)\(^-\)\(^3\)
- Physical Activity\(^1\)\(^,\)\(^4\)
- Estrogen (girls with anorexia nervosa)\(^5\)
- Discouraging smoking\(^6\)
- Discontinue use of contraceptive DMPA\(^7\)

Bone Mass vs. Age


Looker et al., Osteo Int., 20, 1141-1149, 2009
Challenges for QUS

• QUS devices should implement standardization methods to reduce variability of measurements.¹,²

• Most criteria for osteoporosis drug therapies use DXA measurements as a standard. Equivalent criteria must be developed for QUS.

• Appropriate methods for interpreting QUS measurements on girls before they have attained peak bone mass must be developed.

• Not all QUS devices are appropriately sized for use in younger adolescents.

Summary

- QUS on the calcaneus is effective for prediction of osteoporotic fractures.
- Because ultrasound devices are smaller, lighter, and less expensive than x-ray devices, they offer potential to expand bone testing to a much wider population.
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