Pancreatitis and Hyperbaric Oxygen Therapy

Pancreatitis is an inflammatory disease that can be mild/subclinical, acute, severe (systemic complications) or chronic (permanent disease). Severe pancreatitis can be associated with peripheral and systemic secondary alterations that can lead to severe systemic disease and even multi-organ failure. Acute pancreatitis can be successfully treated and the pancreas does have a good healing reserve and regeneration capacity, if the acute syndrome is properly managed. Pancreatitis in domestic small animals has many potential causes and predisposing factors including idiopathic to dietary to genetic to traumatic etiologies. Signs vary depending on the stage of disease and degree of any systemic involvement.

The table below summarizes the beneficial effects of hyperbaric oxygen therapy in the treatment of acute pancreatitis. As with many other diseases, early treatment generally produces the best results. Hyperbaric oxygen is used on conjunction with other conventional therapies for the best outcome. Hyperbaric oxygen reduces morbidity and shortens hospitalization associated with acute pancreatitis.

Characteristics of Pancreatitis	**Benefits of Hyperbaric Oxygen Therapy**
Microcirculatory alterations	Supports microvascular health and vessel integrity
Tissue hypoxia	Increased tissue oxygenation, ↓ hypoxia
Tissue hypoxia, acidosis	Reduces tissue CO2 and lactate
Tissue edema	Tissue edema reduction
Ischemia-reperfusion disease	↓ hypoxia, ↓ neutrophil adhesion to venules
↓ red cell density and velocity in capillaries	Increased deformability of RBCs
Mitochondrial damage & oxidant release (ROSs) reduced peripheral anti-oxidants	Decrease tissue reactive oxygen species, increase endogenous anti-oxidants
Local and systemic inflammation	Anti-inflammatory
Recruitment of WBCs and ↑ cytokine production	Reduces neutrophil chemotaxis and cytokine production
Activation of coagulation cascade	Reduces platelet aggregation
Potential for bacterial translocation	Bacteriostatic and/or bacteriocidal
Hypoxia impairs neutrophilic bacterial killing	Restores optimal oxygen concentrations for neutrophil phagocytosis
Tissue cell death/necrosis	Reduces/blocks apoptosis
Abdominal pain	Analgesic

Pathophysiologic changes in pancreatitis

1. decreased secretion of pancreatic juices initially
2. co-localization of zymogen granules and lysozymes → activation of trypsinogen to trypsin → activates more trypsinogen and other zymogens → local damage with **edema**, bleeding, **inflammation, necrosis**, peri-pancreatic fat necrosis.
3. Inflammatory process → **recruitment of WBCs and cytokine production**
4. Activated enzymes and cytokines circulate → distant complications generalized inflammation, peritonitis, DIC, pancreatic encephalopathy, hypotension, other organ disease.

Activation of pro inflammatory cytokines IL-10 and 11
Inducible transcription factor NF-kB, TNFa, IL-6 & 8, substance P, IL-1 → generalized neutrophil and monocyte activation → **edema & hypoxia**.

5. **increased capillary permeability**, decreased splanchnic blood flow, **decreased pancreatic perfusion, decreased red cell density and red cell velocity in capillaries** and venules → **reduced capillary perfusion.**
6. **Bacterial translocation** from inflamed gut
7. **Mitochondrial damage** and **oxidant release** perpetuates pancreatitis
   Increased myeloperoxidase, thiobarbituric acid reactive substances, protein carbonyl
   Reduced peripheral antioxidants
8. **Activation of the coagulation cascade**
   Activation of platelet activating factor
   Increase in c-reactive protein in dogs
9. **alterations in microcirculation**
10. **IR disease**
11. leukocyte and cytokine activation

Beneficial Effects of HBOT

1. anti-inflammatory - reduces levels of inflammatory mediators
2. Increased tissue oxygenation
3. Increased deformability of RBCs
4. Evidence that HBOT decreases ROS's in the tissue
5. Reduce hemodynamic derangement in severe infections and inflammation.
6. Reduction in cytokine release by activated inflammatory cells.
   HBO reduces release of TNF-a and IL-6 in animal models of pancreatitis
7. Bacteriostatic and bacteriocidal (anaerobes) for some bacteria
   Pressure may slows bacterial replication
   Leukocyte bacterial killing substantially impaired in low oxygen tensions, increases the phagocytic ability of WBC
8. Restores optimal oxygen tensions in diseased tissues
9. Reduces neutrophil chemotaxis
10. Reduces tissue level of CO2 and lactate

Application of HBOT in animals

Hyperbaric protocols – small animals

1. Either 30min @10-14psi day 1 depending on chest, etc. sometimes treat twice the first day if severe/necrotizing. Use 30@14.7 once a day for about 2- 3 d after that.
2. Treatment initiation – As with most diseases, early initiation of treatment is usually met with the best results.

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