Alcohol-Induced Osteopenia

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Role of Bone Turnover in Normal Physiology and Bone Pathology

Bone Formation (Osteoblastogenesis/Osteoblast Activity)

Bone Resorption (Osteoclastogenesis/Osteoclast Activity)

Skeletal growth during early development, puberty, attainment of peak bone mass (~age 25), bone rebuilding post-lactation. Pathology: Osteopetrosis.

pQCT Analysis of Bone

Proximal Tibia

Control  High EtOH

Dose-Responsive Decreases in Trabecular Bone Mineral Content (BMC) in Cycling and Pregnant Female Rats Exposed to Alcohol

UEC – urine ethanol concentration
AUC – area under dose-time curve

Shankar et al Endocrinology 147: 166-178, 2006
Estradiol Protects Against EtOH-Induced Bone Loss in Cycling Female Rats


Shankar et al Endocrinology 147: 166-178, 2006

**Osteoclast surface/Bone surface**

**Cycling Rat**

**Pregnant Rat**

**Total Bone Mineral Density, ex vivo pQCT,**

A)  B)

**Control**

**Ethanol**

E2 = Estradiol
Bone density during pregnancy and lactation

- Pregnancy
- Lactation
- Post-weaning

Bone density

Breast Fed

Bottle Fed

Ethanol ??
Anabolic Bone Rebuilding Post Lactation is Inhibited by Alcohol Consumption in Female Rats

**Dynamic Histomorphomometry**
Bone Formation/Trabecular Volume

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**pQCT**
Trabecular Bone Mineral Density (Slice 3+4)

![Graph showing trabecular bone mineral density](image)

- PND22/TEN
- PND31/TEN
- PND52/TEN
- PND31 ETG
- PND38 ETG
- PND52 ETG

- a < b
- P < 0.001

![Graph showing dynamic histomorphometry](image)

- TEN
- TEN/PND15
- TEN/PND30
- ECH
- ECH/PND15
- ECH/PND30

- a < b < c
- P < 0.05

NAC and E2 Both Block EtOH Induced ROS Formation in Differentiated Primary Osteoblast Cultures

NAC – Dietary antioxidant
N-acetylcysteine

E2 – Estradiol

ROS – Reactive oxygen species

Molecular Mechanisms Underlying Alcoholic Osteopenia

Dietary Antioxidants Block Alcohol-Induced ROS and Transdifferentiation of Mesenchymal Stem Cells into Adipocytes in Bone Marrow

**EtOH induces ROS in mouse tibia**

Nitrotyrosine Staining (10x)


A: Control, B: EtOH, C: NAC, D: EtOH + NAC
Alcohol also Acts as an Endocrine Disruptor of the Vitamin D3/Calcium Axis

Dietary Vitamin D3 Supplementation Reverses Alcoholic Osteopenia in Female Mice

PF – pair fed    EtOH – alcohol treated    VitD – vitamin D

CTX – collagen cross links – bone resorption marker
TRAP – tartarate resistant acid phosphatase – bone resorption marker.
RANKL – TNF family member regulator of osteoclastogenesis
Cathepsin K – marker of osteoclast function

Osteocalcin – bone formation marker
Col1A1 – collagen – marker of osteoblast function

Dietary Feeding of Blueberries (BB) Dose-Dependently Increase Bone Mass Via Phenolic Acid Activation of GPR109A

Zhang et al. Plos One 8(8) e70438, 2013.