

DYSBARIC OSTEONECROSIS IN UW SHEEP DISSUB STUDY AFTER A 3-HOUR OXYGEN PRE-BREATHE FOLLOWED BY A ONE-HOUR AIR BREAK BEFORE DROPOUT DECOMPRESSION

Sobakin AS¹, Lehner CE¹, Dueland RT¹, Wilson MA²,
Gendron-Fitzpatrick AP³, Abraham JL¹.

¹Dept. of Surgical Sciences, ²Dept. of Radiology UW Hospital and
Clinics, ³Comparative Pathology Lab, Research Animal Resources
Center, University of Wisconsin-Madison, Madison, WI, USA.



Background

- The UW Diving Physiology Laboratory has demonstrated that oxygen pre-breathes (15-min, 1-h, and 2-h) before “drop-out” decompression may reduce DCS morbidity/mortality risk in personnel of disabled submarine (DISSUB).
- Even a 2-h O₂ pre-breathe did not prevent the induction of a dysbaric osteonecrosis (DON) in the UW sheep model of the decompressed human.
- In this study, we investigated the potentially mitigating effect of 3-h oxygen pre-breathing followed by a 1-h air break before decompression to surface.

Materials and Methods

- Nine adult female sheep (86-105 kg) underwent dry chamber air exposure at 60 fsw (2.79 atm abs) for 24 hours, followed by an oxygen (88-92%) pre-breathe for 3-h plus a 1-h air break before “dropout” decompression at 30 feet/min (0.9 atm/min) to surface.
- One month after decompression, we used ^{99m}Tc -methylene diphosphonate (MDP) bone scans of radii and tibiae to monitor “hot spots” of remodeling DON lesions.
- Alizarin complexone fluorochrome was injected IV to visualize DON repair.
- One week later, sheep underwent euthanasia and necropsy to observe DON pathology.

Bone scan of sheep with Tc99m MDP used to detect new bone formation of DON lesions undergoing repair.



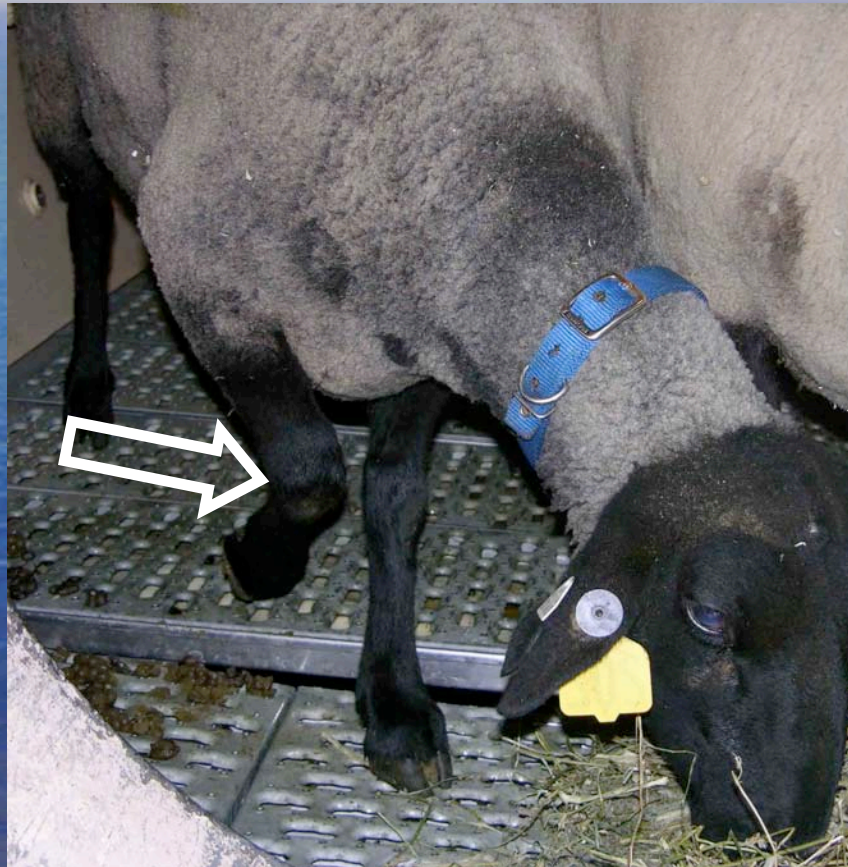
Doppler ultrasound probe detection of circulating bubbles in the decompressed sheep at the precordium



Results

- Nine out of 9 animals (100%) survived the provocative “drop-out” decompression to atmospheric pressure. All nine sheep showed frank signs of limb bends. All sheep were ambulatory at four hours and none required early euthanasia.
- DON developed in all sheep with 100% having bone scan abnormalities indicative of active remodeling typical of DON.
- The average number of DON lesions per long bone was 2.4 (range 1- 4). There were 13 DON lesions observed in the radius (59% of all lesions) and 9 in the tibia.
- Gross pathology confirmed new bone remodeling repair of DON in bone scan “hot spots.”

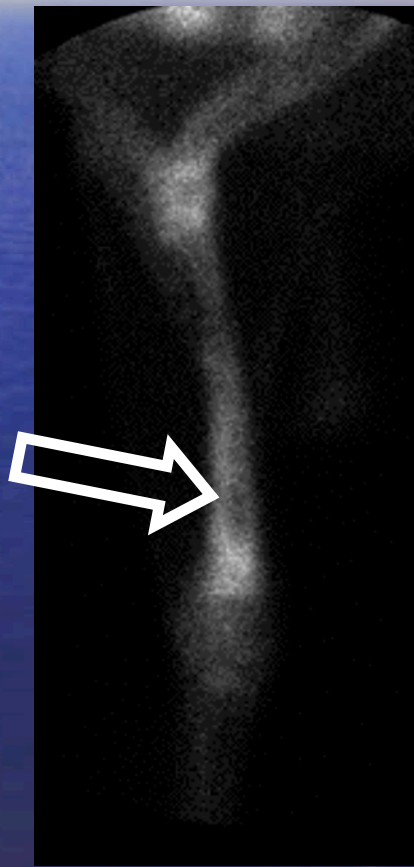
Sheep #192 with a flexed limb, the classic sign of limb bends in the decompressed UW sheep. She wears a loose collar.



The Right Radius of Sheep # 193



Alizarin

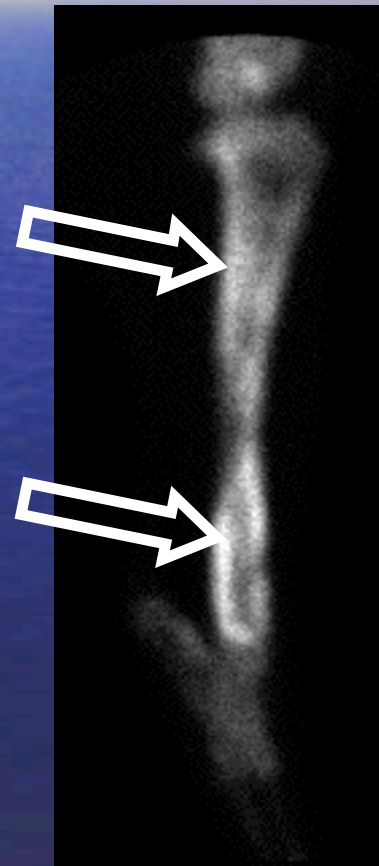


Scan

The right tibia of Sheep #193.



Alizarin



Scan

Conclusions

- This study suggests that 3-h O₂ pre-breathing followed by a 1-h air break that emulated submarine escape and rescue did not prevent the induction of DON in the UW sheep model of the decompressed human.
- Although O₂ pre-breathing in the decompressed human or experimental animal enhances N₂ tissue washout, the extent of washout benefit reflects tissue composition, tissue architecture, and tissue blood flow rates.
- Decompression-induced bubble formation likely slows N₂ gas tissue washout and may lead to pathogenic tissue ischemia and osteonecrosis. This dysbaric osteonecrosis (DON) may be followed by disabling secondary osteoarthritis.