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

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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). But 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.

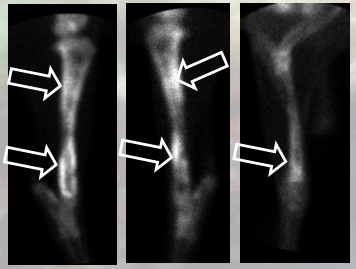

Figure 1. A distal and proximal "hot spot" (arrows) occurred in the DON-affected sheep tibia and radius.

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 99mTc-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.

Figure 2A. The right radius of Sheep # 193.

Figure 2B. The right tibia of Sheep #193.

Figure 2. UW sheep model of dysbaric osteonecrosis pathology: extensive bone marrow necrosis and bone remodeling in the left tibia of Sheep # 193.

Figure 3. Bone scan of sheep with Tc99m MDP used to detect new bone formation of DON lesions undergoing repair.

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."

Discussion and 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.

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