

Hyperbaric Oxygen Facilitates Neurorehabilitation

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Summary

Long-term neurorehabilitation is not readily available or often undertaken. Minimal therapy may be performed to prevent decubiti and help reduce spasticity. Currently, an active therapy approach is not considered. However, at the Ocean Hyperbaric Neurologic Center, a new method has been devised. Late intensive neurorehabilitation has become standard practice where the clinic deals with high-dose oxygen and the recoverable brain. Long-term major brain insults treated therein consist of ischemic thrombotic (1) or hemorrhagic stroke, severe traumatic brain injury, and anoxic ischemic encephalopathy(2), with all of these cases ranging from semi-ambulatory to apolic coma. (3) Encouraging to dramatic results has been observed in a large number of patients treated.

Introduction

Major brain insults are similar to an atom bomb attack whereas there is an epicenter of irreversible damage, but fanning out from the center to the periphery, there is a plume of viable dormant idling neurons receiving enough oxygen to exist but not to fire electrically. This clinic was the first to document existence of ischemic penumbra with sequential single photon emission computerized tomography (SPECT) scanning (functional imaging) before, during, and after hyperbaric oxygenation therapy which has been shown to reactivate this area to firing potentials. (1)(2) All modalities of neurorehabilitation are instituted along with hyperbaric oxygenation. It is imperative that these dormant idling motor and sensory neurons be given a sense of direction.

Thus, hyperbaric oxygenation may open a new dimension for the long-

term, warehoused brain-injured patient for which there has been no other option.

Materials and Methods

A total of 350 seriously incapacitated brain-injured patients have been treated with hyperbaric oxygenation at the Ocean Hyperbaric Neurologic Center in the past fifteen-year timeframe. The age range has been from three to ninety-three. The duration of infirmity has been from six month to fourteen years. Approximately thirty of these patients were in an apolic coma with Glasgow Coma Scales of III to V. Nearly all patients had an initial and sequential SPECT scanning along with the high-dose oxygen therapy. These scans were produced using an Elscint high-resolution single head gamma camera. The tracer was Technesium 99 either as Ceretec or Neurolite. Hyperbaric oxygenation was provided in completely refurbished Vicker's monoplace chambers, either clamshell or horizontal. The pressures utilized were between 1.25 and 1.75 ATA. The total number of treatments ranged from 40 to 500, one hour each at pressure. Sequential scanning was done before and after in most cases. In long-term follow-up cases scanning was performed every 80-100 hyperbaric sessions. All modalities of PT, OT, speech, along with occasional acupuncture, were part of the regime. Nutritional counseling was provided and certain herbal medications were advised in conjunction with the therapy; primarily Ginseng, Ginkgo (when not on Coumadin), COQ10, Pycnogenol and vitamins. All cases were also videotaped before, during and after the completion of hyperbaric oxygenation. Five representative cases will be briefly discussed.

Case Reports

(Five clinical cases studied at the Ocean Hyperbaric Neurologic Center are presented).

CF

Patient is a white male who had right mid-cerebral ischemic thrombotic stroke which occurred on 10/31/98 at the age of fifty-three. All modalities of physical therapy, occupational therapy, and speech therapy had eventually been discontinued and the patient was taken home to be kept comfortable with minimal therapies. When the patient was seen at the Ocean Hyperbaric Neurologic Center on 3/8/00, he had a spastic hemiplegia with a brace on the right leg and a sling on the right arm. Patient had severe expressive aphasia and was emotionally distressed. Patient's BP was 130/60, P: 60, R: 16. He was begun on hyperbaric oxygenation at 1.5 ATA, one hour each exposure and received fifty-one



Figure 1.

treatments. Improvement was substantial and the patient was able to regain his speech and his emotional attitude changed significantly. The patient's leg brace and arm sling were removed. The patient was now able to maneuver well with a simple cane. The brain SPECT scans showed significant improvement in the area of the left cortex. Long-term follow-up on this patient shows that he is now leading a basically normal life and he has approximately eighty percent return of function. He is emotionally stable, cognitively back to normal, and considers hyperbaric oxygenation beneficial.

MP

Patient is a white male who at the age of 23 years who sustained a severe traumatic brain injury. At the time, the patient was a tennis professional. He was in apolic coma for four months and then underwent rehabilitation for six months. The patient remained semi-comatose with a



Figure 2.

Glasgow Coma Scale of VI (see Fig. 3A). At the Ocean Hyperbaric Neurologic Center the patient had 208 hyperbaric oxygenation treatments from 1.5 ATA to 1.75 ATA, one hour each exposure from April 1997 to May 1999. Intensive physical therapy, occupational therapy, and speech therapy were instituted and an entire gymnasium was built for him at home. He has now had a total of 600 treatments and is self-sufficient. Although he does have some residual motor disabilities and slight speech impairment, he has almost fully entered back into society but does require an occasional attendant. Patient has now graduated from the Glasgow Coma Scale, the G-tube has been removed, and all medications have been discontinued. Aggressiveness has disappeared and cognitive function has increased substantially. He is able to make his own decisions. He is now able to hold a tennis racket and hit a tennis ball and is busy with limited participation in outdoor activities. (see Fig. 313)

MJ

Patient was a 31-year-old white male who suffered an anoxic ischemic encephalopathy by a carbon monoxide suicide attempt twelve years previously. He had been comatose since that time and had exquisite care at home. He was seen at the Ocean Hyperbaric Neurologic Center only because his mother had driven 3,000 miles with him to the door of the center and said "Please do something." Should she have called on the telephone, she would have been told that there was little hope. Nevertheless, the patient received about 60 hyperbaric oxygenation treatments. There was marked improvement in the frontal lobes and the patient began



Figure 3.

to rouse from coma. He received physical therapy, occupational therapy, and speech therapy during the treatments along with nutritional counseling, and herbal medications. Because of his remarkable progress and the fact that he required several hundred treatments, arrangements were made for the mother to have a chamber at home. After 350 treatments, this young man returned fully into society with minimal cognitive deficits.

MAB

Patient is an 89-year-old white female who fell and hit her head on the sidewalk one and a half years prior to being seen at the Ocean Hyperbaric Neurologic Center. She was in apolic coma for one month and then in a nursing home for nine months. When seen at the center she had had a G-tube, spastic paralysis to the left extremities and right arm. She had lim-

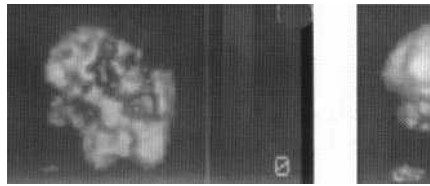


Figure 4.

ited expressive aphasia. She received 38 hyperbaric oxygenation treatments at 1.1 ATA, one hour each exposure between 9/7/01 and 10/5/01. After the treatments, the patient was alert and smiling. She was able to lift her left leg on her own. She was much more aware. The spasticity was substantially reduced and she became mobile and able to walk with help. Her speech improved considerably. Unfortunately, after her return home all modalities of therapy were refused due to the patient's age. She has now maintained the improvements for over six months and will return next month for swallowing function and probable removal of G-tube.

JN

Patient a 21-year-old male seen two years post severe motor vehicle accident with injuries including torn aorta, fractured rib, pelvis, right wrist, bone chip in the right knee. He was in a coma for a two week period and semi-vegetative for the following three to four months. He had made some recovery and became semi-ambulatory but there had been no recent improvements since that time with the exception of eye-hand coordination which showed gradual improvement. Motor skills and balance were poor, short-term memory and cognition were lacking. The patient was able to read and write a small amount. When seen at the center on 1/28/98, a baseline brain SPECT scan was per-

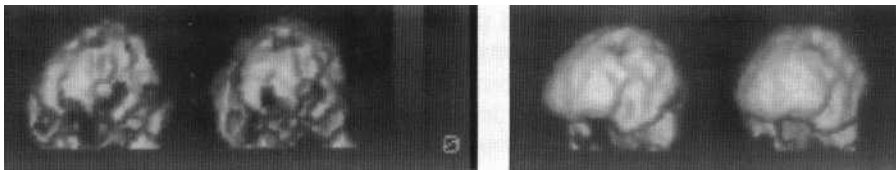


Figure 5.

formed and he had 64 hyperbaric oxygenation treatments from 1.5 ATA to 1.75 ATA, one hour each exposure. The changes in the scan were significant. Clinically, ambulation and balance were improved, there was more flexion in the knees, he was much more alert and oriented, speech and thought were still somewhat slow, but cognitive improvement was noticeable. Overall the patient had made a substantial improvement with hyperbaric oxygenation.

Results

Over the past years, the Ocean Hyperbaric Neurologic Center has treated a large number of patients with intensive, long-term neurorehabilitation. Most of these patients were seen as a last hope as their previous doctors had told them that after a certain length of time, nothing further could be done. Late neurorehabilitation may be divided into three headings, all a consequence of severe brain insults: 1) stroke, ischemic thrombotic, or hemorrhagic, 2) traumatic brain injury, 3) anoxic ischemic encephalopathy. Each patient in this series was treated as their own control. Since all other modalities had been utilized with the only variable being hyperbaric oxygenation, the results clinically paralleled the findings in the functional brain imaging SPECT scans⁽⁴⁾. The opportunity for spontaneous recovery had long since passed in this group. These cases illustrate the potential beneficial results that may ensue. An overall average of varying degrees of improvement from the large series of cases studied is approximately sixty-five percent. In certain coma cases, although improvements were mild, it was very meaningful to the families. Eighty percent of the G-tubes and seventy percent of the tracheotomies were removed, hospitalizations were reduced substantially, and drug costs were lessened. The overall reduction in cost for the serious type patient was approximately ninety percent. In most patients with Glasgow Coma Scale I to III, the treatment resulted in improvement of a scale from VIII to X. Very few of these patients have as miraculous an improvement as did the case presented⁽⁵⁾. Rarely do they return fully to society but after hundreds of treatments certain of these patients will be able to respond either verbally, by word board, or with a computer. With the removal of the G-tube and tracheotomy, their nutrition becomes substantially better and easier, and their bowels became normal.

In the long-term stroke survival, we have a general reaction that the

hemorrhagic type over a long period seems to fare better with hyperbaric oxygenation than the thrombotic stroke. In the traumatic brain injury, which may range from mild with inability to re-enter society - to coma, results are quite variable. In the severe anoxic ischemic encephalopathy, the vast destruction of the cortex is probably the most challenging of all. In certain of these cases, even after four to five hundred treatments, they may begin to respond to some extent. This is difficult to evaluate, since the families with wishful thinking are not really objective.

Conclusion

Intensive neurorehabilitation has a short lifespan and is intimately related to plasticity, muscle education, and patterning. Usually after major brain insults, intensive stabilization and sub-acute therapy is discontinued after a three + month period and insurance reimbursement ceases. The family is then told to put the patient in a nursing home or take them home and keep them comfortable. Minimal therapy is attempted throughout the years.

Hyperbaric oxygenation offers a new dimension to neurorehabilitation, especially in late cases after all other modalities have been discontinued. This is associated with the recoverable brain or dormant idling neurons that receive enough oxygen to exist, but not enough to fire electrically. Reactivation and re-firing of such neurons has been published showing clinical improvement for periods up to fourteen years. ⁽¹⁾⁽²⁾ Thus, after high dose oxygen and reinstatement of all modalities of neurorehabilitation may not only offer new hope to the patient, but also be extremely cost-effective.

The ultimate outlook for long term brain insults depends upon 1) the location and volume of irreparable damage, 2) the volume, location of dormant, idling but recoverable cells, 3) the organization and reorganization of impaired and non-impaired sensory motor neurons, and 4) the degree of asymmetry, 5) the desiccation at the cord medullary junction. It is suggested that many cases in which all approaches have failed after months or years have passed, that there may remain the possibility of some degree of recoverability. While hyperbaric oxygenation and reinstatement of the therapies is not a panacea, it is often helpful. It is hoped that this presentation will stimulate further research on hyperbaric oxygenation and long-term neurorehabilitation.

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