

COMPARISON OF DYSBARIC OSTEONECROSIS SEVERITY IN THE UW SHEEP MODEL AFTER A 24 HOUR DIVE AT 60 FSW FOLLOWED BY EITHER A 15-MIN, 1-H, OR 2-H OXYGEN PRE-BREATHES BEFORE DROP-OUT DECOMPRESSION



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Introduction:

After a provocative dive, bubble formation in fatty long bone marrow may lead to a bone compartment syndrome of elevated intramedullary pressure with bone and marrow ischemia and necrosis. We evaluated oxygen pre-breathes (15-min, 1-h, and 2-h) to determine which would be most likely to provoke dysbaric osteonecrosis (DON) and where DON would occur.



Figure 1. Bone sites used to calculate alizarin deposition.

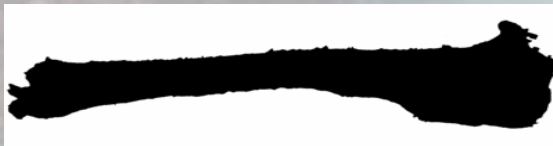


Figure 3. Whole area of bone using Scion Image software (right tibia Sheep 168).

Discussion and Conclusions:

Brief 15-min O₂ pre-breathe dives show greater DON severity than 1-h and 2-h O₂ dives. In humans, DON often may trigger secondary osteoarthritis. These findings indicate that even a 2-h O₂ pre-breathing did not prevent DON in decompressed sheep, but enabled "dropout" survival.

Materials and Methods:

Twelve adult female sheep (99 ± 14 kg SD) underwent dry chamber air exposure at 60 fsw (2.79 atm abs) for 24 h followed by oxygen (88-92%) pre-breathes either (15-min, 1-h, or 2-h) before "dropout" decompression 30 fsw/min (0.91 atm/min). One month later, 99mTc-methylene diphosphonate (MDP) bone scans of radii and tibiae were used to detect "hot spots" of remodeling DON lesions. Alizarin complexone fluorochrome was injected IV to visualize sites of DON repair. Six weeks post "dropout" decompression, sheep underwent euthanasia and necropsy to observe DON pathology. Images of long bone gross pathology were taken. Using *Scion Image* software (Scion Corporation, Frederick, MD), we mapped the areal extent of alizarin complexone deposition as the index of DON severity. Statistical analysis of DON severity was performed using a two-way repeated measures analysis of variance (ANOVA) model. The two factors were bone types (femur, humerus, radius, tibia) and oxygen groups. Repeated-measures ANOVA were used because there were multiple measurements of each sheep (each of the four bones).



Figure 2. UW sheep model of dysbaric osteonecrosis pathology: extensive bone marrow necrosis and bone remodeling occurred in the right tibia (Sheep 168).



Figure 4. The affected area of bone with alizarin complexone deposition (right tibia Sheep 168).

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Results:

Alizarin complexone deposition was greater in sheep experiencing 15-min O₂ pre-breathe dives than in sheep undergoing 1-h and 2-h O₂ pre-breathe dives ($P=0.0056$, $P=0.001$, respectively). However, there was no statistical difference between the 1-h and 2-h O₂ pre-breathe groups ($p=0.2538$). Proximal limb bones (femur, humerus) were less affected than distal bones ($P<0.0001$). Overall, bone scans of early DON did not reveal fully the extent of widespread bone and marrow necrosis induced and later observed in these animals at necropsy.

Least Squares Means of Alizarine Deposition in Sheep Bones

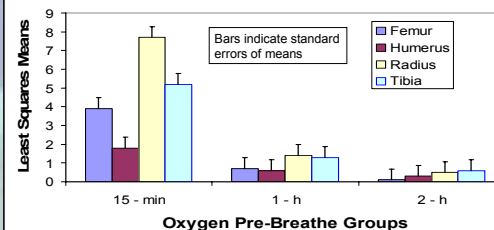


Figure 5. Least square histogram with 95% confidence interval of alizarin deposition in sheep long bones.

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