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Hyperbaric Oxygen as an adjunct in Strokes due to Thrombosis

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SUMMARY

Stroke is a major cause of serious disability in all developed countries. Unfortunately of the 700,000 strokes that occur in the United States each year, only a small percentage makes a full recovery with or without therapy. Currently, world wide there are over 3,200,000 stroke victims alive today requiring various degrees of support. Clearly, a need exists for more effective rehabilitation in the post-stroke problem. With the aging population, the situation will only become more pronounced. Currently over 70% of all stroke victims are age 65 or older. The **financial burden to Medicare, Medicaid and insurance carriers is almost catastrophic.**

The general consensus of opinion is that if a stroke patient does not improve within three months, that no further improvement will occur clinically or neurologically. All physical, occupational, and speech therapies and support mechanisms expire promptly within the three month period and stroke remains a devastating blow to the **patient as well as one of the most expensive maladies in the world. Basically, the patient is closeted.**

Recent data, however, has indicated that there may be a window for improvement for certain patients with long term neurologic deficit of stroke with hyperbaric oxygenation.

One approach towards rehabilitation and lessening the burden to the patient and the finances for treatment of the late stroke manifestations has been the administration of hyperbaric oxygen. This relates to reactivation of dormant, idling neurons and the results have been encouraging.

MATERIALS AND METHODS

Newer imaging techniques, particularly single photon emission computerized tomography (SPECT) and weighted MRI now allow a rapid and efficient visualization of brain function. These are similar to PET but are far less expensive and more readily available. At the Multi-disciplinary Brain Repair Center in Lauderdale by the Sea, FL we have been using a tracer of technetium 99 HM-PAO (Ceretec) which crosses the blood brain barrier and therefore measures not only blood flow but also metabolism has been the main isotope. Others, however, are available, but it is felt that this was the best demonstrating ischemia. The chronic stroke protocol is: 1) baseline scan.

DISCUSSION

Improvement with hyperbaric oxygen therapy relates to the reactivation of dormant idling neurons referred to as the ischemic penumbra, originally described by Siejso and Adams in the baboon model. With sequential SPECT scanning and hyperbaric oxygen this area may be color coded, digitized and actually treated to the point of recovery of electrical function. We were the first to be able to visualize this area with sequential SPECT scanning utilizing hyperbaric oxygen challenge. We have published a case history of a patient demonstrating recoverable brain tissue fourteen years post ictus with associated clinical improvement, indicating a long viability of the ischemic penumbra.

The ischemic penumbra originally was thought to last for minutes to hours, but with our intervention of imaging (SPECT) along with provocative hyperbaric oxygen, we are able to demonstrate a much longer viability of this zone. Thus the size and location of the original infarct, plus the volume and location of the ischemic penumbra has much to do with the ultimate recovery and improvement in the patient with late stroke.

The chronic stroke may be likened to an atomic bomb attack. There is an epicenter of which is irreversibly damaged and little hope exists for this area. Fanning out, however, towards the periphery, a zone of viability exists; the further from the devastation, the better the chance of recoverability.

We have treated many patients with chronic stroke syndrome. Hyperbaric oxygen is not a panacea, nor is it for all cases Patients in which this is applicable may be identified by the responses in the SPECT scan following a challenge with pressurized oxygen. There is a high correlation between improved flow in SPECT scanning and clinical improvement. Although only several cases are presented here, the overall average is about 70% of such neurologically damaged patients may receive some benefit from either short term or prolonged (20-100) hyperbaric oxygen treatments. Coupled with physical, speech and occupational therapies, biofeedback, nutritional support and certain herbal medications, most patients have had varying degrees of improvement, irrespective of location or duration of deficit. In no instance has a patient been completely cured. An occasional patient with a severe vasculopathy will need follow-up treatments in the future. The ones that do make striking progress, usually maintain this improvement and there is no deterioration without the continued hyperbaric oxygen. Age is not a barrier, nor is the length of time of the disability a limiting factor to the use of this safe and logical type of regimen. Improvement in cases of long standing duration have been published.

The physiologic rationale for treating stroke and other brain injuries with HBO is as follows: HBO, by reducing cerebral edema, increasing oxygen content in blood, and increasing the diffusional driving force for oxygen, results in an increased tissue oxygen availability, which, in turn, overcomes ischemic hypoxia, stimulates active transport mechanisms (i,ii,iii) and, thereby, metabolically stimulates the idling neurons.

Figure 1 A Pre HBO

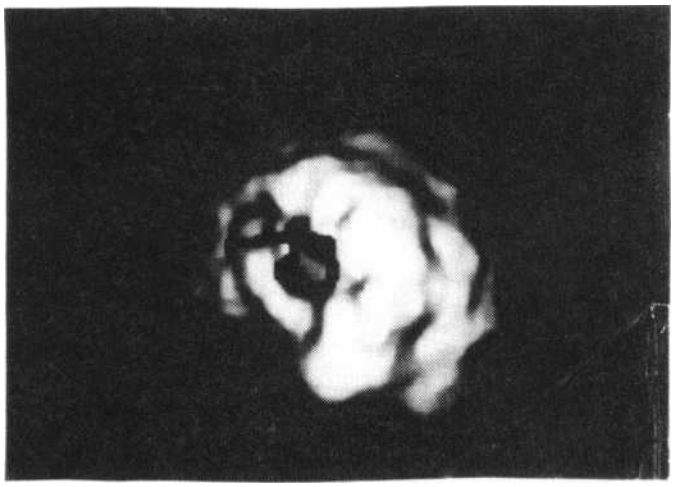

Figure 1 B Post 6 HBO

Figure 2A Pre HBO

Figure 2B Post 5 HBO

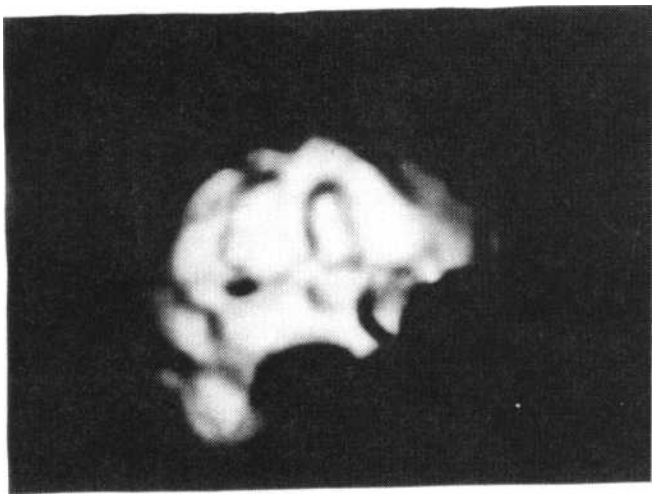

Figure 3A Pre HBO

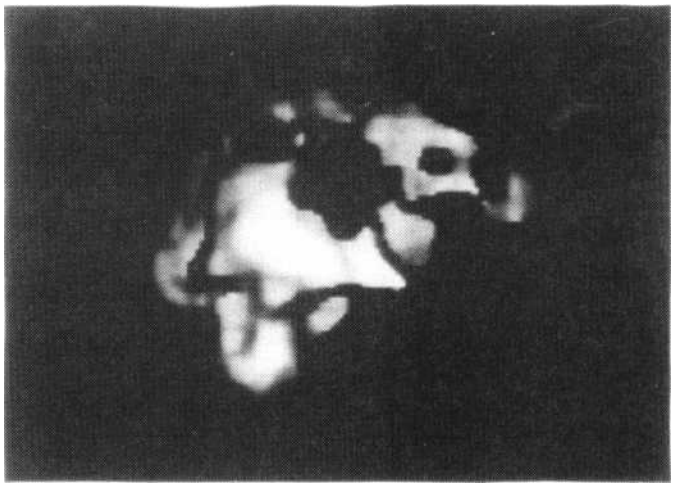

Figure 3B Post 92 HBO

2) This is followed by one hour hyperbaric treatment or a series of one hour treatments of hyperbaric oxygen exposures (1.5 ATA) with a repeat scan after one or a number of treatments depending upon the severity of the case. Under these circumstances, a predictability of the outcome may be available depending upon the zone of recoverable brain tissue. For the specific treatment protocol of stroke, we have not modified the protocol since the publication of 1980 with the exception of an extension of past 20-40-60 treatments when necessary, dictated primarily by clinical improvement and SPECT enhancements Also incorporated at this center are all modalities of physical, occupational, speech therapies, nutritional counseling and certain herbal products.

CASE REPORTS

1 A & 1 B) 91 yr old white male diabetic who suffered a severe CVA, this being a left mid-cerebral. About 10 days prior to treatment, he was in the hospital because of nausea, vomiting, and control of his diabetes. He received minimal therapy there. The scan shows a large left mid-cerebral deficit which after six treatments (1 hr/ 1.5 ATA) of hyperbaric oxygen showed a remarkable clearing. The patient received a total of 10 hyperbaric oxygen treatments. The therapy was discontinued, the patient went home to a normal existence with no neurologic or mental deficit. It is noted that this patient may well have improved spontaneously without the hyperbaric oxygen therapy, but the predictability is on importance.

2A & 213) 84 year old white female had a CVA three months ago and was still partially hemiplegic, memory difficulties, but not institutionalized. The scan shows the deficits that occurred in the area of the right mid-cerebral flow. After five one hour treatments of hyperbaric oxygen the situation seemed vastly improved as well as the clinical parallel.

3A & 3B) 85 year old female suffered a massive CVA 6 months prior to beginning hyperbaric oxygen This was a massive global attack with almost complete ablation of the left mid-cerebral cortex. Global problems also were involved. She remained wheelchair bound until hyperbaric oxygen was begun. A SPECT scan was performed prior to beginning hyperbaric oxygen and the marked global phenomena was observed. Although the patient's most severe deficit was in the area of the left mid-cerebral artery, scans of the right mid-cerebral distribution are presented to again reiterate the fact that stroke is a global attack. The patient then had 92 hyperbaric oxygen treatments and a repeat scan was performed. There was substantial improvement in the flow to the left mid-cerebral artery, but the striking changes at the right cortex are presented. The patient also had a severe expressive aphasia, lack of orientation, severe cognitive deficits. With improvement in the flow to the entire brain, the patient was able to abandon the wheelchair, walked very well with help or occasionally with a walker. Concomitantly, the patient had a increase in appetite, weight gain, improved cognition and ability to control her bowel and bladder. The patient took a total of 109 hyperbaric oxygen treatments. The only remaining major neurologic disability was that of a continually improving expressive aphasia.

Also, hyperbaric oxygen a known scavenger of free radicals stimulates phagocytosis - thereby providing endogenous debridement, fibroblastic activity with the laying down of new connective tissue, and angiogenesis (iv). The development of new blood vessels into ischemic penumbral areas is thought to be the mechanism underlying long-term recovery, since by bringing oxygen and energy to other metabolically lethargic neurons they will not only aid in neuronal reactivation, but they will also provide the continuous source of oxygen, energy, nutrients, and removal of waste products that are associated with any functioning tissue.

CONCLUSIONS

The ultimate clinical status and recovery with brain injuries depend upon: a) the size and location of the epicenter or core of destruction, with is irreversible, and b) the surrounding zone of dormant but recoverable neurons fanning out in varying rings from the center core c) the asymmetry involved d) the organization and reorganization with plasticity of altered and non-impaired sensory and motor brain functions. and e: **meshing of sensory and motor fibers at the brain stem cord junction. In severe neurologic conditions, where there is no matrix, pressurized oxygen has beneficial effects in that it: 1) restores the integrity of the blood-brain barrier and cell membranes, 2) reduces cerebral edema, 3) reduces intracranial pressure, 4) neutralizes toxic amines, 5) increases neovascularization, 6) acts as a scavenger of free radicals, 7) efficiently elevates diffusional driving force for oxygen thereby increasing tissue oxygen availability, 8) promotes phagocytosis, (thereby internal debridement), 9) stimulates angiogenesis and reactivates idling neurons. It is suggested that SPECT imaging and hyperbaric oxygen where available may possibly aid in treatment and prognostication. More work in this area is encouraged.**

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