



15 AND 45 MINUTES OF OXYGEN PRE-BREATHE SIGNIFICANTLY REDUCES SEVERE DECOMPRESSION ILLNESS AFTER SATURATION DROPOUT IN 70 KG SWINE

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Abstract

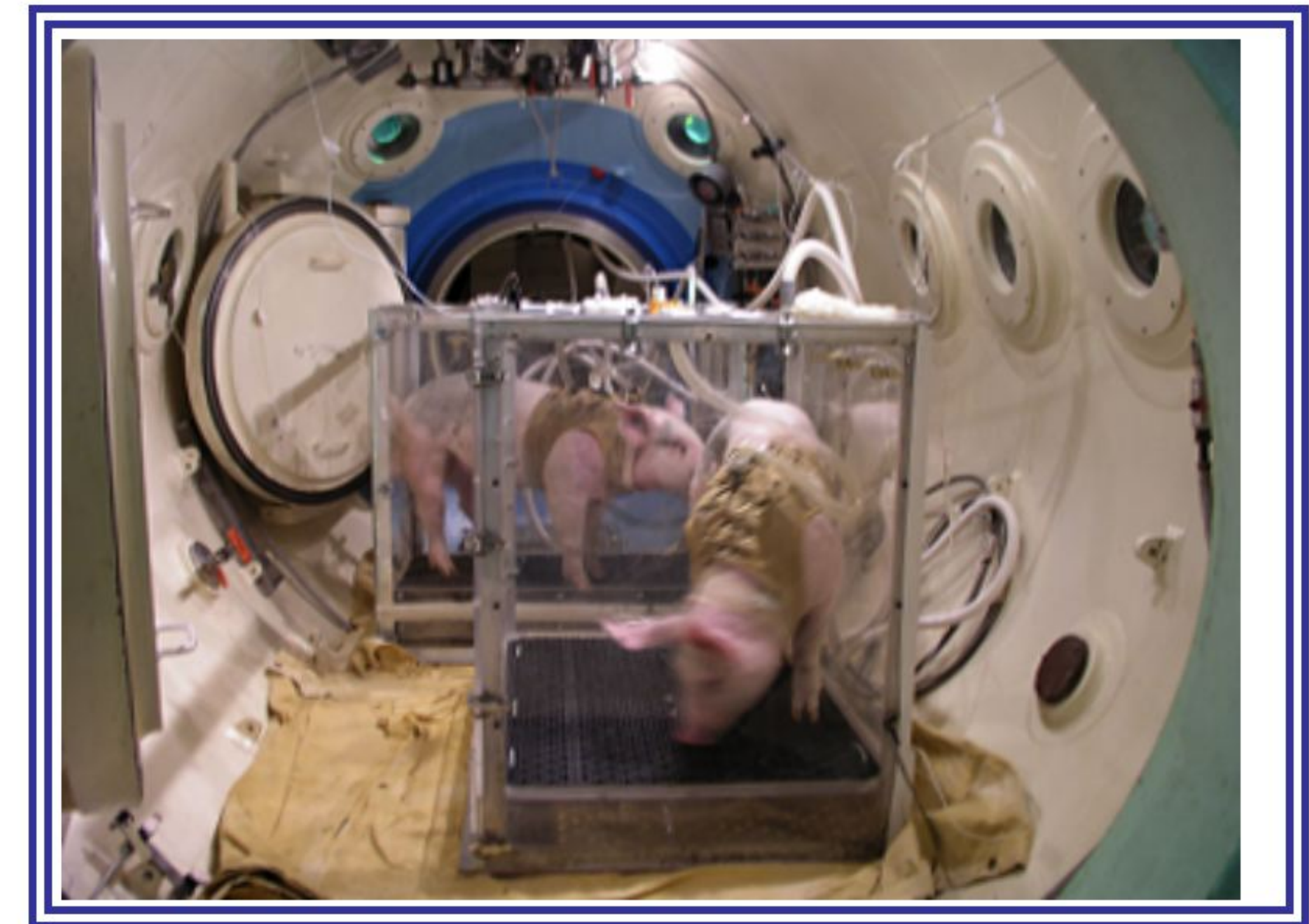
Introduction: Breathing 100% O₂ prior to decompression reduces the incidence of altitude decompression illness (DCI). Similarly, we have previously demonstrated that an isobaric oxygen prebreathe (OPB) of ≥ 1 h will eliminate lethal DCI. However, the use of OPB < 1 h has not been studied in the hyperbaric environment. This study reports the results of OPB of < 1 h in a swine model of saturation at 2.8 ATA (60 fsw) followed by rapid decompression to surface.

Methods: Unrestrained, catheterized, male Yorks hire swine (68.5 kg +/- 2.4kg) were placed in individual Plexiglas boxes within a large animal hyperbaric chamber. The chamber was compressed with air to 2.8 ATA for 22 h. Following saturation and while still at depth, gas to the boxes was remotely switched so that the animals received either 1) 45 min O₂ pre-breathe; 2) 15 min O₂ pre-breathe, or 3) no O₂ pre-breathe (control) prior to rapid decompression (0.91 ATA/min) to surface. Animals were then observed for signs of DCI. Animals with severe DCI (cardiopulmonary or neurologic) were euthanized and sent for necropsy. Animals without severe DCI were observed for 6 days and then underwent necropsy. The lungs were inflated with 1.5% agarose in isotonic saline, fixed, and counterstained with H and E.

Results: 45 min of OPB at 2.8 ATA eliminated severe DCI from saturation dropout. DCI was reduced from 73% (8/11) in control animals to 8% (1/13) with 15 min OPB. Both periods of OPB represent a statistically significant improvement (p<0.0001) over no OPB. OPB also resulted in significant decreases in *cutis marmorata* (p<0.0005). No evidence of lung histopathologic abnormalities was observed in swine that did not suffer from DCI.

Conclusions: OPB of 15 and 45 minutes significantly reduces severe DCI following dropout decompression from saturation at 2.8 ATA in 70 kg swine. These results demonstrate that even very short periods of OPB could be expected to improve outcome in a disabled submarine scenario.

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Methods

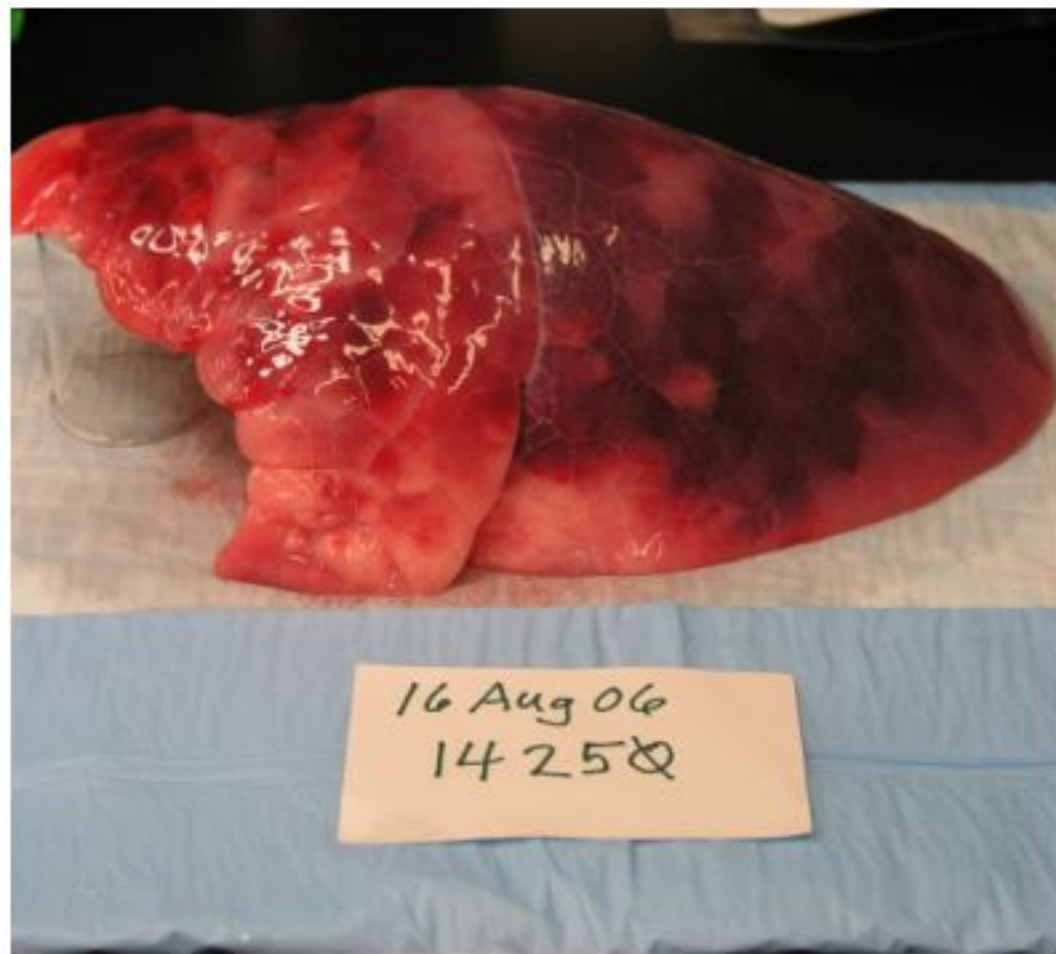
- Animals**
- Neutered male Yorkshire swine (*sus scrofa*)
- Pre-dive Preparation**
- A customized catheter was inserted into the left external jugular vein.
 - A custom designed fabric vest was fitted around the animal’s thorax and back, securing and protecting the catheter line and port.
 - After 24h of recovery the animals were lead into Plexiglas Boxes within the Multiple Large Animal Chamber (MLAC)
- Hyperbaric Exposure Protocol**
- The catheter extension line was freed from the vest, fed through a Tygon tube and the animal was placed in a modified transport kennel. A 360° swivel, allowed the animal to move freely without twisting the line.
 - Animals compressed to 2.82 ATA with air. Compression began at 0.15 ATA · min⁻¹. until reaching test pressure.
 - Temperature was maintained between 26.7-29.4° C, humidity between 50-75%, and CO₂ concentration was < 0.3%.
 - After 22 h, Paired animals received either 45min 100% oxygen; 15 min 100% oxygen or were directly decompressed (control).
 - Animals were decompressed at a rate of 0.91 ATA · min⁻¹ without decompression stops.
 - Dedicated observers recorded signs of DCS to the nearest minute for 2 h.
 - Animals without severe DCS recovered for one week.

Type II DCS Criteria
Neurological

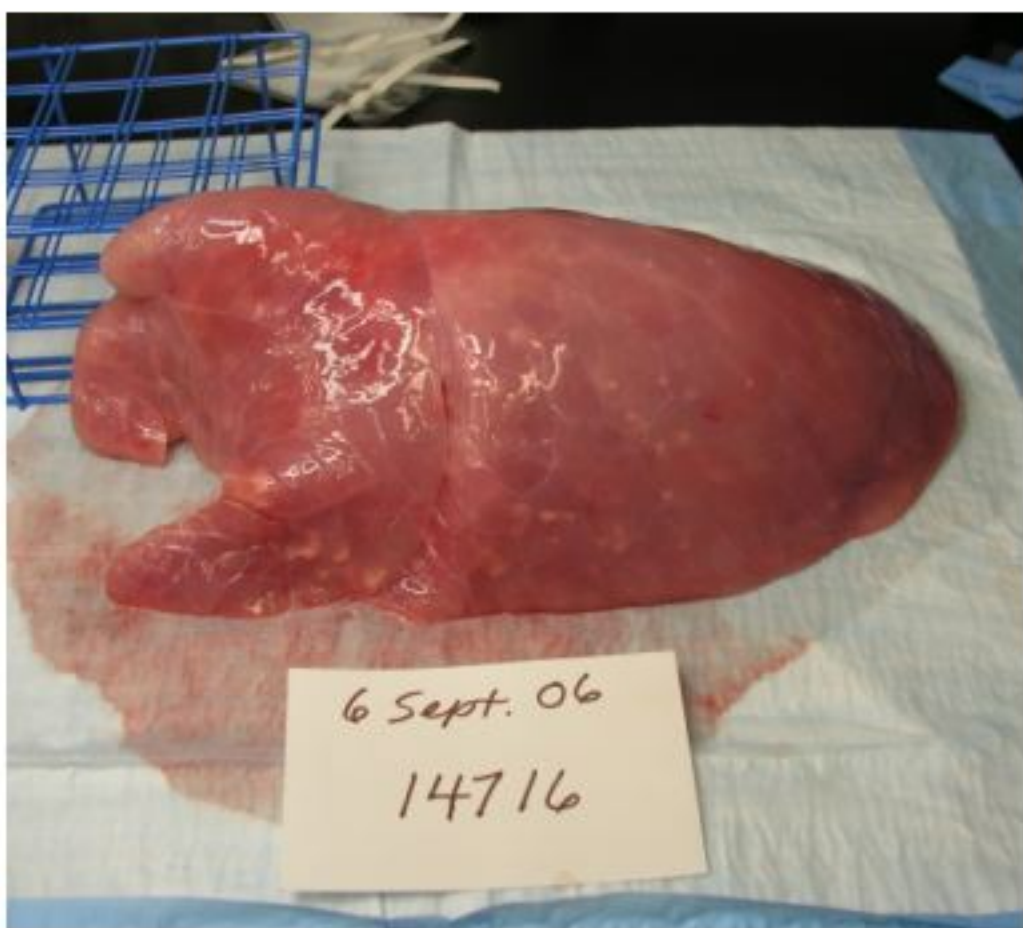
- Motor deficit (limb weakness, repeated inability to stand after being righted by the investigator),
- Paralysis (limb flaccidity, areflexia, hypotonia),
- Cranial nerve dysfunction
- Seizure activity

Cardio-Pulmonary

- Respiratory distress, and
- RR > 200% increase surface baseline
 - HR > 150% increase surface baseline
 - SpO2 <80%
- All maintained for at least 1 minute.



Lung Pathology: Examples of severe cardiopulmonary DCS.



Lung Pathology: Lungs after 7 days post-surface (surviving animals) shown no abnormalities in histology when compared to non-exposed controls

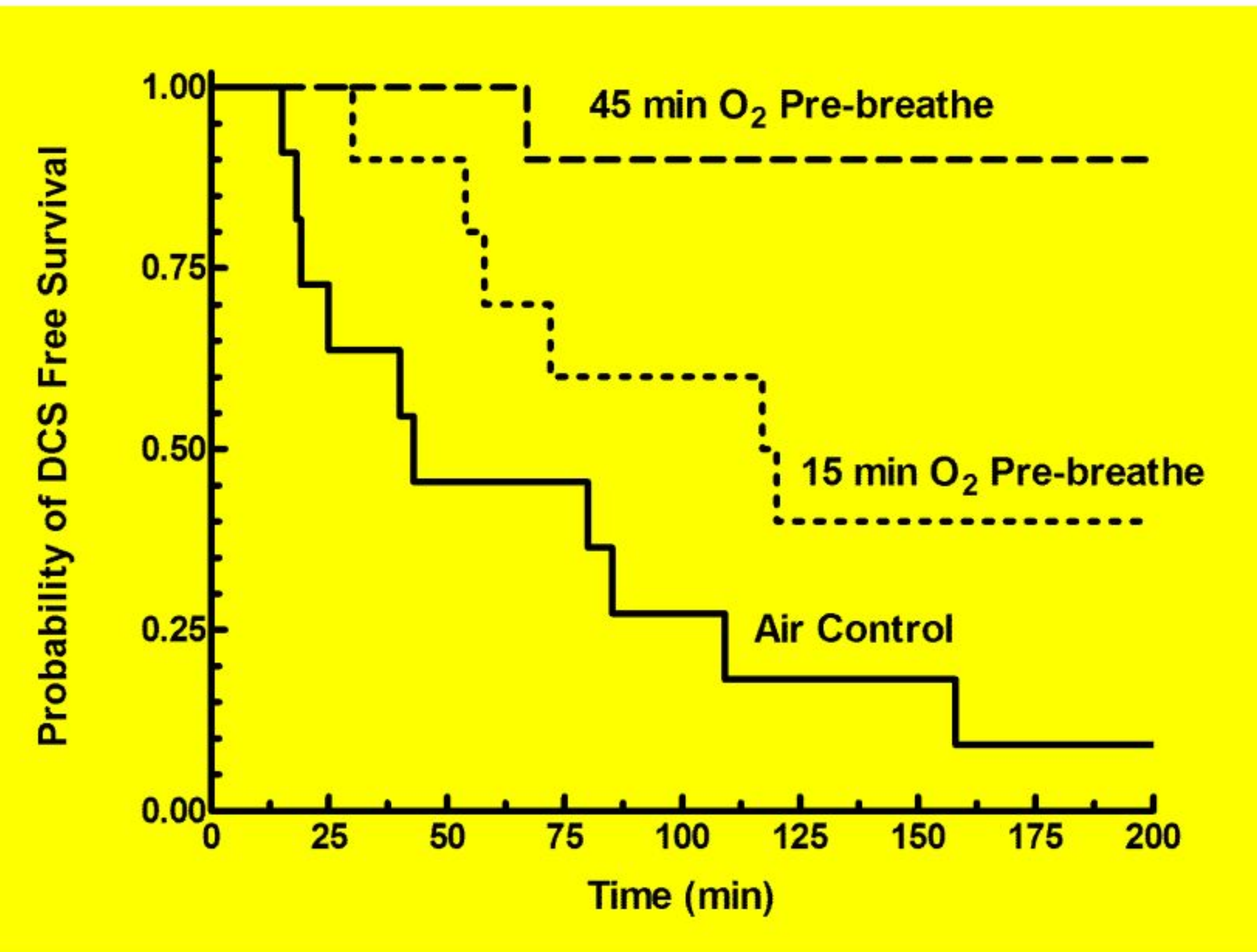


Example of cutis DCS

Results

Group	n	DCS _{cutis}	DCS _{neuro}	DCS _{cardiopulm}
Control	11	10	5	8
OPB ₁₅	13	6	1	0
OPB ₄₅	10	1	0	0

Group characteristics where for the control, oxygen prebreathe of 15 minutes (OPB₁₅) and oxygen prebreathe of 45 minutes (OPB₄₅). Where DCS_{cutis} = number of subjects with cutis DCS, DCS_{neuro} = number of subjects with neurologic DCS, and DCS_{cardiopulm} = number of subjects with cardiopulmonary DCS



Kaplan-Meier curves for the proportion of subjects without manifestations of Type II or Cutis DCS vs. time after surfacing for the three treatment groups.

Conclusions

OPB at 2.8 ATA eliminates cardiopulmonary DCS in a dropout from saturation decompression swine model
OPB reduces Cutis Marmorata and delays its onset
Survivors of OPB shown normal lung histology at one week

If I was on a DISSUB I’d want OPB