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Case Studies Using Hyperbaric Oxygen Therapy (HBOT) To Treat Lingering COVID-19 Symptoms

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Abstract

Background: SARs-Cov-2 infections can produce prolonged illness and significant disability. Patients recovering from COVID19 can have persistent symptoms leading to long-term morbidity.

Methods: Six patients with long-lasting (> 30 days) COVID19 symptoms were treated with hyperbaric oxygen therapy (HBOT). All patients were assessed for symptoms using the ImPACT questionnaire, a muscle and joint pain scale, and a modified Borg dyspnea scale. Patients were assessed before, during and after HBOT treatments.

Results: All patients saw improvements in the measured symptoms to levels that were the same as pre-infection levels (5 of 6 patients) or had significant improvement in symptoms (1 patient).

Conclusions: The results suggest that HBOT helped to improve symptom scores, reduce the length of time of symptoms, and improved the quality of life.

Introduction

It is estimated that 20-50% of people infected with COVID-19 have prolonged symptoms¹ that last weeks to months. Symptoms have been characterized by fatigue, prolonged shortness of breath, myalgias, physical impairment, neurodegenerative symptoms,² cognitive impairment,^{3,4} emotional lability, and a sense of despair. In addition to the dyspnea and muscle and joint pains, many of these symptoms can be categorized as psychological or neurological/physiological change brought on by the SARs-Cov-2 infection. The prolonged illness can delay or compromise return to daily activities and employment.

Hyperbaric oxygen treatment (HBOT) has been shown to reduce endothelial injury,⁵ reduce hypoxia induced inflammation in reperfusion injury,⁶ increase stem cell proliferation⁷, enhance brain recovery from inflammation,⁸ reduce chronic pain,⁹ assist in reducing symptoms in chronic fatigue syndrome,^{10,11} improve neuroplasticity,¹² and poor quality of life,¹³ and alter genes involved in neural responses to stress and transmission.¹⁴ Hyperbaric oxygen has analgesic effects demonstrated in nociceptive, inflammatory and neuropathic pain models in mice,^{15,16,17} and human pain syndromes.^{18,19}

Because of our experience in successfully treating patients with traumatic brain injury,^{20,21} whose symptoms are sometimes similar to those experienced in post COVID recovery, HBOT was provided to this patient population. Hyperbaric oxygen has been used successfully to treat symptoms of pain in patients with PTSD,^{22,23} post-concussion syndrome,^{24,25} chronic fatigue syndrome and fibromyalgia.^{26,27}

Six case studies were carried out to assess the potential of HBOT to improve post-COVID-19 symptoms. The ImPACT questionnaire to assess the severity of symptoms, the modified Borg dyspnea scale to measure change in shortness of breath (SoB), and a modified verbal analogue pain scale for myalgia and joint pain were used before, during and after study participants underwent HBOT treatments.

Here we report the effects of HBOT on COVID19 symptoms that lingered for greater than 30 days post SARs-Cov-2 clearance (range of symptom duration, 34-192 days) in this small, non-randomized population.

Methods

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Patients were treated with hyperbaric oxygen (100% oxygen, 2 atmospheres absolute (ATA)/101.3 kilopascals (kPa)) over ambient pressure for 90 minutes. Treatments were performed once a day for 3 to 5 days per week. Patients with lingering COVID-19 symptoms that were not responding to standard therapy were referred to the Hyperbaric Medicine Inc. facility in Fort Walton Beach, FL. All HBOT treatments were provided to the patients in Sechrist monoplace chambers.

All symptom testing was done at the Hyperbaric Medicine Inc. facility in Fort Walton Beach, Florida by a trained physician (AEZ). A baseline medical history for each study participant was carried out by the referring physician and further testing was done with the ImPACT concussion assessment questionnaire. Muscle and joint pain were measured by a modified verbal rating scale.²⁸ Assessment for dyspnea was done using a modified Borg dyspnea score to measure perceived dyspnea at rest and on exertion.²⁹

Results

Six patients with COVID-19 symptoms were treated with HBOT. Patients exhibited symptoms that lasted from 34 days to 197 days (Figure 1A) prior to beginning HBOT treatment. Patients were assessed on a modified Borg dyspnea scale (Figure 1B). No dyspnea symptoms prior to infection were noted, with the exception of patient #4. All patients developed dyspnea symptoms in the Slight to Moderate range of the modified Borg scale (average dyspnea score: 3.81). After completing 15-29 HBOT treatments, dyspnea scores were significantly reduced (average dyspnea score post-HBOT: 0.17) in all patients.

Other symptoms associated with a COVID-19 diagnosis were assessed using the ImPACT symptoms questionnaire³⁰. Each symptom has a 6-point maximal intensity scale (none:0; slight:1-2; moderate:3-4; severe:5-6) and the questionnaire was proctored by a trained assessor (EZ). The summed scores (Figure 2A) for each patient are displayed and reveal the overall general state for each patient before HBOT (purple columns), at the start of HBOT (red columns) and after the last HBOT treatment they received (green columns). Each patient saw a significant reduction in their overall symptom state. Tracking the change over time (Figure 1B and 2B) for each individual patient's symptoms shows a distinct lack of improvement prior to starting HBOT treatments (time period prior to starting HBOT: -46 to -26 days). The trajectory of improvement after starting HBOT (starting day 0), shows a rapid and distinct improvement of symptoms for each patient.

Although the number of symptoms and symptom severity ImPACT scores improve over time, the linear fit to the symptoms scores per day per patient shows very little change in the slope of the line prior to starting HBOT (Figure 3). After starting HBOT, the scores drop rapidly (symptoms improve), and the trend line shows a marked negative (symptoms reduction) slope over time.

Each symptom category (Figure 4) shows a stable set of symptoms preceding the first HBOT treatment (purple and red columns). No significant change in symptom severity across all six patients were detected three to four weeks prior to starting HBOT treatments. The average symptom scores (for the six patients) after the last HBOT treatment received are statistically significant ($\alpha=0.05$, Student's T-test) from the start of treatment across 13 of the 22 symptoms assessed in the questionnaire. A separate assessment of joint and muscle pain (Table 1) showed improvements (reduction in pain) occurring after starting HBOT.

DISCUSSION

Patients that test positive for SARs-Cov-2 and develop COVID-19 symptoms can develop long term symptoms. These individuals that have persistent symptoms that can last for weeks, and in some cases for months. For severe cases stemming from a SARs-Cov-2 infection, symptoms usually last for 28 days,

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while mild cases last for 11 days.³¹ The symptoms of COVID-19 can start out as mild, not improve over time and flare up sporadically. Yet, these symptoms and flare-ups are not so severe that they require emergency room visits or hospitalizations³². Patients that fit into the category of “long haulers” have symptoms that can last for 6 weeks or more.^{33,34}

SARs-Cov-1 symptoms overlap significantly with SARs-Cov-2 symptoms. SARS-Cov-1³⁵ symptoms were recognized to last for greater than 19 months in an exposed, population of health care workers and the SARs-Cov-1 symptoms were similar to fibromyalgia and chronic fatigue symptoms³⁶. Fibromyalgia, chronic fatigue symptom, SARS-Cov-1 and SARs-Cov-2 have presented with cognitive impairment^{37,38}, emotional lability, and a sense of despair accompanying each of these infections and conditions.

For the majority of people that become infected, 2 to 6 weeks is the norm for recovery.³⁹ Our patient population averaged 91 days of COVID symptoms (range 34-197 days).

Four of the six patients saw improvement that reduced overall ImPACT symptom scores below 5 points (out of 132 points), with two patients still experiencing symptoms of 20 or more points. Individuals were provided with as many sessions of HBOT required until they stopped improving or decided to stop treatment. In one case (Patient 6) had a 3-4 week period of not receiving HBOT treatments, which may have affected the overall improvement trajectory. Dyspnea and neurological symptoms did not come back in 5 out of 6 patients after 30 days of follow-up.

Patient 5 returned 18 days after completing 24 HBOT treatments. The patient had a return of dyspnea (measured as a 6 out of 6) and experienced a mild resurgence in symptoms (fatigue-1; sleeping more than usual-1; nervousness-1; drowsiness -1). After receiving 5 additional treatments, the dyspnea resolved (measured as 1).

Conclusion

The results from this pilot study suggest that COVID-19 long haulers could benefit from hyperbaric oxygen treatments to overcome the lingering respiratory and neurological symptoms associated with the SARs-Cov-2 infection. The significant reduction and rapid improvement in symptoms after a greater than 30 day of period of non-improvement, using HBOT, holds promise for the recovery of these individuals with lingering post-SARs-Cov-2 infection.

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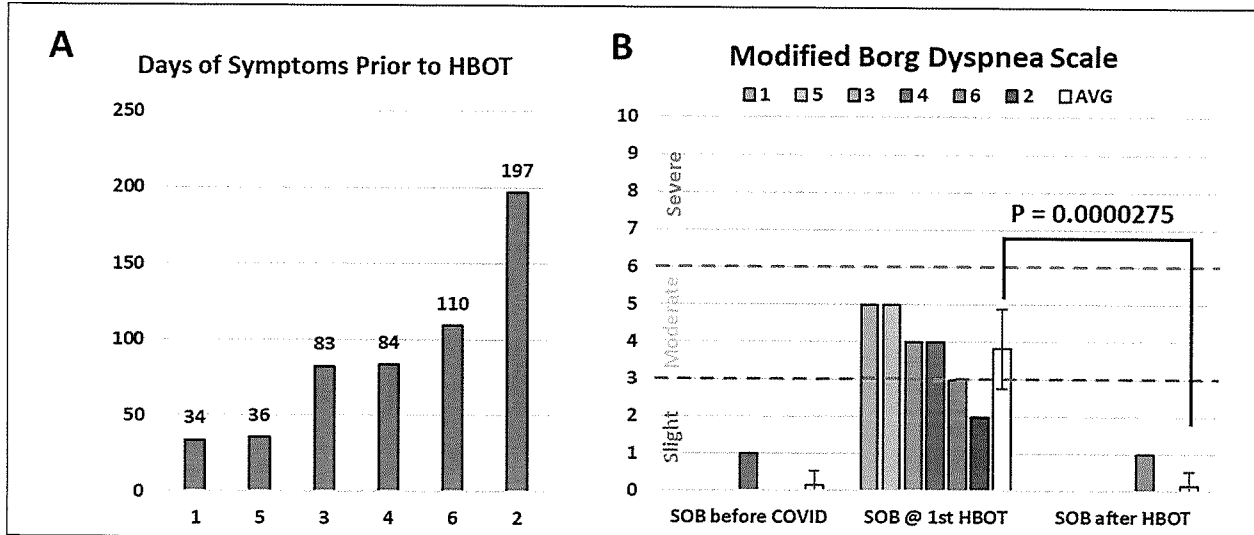


Figure 1 – Details of COVID-19 symptom and dyspnea severity. A, length of COVID-19 symptoms duration for each patient prior to beginning HBOT treatment. B, dyspnea score before COVID-19 diagnosis, at the time of first HBOT treatment and after completing 15-24 HBOT treatments. Average of 6 scores (white column). Error bars are standard deviation. P-value is derived from a Student’s T-test (N=6); $\alpha = 0.05$.

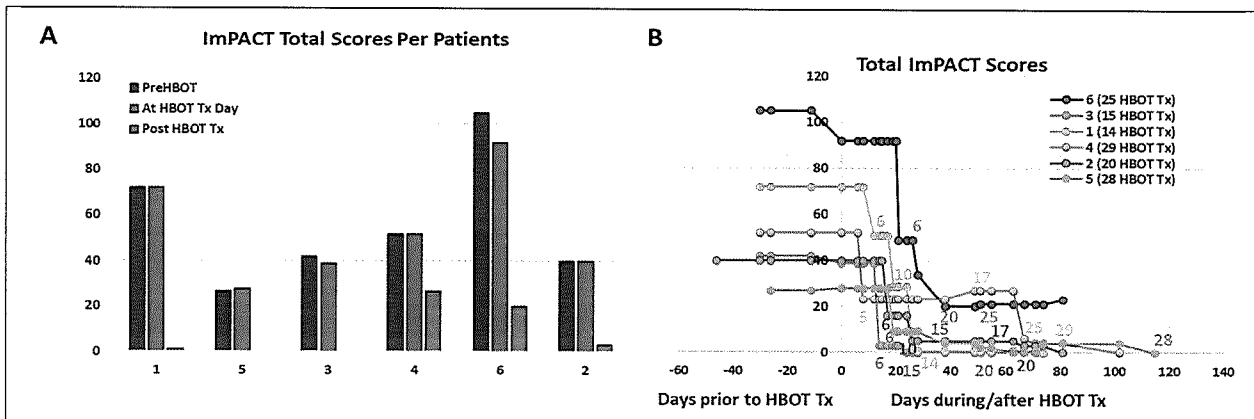


Figure 2 – Summed IMPACT scores of each patient. A, summed scores for each patient at a representative time period before HBOT, right after first HBOT treatment and after the last (or final) HBOT treatment. B, time plotted summed IMPACT scores for each patient. Numbers next to the points are color coded to the patient and represent the number of HBOT exposures at the time of the IMPACT testing. Zero value on the Y-axis is the date of the first HBOT exposure.

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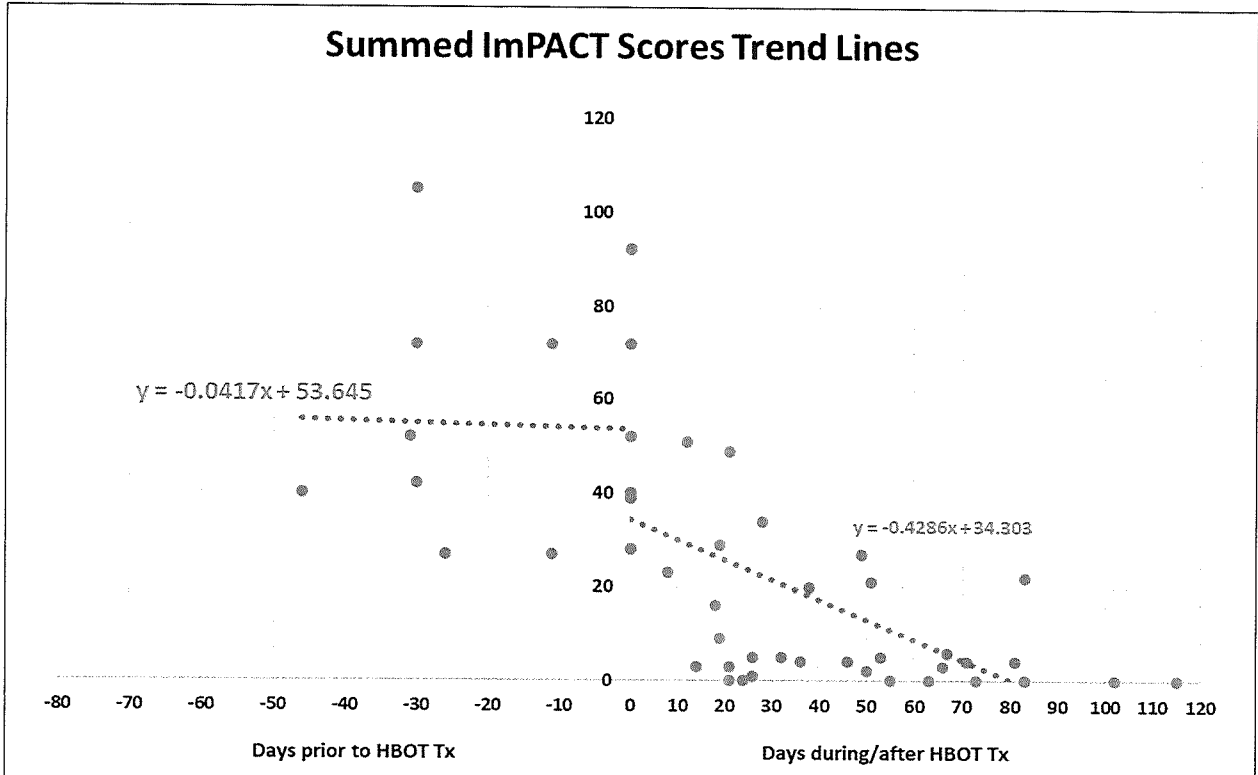


Figure 3 – Summed IMPACT scores at time points before HBOT treatment (left graph) and during/after HBOT treatment (right graph). Linear regression was carried out for both time periods.

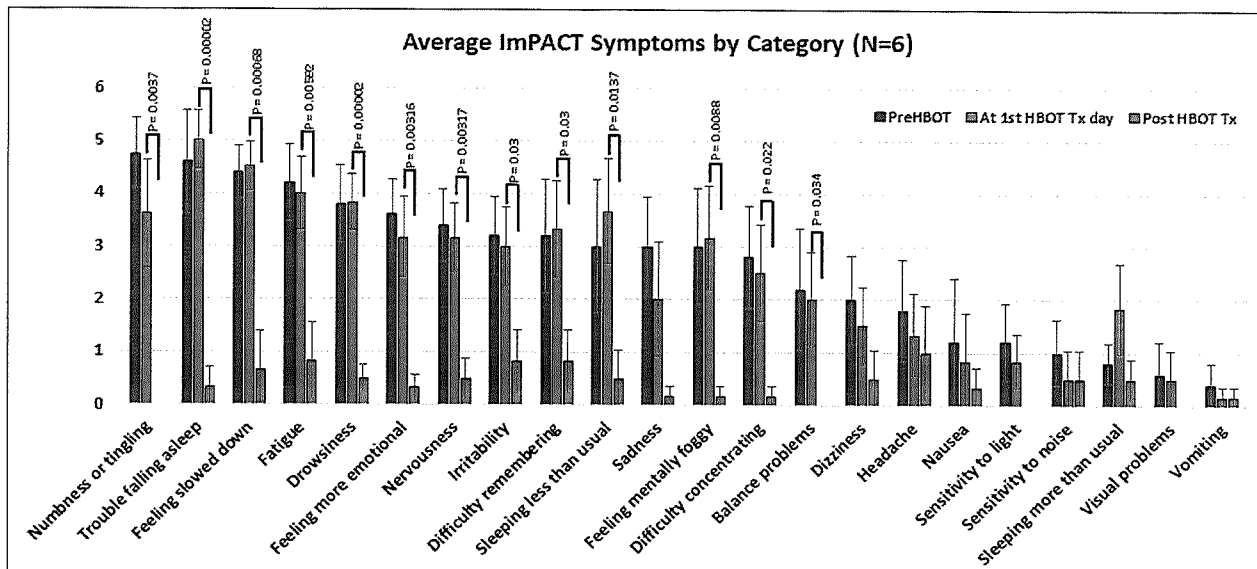


Figure 4 – Average symptom scores for each symptom. Error bars are standard error of the mean. P-values are derived from a Student's T-test (N=6); $\alpha = 0.05$.

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Joint and Muscle Pain Score (0-6)							
Pain Scores	Pt. Number	1	2	3	4	5	6
	Before COVID		0	0	1	0	0
	One month prior to HBOT	2	5	0	4	3	5
	1st HBOT	2	5	0	4	3	5
	Mid-HBOT	1	3	0	2	1	3
	Last HBOT	0	2	0	1	0	2
	1 Month Post HBOT	0	2	0	0	0	2

Table 1 – Joint and muscle pain scores prior, during and after finishing hyperbaric oxygen therapy. Pain scores are as follows: 0, no pain; 6, highest pain.

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