Hyperbaric oxygen: A useful adjunct for purpura fulminans

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Hyperbaric oxygen: a useful adjunct for purpura fulminans: case report and review of the literature
Introduction

Purpura Fulminans (PF), also known as Purpura Gangrenosa, is a fulminant and devastating disease, usually of children.

Three forms of PF are described:

- **Idiopathic Purpura Fulminans**
  - associated with the post infectious period of a benign disease, most commonly seen during recovery from chicken pox or strep

- **Acute Infectious Purpura Fulminans**
  - associated with severe sepsis, usually with meningococcemia or streptococcemia.

- **Neonatal Purpura Fulminans**
  - due to congenital clotting factor deficiencies.
In PF, clotting factor deficiencies in conjunction with disseminated intravascular coagulopathy (DIC) lead to:

- Intravascular occlusion with micro-thrombi and a hemorrhagic vasculitis.
- Cutaneous and visceral ecchymosis and edema
- Ischemia, gangrene and shock.

Typical lesions:

- symmetrical ecchymoses on the extremities (lower predominate) and buttocks.
- The lesions are painful and progress to necrosis, hemorrhagic blebs and gangrene.
Introduction- M&M

PF has a high mortality rate, variously reported as 13,36,44 or 90%. Significant morbidity occurs in almost all patients given the high rate of amputations and invalidity.

• One series (n=70) reported amputations to all extremities in 25%.

• In another 3/9 died and 5/6 of the survivors had at least 2 amputations

• Disfiguring facial involvement occurs frequently
Introduction- Treatment

Treatments for this disease include:
• Heparin/low molecular weight Heparin
• fresh frozen plasma
• empiric antibiotics covering MRSA, Neisseria and streptococcal species
• low molecular weight dextran
• steroids.
• In deficiency states, antithrombin III and protein C concentrates are given
• Intra-arterial thrombolysis has been utilized as well as sympathectomy or regional anesthesia to reduce vasospasm
• Often require fasciotomy for compartment syndrome and excision of gangrenous areas to prevent invasive sepsis
A previously healthy, 43 year old male with an apparent flu-like illness precipitously declined the day following the onset of symptoms. He developed:

- Pneumococcal Sepsis
- Renal Failure With Anuria
- Shock With Brief PEA Arrest
- Disseminated Intravascular Coagulation (DIC)
- Purpura Fulminans (PF)

He required one week of aggressive care before being stable enough to consider HBOT. He required continuous renal replacement therapy, antibiotics, blood products and ventilator support.
Case Report- HBOT

His initial course of HBOT was complicated by upper airway infection (viral stomatitis) & marked confusion.

He required intubation for airway control and to decrease the work of breathing. He tolerated a t-piece better than our simplistic chamber ventilator (Sechrist 500a).
Case Report- Outcome

• He received 17 HBO treatments in total
  • (twice daily at first) done at only 2.0 ATA as we were unable to give air breaks on T-piece.
• Transcutaneous oximetry was not done but may have aided in determining an endpoint to HBOT.
• Marked reduction of purpuric, ischemic appearing tissue with good demarcation of blackened tissue to the distal digits.

40 days out
Case Report- Outcome

Adjunctive HBOT treatment spared much at risk tissue.

At one month follow up it was apparent that he would need some distal amputation of his digits but, he would have good function of all proximal joints including thumbs and great toes.

His renal function was improving- He would not require long-term dialysis.

Long term: He refused a right foot amputation and deals with chronic osteomyelitis in that foot. Otherwise he is high functioning with family and employment.
Review of Literature

- A Medline search was done using the key words purpura fulminans and gangrenosa in conjunction with hyperbaric oxygen.
- Fifteen case report papers were identified, with only 19 total patients with purpura fulminans treated with HBOT.
- An additional unpublished report was found that noted six children who did well with early and aggressive HBOT (Personal communication, P. Allinson).
- No controlled studies were found to exist.
Hyperbaric oxygen appeared to be of value in most of the reported cases, and the degree of improvement appears to be associated with the timeliness as well as the aggressiveness of the treatments.

Aggressive treatment started within 24 hours did well in both short- and long term, with only some minor distal digital amputations necessary.

Those treated late (five- to 10 days post-onset of PF) had more variable results. Two out of five required below-the-knee amputation, and another required multiple debridement and skin grafting. A fourth patient had minor digit loss.
# TABLE 1. Correlation of Better Outcomes with Earlier and More Aggressive HBO₂ Treatments

<table>
<thead>
<tr>
<th>Author</th>
<th>Age</th>
<th>HBO₂ **</th>
<th>OTH*</th>
<th>Etiology</th>
<th>Delay (Days)</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Krzelj</td>
<td>13m</td>
<td>8*60'@2.2 atm qd</td>
<td>17</td>
<td>Varicella zoster</td>
<td>0.5</td>
<td>No sequel, progression stopped 24h after 1st HBO₂tx</td>
</tr>
<tr>
<td>Waddell</td>
<td>1</td>
<td>8*300'@2.0 atm bid</td>
<td>80</td>
<td>H. flu, diplococcus, nocardia</td>
<td>1</td>
<td>Great, no surgery</td>
</tr>
<tr>
<td>Maynor</td>
<td>4</td>
<td>19*90'@2.5 atm tid-bid</td>
<td>71</td>
<td>N. men.</td>
<td>1</td>
<td>Left forefoot amputation, saved from BKA</td>
</tr>
<tr>
<td>Karz</td>
<td>19</td>
<td>19*120'@2 atm bid-qd</td>
<td>76</td>
<td>S. pneumo.</td>
<td>1</td>
<td>Some sloughing, no surgery</td>
</tr>
<tr>
<td>Monies-chass</td>
<td>2</td>
<td>6*120'@2.8 atm q4h</td>
<td>34</td>
<td>Allergic vasculitis</td>
<td>1</td>
<td>Toes</td>
</tr>
<tr>
<td>Nachum</td>
<td>17m</td>
<td>36*90'@2 atm bid</td>
<td>108</td>
<td>S. pneumo.</td>
<td>2</td>
<td>Marked improvement in severe case, bilateral forefoot amputations</td>
</tr>
<tr>
<td>Siraneci</td>
<td>8m</td>
<td>20*120'@2.5 atm bid</td>
<td>100</td>
<td>Varicella zoster</td>
<td>2-3</td>
<td>Great, improved by Day 6</td>
</tr>
<tr>
<td>Dollberg</td>
<td>4m</td>
<td>8*90'@2.2 atm bid-qd</td>
<td>26</td>
<td>H. flu. meningitis</td>
<td>4</td>
<td>OK, no surgery</td>
</tr>
<tr>
<td>Allinson</td>
<td>5 cases</td>
<td>15*90'@2.2 atm 10 bid 5 qd</td>
<td>“no delay”</td>
<td>“no delay”</td>
<td>1 of 5 digital amp otherwise all did well</td>
<td></td>
</tr>
</tbody>
</table>

- **HBO₂** dosage in minutes of pressure at 2 atm
- **OTH** number

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<thead>
<tr>
<th>Author</th>
<th>Age</th>
<th>HBO₂ **</th>
<th>OTH*</th>
<th>Etiology</th>
<th>Delay (Days)</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Krzelj</td>
<td>18m</td>
<td>10*60'@2.2 atm</td>
<td>22</td>
<td></td>
<td>5</td>
<td>Bilateral BKA</td>
</tr>
<tr>
<td>Kuzemko</td>
<td>1</td>
<td>6*75'@2.5 atm bid</td>
<td>20</td>
<td></td>
<td>5</td>
<td>Great</td>
</tr>
<tr>
<td>Dudgeon</td>
<td>6</td>
<td>2*120'@2.0 atm qd</td>
<td>8</td>
<td>Streptococcal?</td>
<td>10</td>
<td>BKA and multiple grafts</td>
</tr>
<tr>
<td>Dudgeon</td>
<td>3</td>
<td>4*120'@2.0 atm qd</td>
<td>16</td>
<td>Measles</td>
<td>6</td>
<td>Multiple grafts and debridement</td>
</tr>
<tr>
<td>Takac</td>
<td>0</td>
<td>52*45-60'@1.5-1.8 atm 8 bid</td>
<td>86</td>
<td>N. men.</td>
<td>10</td>
<td>Minor digit loss</td>
</tr>
<tr>
<td>Allinson</td>
<td>?</td>
<td>15*90'@2.2 atm 10 bid 5 qd</td>
<td>56</td>
<td>Adv. necrosis present</td>
<td>“delayed”</td>
<td>Multiple grafts</td>
</tr>
</tbody>
</table>
Discussion

Hyperbaric oxygen appears to ameliorate the complications of purpura fulminans by:

• reducing edema
• increasing local tissue oxygenation via increased partial pressures and increased diffusion distance
• attenuating reperfusion injury and platelet aggregation
• enhancing leukocyte-killing activity
• capillary and fibroblast proliferation and collagen production
Discussion

In addition, HBOT may provide benefit by increasing red blood cell (RBC) deformation, allowing RBCs to perfuse areas that they otherwise could not due to capillary and small arteriolar damage from the purpura fulminans or from impaired RBC deformability contributing to sludging and inability to offload oxygen through the capillary

Hyperbaric oxygen appears to be useful in other purpuric eruptions such as Henoch-Schonlein purpura and thrombotic thrombocytopenic purpura, likely by the same mechanisms
Conclusions

1. Multiple reports emphasize the use of early and aggressive hyperbaric oxygen in purpura fulminans balancing its utility against issues of hemodynamic instability and potential pulmonary oxygen toxicity.

2. Transcutaneous oximetry may be useful in determining an endpoint to treatment with hyperbaric oxygen.

3. Although a randomized controlled study is fairly infeasible, a retrospective case-controlled study comparing cases treated with and without hyperbaric oxygen may better define the usefulness of HBO2 for purpura fulminans as well as clarify the issues of early versus late treatment and the utility of aggressive therapy.
Behold!
My Hyperbaric Oxygenator

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