DYSBARIC OSTEONECROSIS IN UW SHEEP DISSUB TRIALS AFTER A 3-HOUR OXYGEN PRE-BREATHE BEFORE DROP-OUT DECOMPRESSION

Sobakin AS[1], Lehner CE[1], Wilson MA[2], Gendron-Fitzpatrick AP[3], Sauder AM[1], Eldridge MW[1].

[1]Dept. of Pediatrics, School of Medicine and Public Health, [2] Dept. of Radiology UW Hospital and Clinics, [3] Comparative Pathology Laboratory Research Animal Resources Center, University of Wisconsin-Madison, Madison, WI, 53706 USA.

Background:

We have previously demonstrated that oxygen "pre-breathes" before "drop-out" decompression may reduce DCS morbidity/mortality risk, but did not prevent the induction of a dysbaric osteonecrosis (DON) in the UW sheep model of the decompressed human. This ongoing study explores the potentially mitigating effect of 3-h inspired oxygen pre-breathing at 60 fsw before emergency escape.

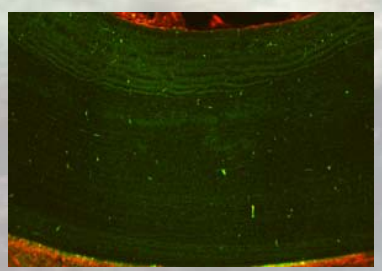

Figure 4. Live/Dead stain observation in the cortical bone Sheep # 215.

Materials and Methods:

Ten adult female sheep (91.4 ± 9.2 SD kg) underwent dry chamber air exposure at 60 fsw (2.8 atm abs) for 24 hours, followed by an oxygen (88-92%) pre-breathe for 3-h before "dropout" decompression at 30 feet/min (0.9 atm/min) to surface. One month after decompression, we used 99mTc-methylene diphosphonate (MDP) bone scans of radii and tibiae to detect "hot spots" of remodeling DON lesions. Alizarin complexone fluorochrome was injected IV to visualize DON repair. One week later, the sheep underwent necropsy for gross evaluation of DON pathology.

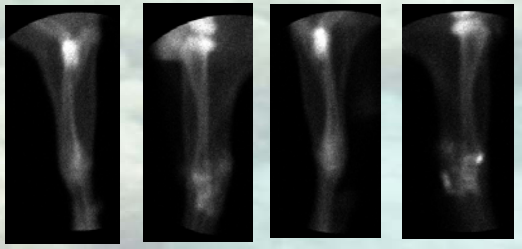

Figure 1. The bone scan of Sheep # 215. There are no lesions found.

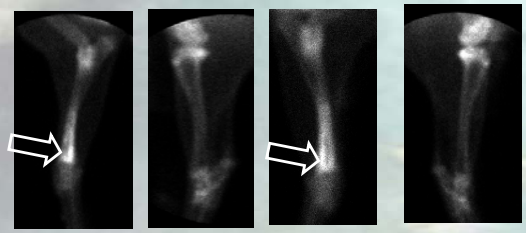

Figure 2. A distal "hot spot" (arrows) occurred in the DON-affected Sheep # 217 radius .

Figure 3. UW sheep model of dysbaric osteonecrosis pathology: extensive bone marrow necrosis and bone remodeling in the left radius of Sheep # 217.

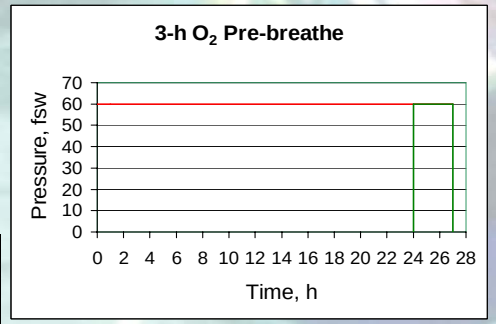

Figure 5. Oxygen pre-breathe trial with 24-h at 60 fsw exposures.

Results:

All 10 animals survived the provocative "drop-out" decompression. Six showed frank signs of limb bends, with one animal developing signs of respiratory decompression sickness (RDCS). All the sheep were ambulatory at four hours and none required early euthanasia. Six animals developed DON with 100% agreement between bone-scan (hot-spot) and gross pathology abnormalities, all indicative of active bone remodeling. In the six animals that developed DON three had lesions in all long bones, and three had lesions in only two long bones. Overall, we found 18 lesions with 11 in the radius and 7 in the tibia.

Discussion and Conclusions:

Previous studies using this decompression scenario without oxygen pre-breathing resulted in 100% mortality. This study strongly suggests that 3-h O_2 pre-breathing of emulated submarine escape and rescue will enhance survival and reduce DON in the UW sheep model of the decompressed human. Although O_2 pre-breathing in the decompressed human or experimental animal enhances N_2 tissue washout, the extent of washout benefit reflects tissue composition, tissue architecture, and tissue blood flow rates. Decompression-induced bubble formation likely slows N_2 gas tissue washout and may lead to pathogenic tissue ischemia and osteonecrosis. This dysbaric osteonecrosis (DON) may be followed by disabling secondary osteoarthritis.

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