Bone densitometry and bone markers in wild ungulates. Possible future application.

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Introduction

Animal health has a huge impact on public health, food production, economy and environment. The animals, and especially wildlife, are considered the source of more than 70% of emerging diseases. Health surveillance of wildlife is critical in order to control these diseases. This surveillance includes the capture and handling of animals for different purposes. In these operations a stress response occurs and the risk of traumatic injuries increases. Many of the traditional imaging diagnostic techniques are already widely used in veterinary. By contrast, the use of QUS, DXA and biochemical markers of bone remodeling is not widespread. This is accentuated in the field of wildlife. Our intention is to make a review of the noninvasive diagnostic methods for assessing bone status, with particular attention to the DXA and bone biochemical markers.

Assessment of bone density and biomechanical properties

Bone mass decrease → Bone fragility → Major fracture risk

Bone mass is evaluated by measuring bone mineral density (BMD). The leading techniques that exist to assess BMD are DXA and QUS.

Quantitative Ultrasound (QUS):

It is a diagnostic method capable of measuring the properties of bone that does not use ionizing radiation.

Human medicine: routinely used to assess and monitor metabolic bone diseases, evaluate the effects of exercise, and to predict stress fractures.

Veterinary medicine: its use highlights in horses and has been validated to measure bone properties in different anatomical areas. It is a monitoring tool with great potential for the detection of fracture risk[1].

Dual-energy X-ray absorptiometry (DXA):

It is an indirect technique of body composition analysis.

Human medicine: It is the standard method for noninvasive assessment of the mineral content and BMD.

Veterinary medicine: it has been used in the food industry, anatomy, nutrition, internal medicine, orthopedics and diagnostic imaging.
DXA has been practiced in research animals (rodents), domestic animals (horse, cat, dog, rabbit and guinea pig), livestock animals (sheep, goat, cow, pig, chicken and turkey) and wildlife (non-human primates, reptiles, marine mammals and different groups of birds)[2].

Assessment of bone metabolism

Bone markers (*table 1)* are enzymes derived from bone cells or bone matrix components. They can be determined in blood and/or urine. The amount of bone mass depends on the balance between bone production and bone resorption (*figure 1).*

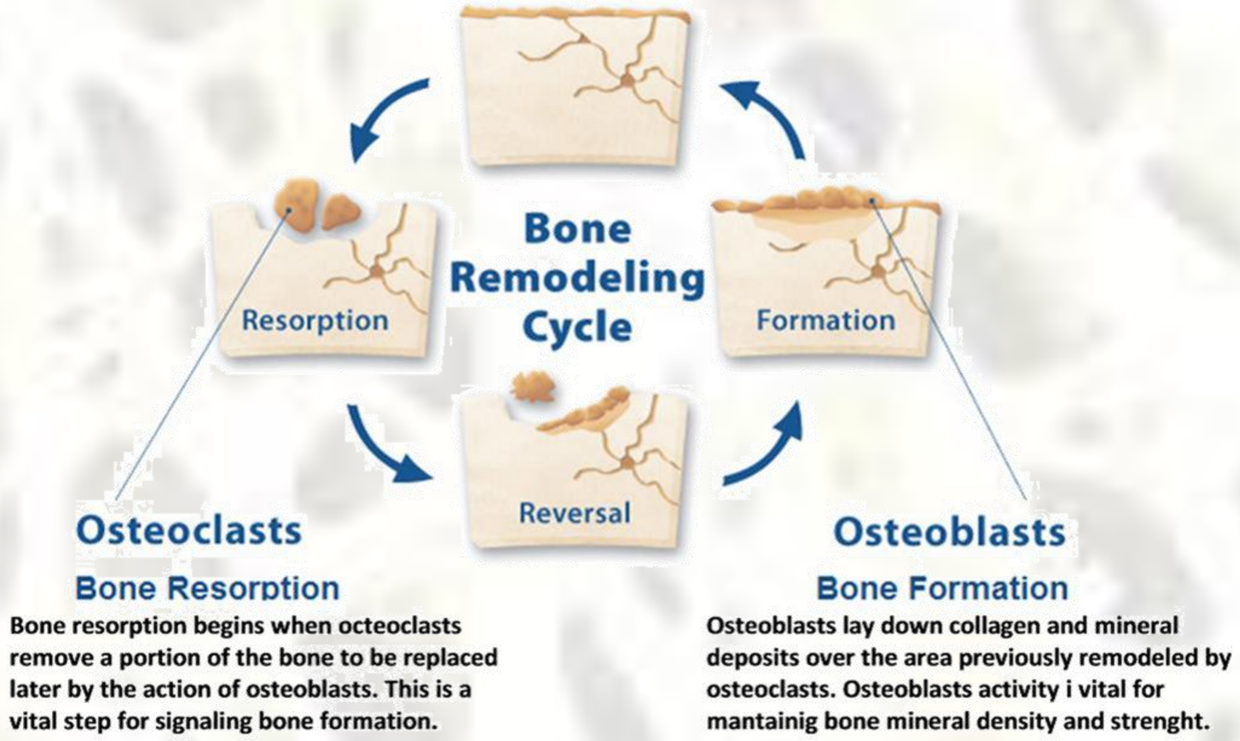

Figure 1: Bone Remodeling Cycle

They do not provide information about skeletal mass and architecture of bone. It is a method to aid diagnosis and therapeutic monitoring of metabolic bone diseases.

Table 1: Biochemical Markers of Bone Turnover

Biochemical Markers of Bone Turnover	
Bone Formation Markers	**Bone Resorption Markers**
Total Alkaline Phosphatase (ALP)	Calciuria
Bone Alkaline Phosphatase (BALP)	Hydroxyproline (HOP)
Osteocalcin (OC)	Pyridinolines (Pyr and D-Pyr)
Terminal propeptide of type I procollagen (PICP)	Carboxy-terminal telopeptide (CTX and ICTP and amino terminal (NTX) type I collagen)

There are RIA and ELISA commercial kits in human medicine for the assessment of these bone markers.

Veterinary medicine: Bone markers are still under study. Despite its great potential, its application has been limited mainly to research. They have been studied in cow, horse dog, cat and pig.

Some animals markers can be evaluated with human commercial kits, as they have acceptable cross-reactivity for BALP, PICP, OC, Carboxy-terminal telopeptide and pyridinolines in some species[3].

Conclusions

1. Bone assessment by QUS has been of great interest in human medicine. As for veterinary medicine, QUS has great potential for assessing bone status in animals. Yet, more studies are needed in order to use this technique to determine the risk of bone fracture.

2. The DXA has been used in several animal species. However, there are a large number of animals that has ever been used on. This is particularly pronounced in wildlife. The DXA has not been validated in wild ungulates. To establish benchmarks and validate the test in these species, we believe the protocol used by Zotti *et al.* (2003)[4] could be a model to start with it.

3. Biochemical bone markers use in human medicine is increasing. In veterinary medicine, they have potential to provide valuable information regarding bone turnover. This requires standardization of analytical techniques and the pre-analytical conditions, and identifying the factors that could change their concentrations in blood.

4. The interpretation of the measured changes in bone metabolism, structure and BMD, should be helpful in the future to identify animals at risk of fracture. For future evaluation of the bone structure of wild ungulates, it would be best the combine use of noninvasive methods described throughout this literature review, as each gives us different information.

References

1. Lepage, O. M., Carstanjen, B., and Uebelhart, D. (2001). Non-invasive assessment of equine bone: an update. *Vet J, 161(1), 10–22.*

2. Stone, M. D., and Turner, A. J. (2012). Use of Dual-Energy X-Ray Absorptiometry (DXA) with Non-Human Vertebrates: Application, Challenges, and Practical Considerations for Research and Clinical Practice. In: *A Bird's-Eye of Veterinary Medicine. Croatia. Ed: In Tech. pp. 99 – 116.*

3. Allen, M. J. (2003). Biochemical Markers of Bone Metabolism in Animals : Uses and Limitations. *Vet Clin Pathol, 32(3), 101–113.*

4. Zotti, A., Rizzi, C., Chiericato, G., and Bernardini, D. (2003). Accuracy and Precision of Dual-Energy X-Ray Absorptiometry for Ex Vivo Determination of Mineral Content in Turkey Poult Bones. *Vet Radiol Ultrasound, 1, 49 – 52.*