

FT-IR IMAGING ANALYSIS OF BONE MINERAL CHANGES IN OVARIECTOMIZED AND DIETARY INDUCED METABOLIC ACIDOSIS TREATED SHEEP

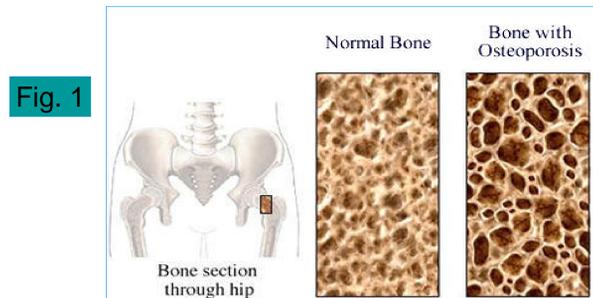
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INTRODUCTION

Osteoporosis (OP) is defined as a skeletal disorder characterized by low bone mass and structural deterioration of bone tissue, leading to bone fragility and an increased susceptibility to fractures of the hip, spine, and wrist¹ (Fig. 1).

Osteoporosis, a major public health problem:

- affects over 10 million Americans
- 34 million more have low bone mass, and are at risk for OP



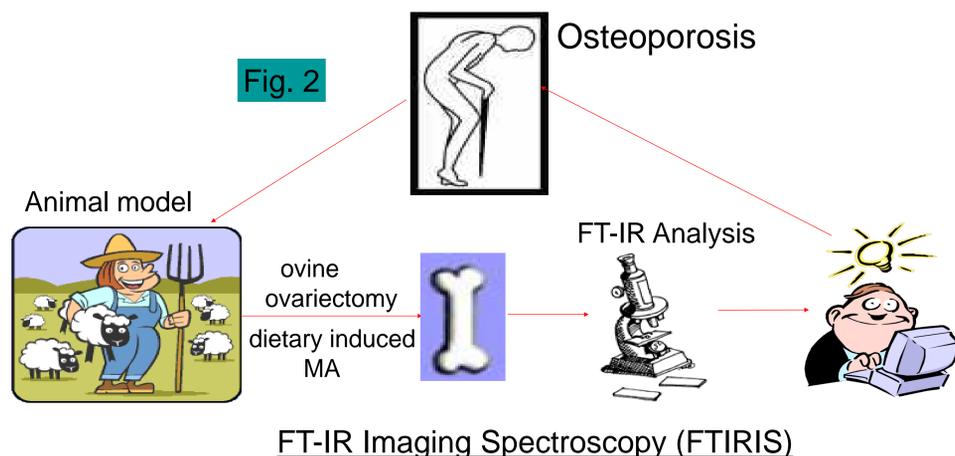
The etiology of osteoporosis OP is multifactorial^{2,3} and can be influenced by:

- genetics
- gonadal hormone levels
- dietary induced metabolic acidosis
- alcohol consumption
- smoking
- long term steroid use

Animal models are used in the study of osteopenia and osteoporosis to minimize the effect of confounding factors and provide access to tissues for analyses.

STUDY AIM (SHEEP MODEL)

Compare the effects of ovariectomy and dietary induced metabolic acidosis on bone mineral properties in the vertebrae using FT-IR Imaging Spectroscopy (FTIRI) (Fig. 2).

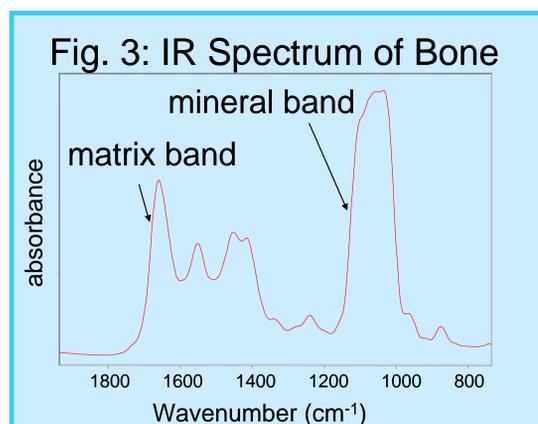


• a well-established technique that has been successfully applied to study molecular changes in bone⁴.

• spatial resolution of ~7 μm in histological sections.

• The collagen **matrix** (amide I band) and **mineral** (phosphate) constituents in bone produce intense, structure sensitive IR absorbance bands (Fig.3).

• **Mineral:matrix** ratios, calculated from the integrated areas of the phosphate and amide I absorbance bands are correlated with ash weight and are an indicator of mineral content.⁵



MATERIALS & METHODS

Three groups of six skeletally mature (4-7 year old) Rambouillet-Columbia cross ewes

- **Group 1** control (normal diet-ND)
- **Group 2** consumed a normal diet and were ovariectomized (OVX)
- **Group 3** consumed a diet that induced metabolic acidosis (MA) without OVX.

After 180 days bone biopsies from the lumbar vertebrae were taken from each animal for FT-IR image analysis in transmission mode.

RESULTS

Differences exist in the mineral content and mineral distribution between the three groups (Fig. 4).

- The MA treated group had a significantly lower mineral content ($p < 0.05$) than both the control group and the OVX group. There was no histologic evidence of osteomalacia (not shown).
- There were no significant differences in mineral content and distribution between the OVX group and the controls.

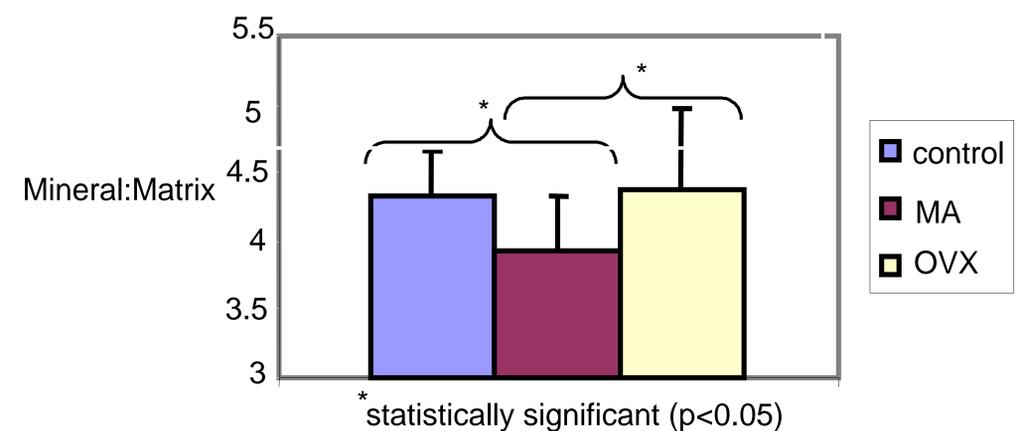
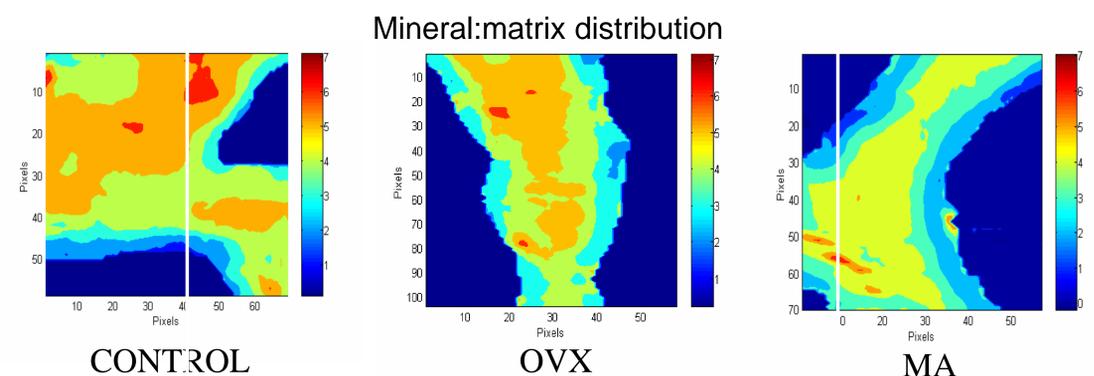


Fig. 4: Bone mineral changes in control, ovariectomized and metabolic acidosis treated sheep

DISCUSSION

• FT-IRI Analysis shows that after 180 days the mineral content of trabecular bone from the lumbar vertebrae of sheep is significantly less mineralized compared both to control and to ovariectomy.

• The MA sheep bone has less mineral and shows less variation in the mineral to matrix distribution which is similar to that seen in human osteoporosis⁴.

• From this study, dietary induced metabolic acidosis in sheep provides a model for studying human osteoporosis by rapidly inducing osteopenia and osteoporotic changes in bone.

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