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# Theories for Hyperbaric Therapy in Tissue Regeneration

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# "Putting the Pressure on Disease"

## Theories for Hyperbaric Medicine in Tissue Regeneration

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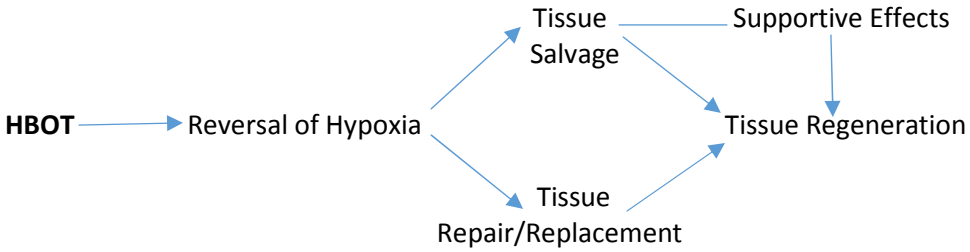
I. Beneficial Effects of Hyperbaric Therapy
- Reduction in tissue hypoxia (hyperoxia, hyperoxemia)
- Vasoconstriction
  - ↓ edema
- Stem cell release from the bone marrow
- Growth factor stimulation and synergism
- Collagen deposition
- Vascular neogenesis
- Enhanced white blood cell microbial killing
- Bacteriostatic/cidal activity
- ↓ cerebral blood flow

II. Tissue regeneration and HBOT




III. Hypoxia
- Types of hypoxia
  - Hypoxic hypoxia – all types where insufficient oxygen reaches the alveoli
  - Anemic hypoxia – not enough $O_2$ can be transported
  - Circulatory Hypoxia – inadequate delivery of $O_2$ to the tissues
  - Histotoxic hypoxia – Tissues cannot utilize the $O_2$ delivered

  HBOT

- HBOT – Primary Physiologic Effect
  - Increasing inspired oxygen concentration as much as 1-1.5 times normal
  - Arterial $O_2$ rises 12-15 times normal
  - Tissue $O_2$ diffusion → concentration gradient + distance
    - 20x increase in $PaO_2$ → 4 fold ↑ in diffusion distance
    - < 30 mmHg tissue O2 stops or significantly delays healing

IV. Tissue salvage
- The ability of HBOT to save those cells that are on the verge of dying by reversing the intracellular hypoxia, these cells can then participate in repair.

V. Tissue Repair and Replacement

- Goal – "Functional tissue replacement"
- O2 tension in tissue of 30 mmHg required for cell division and healing
  - Mitochondria require minimum tension of .5-3 mmHg
  - Required for oxidative phosphorylation
  - Required for cytochrome c activity
  - 50-100  Hg is optimal for healing in wounds

- Oxygen's Role
  - Hypoxia is good and bad
    - Initial stimulus
    - Eventual deterrent
  - Oxygen required for hydroxylation of proline and lysine necessary for release of collagen from fibroblasts
    - 10m mHg or < fibroblasts do not migrate
    - Collagen production is stimulated by lactate ↑ from hypoxia, but raising tissue O2 to 40 mmHg increases collagen production 7 fold.
  - Lactate increase from hypoxia → increases angiogenic factor production by macrophages (not inhibited by O2 administration
  - Compromised tissue is most responsive to HBOT
  - Hypoxia and ischemia → non-healing, difficulty healing
  - ↑ metabolic requirements and energy needs at a time when circulation is impaired
    - Energy crisis in tissue
- Summary – Oxygen's Role in Tissue Regeneration
  - Reduction of hypoxia,  maintenance of energy requirements
  - Synergistic with growth factors
  - Stimulation of matrix production
  - Neoangiogenesis
  - Stem cell release and support
  - Cellular proliferation and differentiation

Vi. Supportive Effects

- Reduction of edema
- Decrease inflammatory response
- Support of leukocyte capabilities during an infection