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Journal of the Chinese Medical Association xx (2014) 1–3

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Case Report

Hyperbaric oxygen therapy as an effective adjunctive treatment for chronic Lyme disease

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Received January 17, 2012; accepted June 26, 2012

Abstract

Lyme disease is the most commonly reported vector-borne illness in the United States, but it is relatively rare in Taiwan. Lyme disease can be treated with antibiotic agents, but ~20% of these patients experience persistent or intermittent subjective symptoms, so-called chronic Lyme disease (CLD). The mechanisms of CLD remain unclear and the symptoms related to CLD are difficult to manage. Hyperbaric oxygen therapy (HBOT) was applied in CLD therapy in the 1990s. However, reported information regarding the effectiveness of HBOT for CLD is still limited. Here, we present a patient with CLD who was successfully treated with HBOT.

Keywords: chronic Lyme disease; hyperbaric oxygen therapy

1. Introduction

Lyme disease is an infectious disease with a worldwide impact, caused by the tick-carried *Borrelia burgdorferi* bacterium.[1] In Taiwan, a laboratory-diagnosed human case of Lyme disease had been reported in 1998, while the spirochetes related to the causative agent, *B. Burgdorferi* sensu lato, were first isolated from rodents in the Taiwan area.[2,3] The medical diagnosis of Lyme disease is based on a combination of manifestations, including dermatological, rheumatological, neurological, and cardiac abnormalities, as well as laboratory assays.[4] Evidence shows that it can be treated successfully with antibiotic agents if intervention occurs soon after infection.[5] However, some patients will continue to suffer from chronic Lyme disease (CLD) despite receiving an adequate course of therapy. [6]

The precise mechanisms of CLD symptoms are unknown. Hyperbaric oxygen therapy (HBOT) serves as a primary or adjunctive therapy for a range of medical and surgical conditions,[7] and has been applied in therapy of CLD since the 1990s. We present a patient with CLD who was successfully treated with HBOT.

2. Case report

In April 2003, our patient was a 31-year-old healthy man who worked in the financial industry and lived in Taipei City, who began suffering from intermittent low- and high-grade fever. These symptoms were accompanied by fatigue and multiple bone pain, especially in the sternum, ribs, and lower back, which made it difficult for the patient to walk. Since that time, the

Conflicts of interest: The authors declare that there are no conflicts of interest related to the subject matter or materials discussed in this article.

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http://dx.doi.org/10.1016/j.jcma.2014.02.001

patient had only received symptomatic medications such as painkillers. In January 2004, some erythema migrans lesions were found over the patient's legs. In addition, he suffered from joint pain in both knees, the shoulders, and temporomandibular joints. Tracing back the patient's history 2 years prior to clinical presentation, it was noted that he was a frequent hiker in the Yang-Ming Mountains in Taipei, Taiwan, where he often sat on the grass and had contact with wild cattle. He had previously visited infection and dermatology clinics, where his *Borrelia* serology IgG was positive, and Lyme disease was strongly suspected. Soon thereafter, 500 mg amoxicillin twice daily was prescribed for 1 month, which caused the patient's symptoms to subside partially. However, in the next 3 years, he was bothered by symptoms including: (1) nervous system, comprised of irritability, mood swings, poor concentration, loss of short-term memory, sleep disturbance, facial tingling, blurred vision, and photophobia; (2) cardiovascular system, consisting of chest pains and palpitations; (3) musculoskeletal system, associated with migrating arthralgias; and (4) other problems, including headache and pelvic pain.

In 2007, the patient again visited another infection clinic, where he received antibiotic agents such as doxycycline, amoxicillin 250 mg + clavulanic acid 125 mg (Augmentin), parenteral penicillin, and oral cefuroxime over the following 4 years. Because the above symptoms had not improved significantly, in October 2011 the patient visited us for HBOT. Before HBOT, some residual symptoms such as elbow and joint pain, numbness of the extremities, perioribital twitch, sleep disorder, and affected thinking ability persisted. After we excluded other infectious and noninfectious etiologies that can mimic certain appearances of the typical multisystem illness seen in CLD, HBOT at 2.5 ATA with treatment duration of 1.5 hours for 30 sessions was given. In the first 10 sessions of HBOT, nervous-system-associated symptoms such as loss of thinking ability and sleep disorder disappeared. In the second 10 sessions of HBOT, additional nervous system symptoms such as numbness of the extremities and perioribital twitch also disappeared. In the third 10 sessions of HBOT, musculoskeletal system symptoms such as migrating arthralgia also vanished. Overall, completion of 30 sessions of HBOT caused noted longstanding Lyme-disease-related symptoms affecting most of the previously affected bodily areas to disappear.

3. Discussion

Lyme disease was recognized in 1976 and is caused by the tick-borne spirochete *B. burgdorferi*.[1,8] In the United States, it is the most common vector-borne illness, where >20,000 cases have been diagnosed annually. In Taiwan, Shih and Chao conducted a zoonotic survey for evaluating spirochetal infection of rodents in Taiwan. They reported that the overall infection rate throughout Taiwan was 16.6%, and the highest infection rate (25.8%) was observed on Kimman Island. By contrast, the infection rate in Taipei area was only 6.7%.[3,9] Erythema migrans or "bulls-eye" rash following receipt of a tick bite and joint swelling typical of arthritis are the classic clinical appearances of Lyme disease. However, only 50−60% of patients remembered having received a tick bite, and often the skin lesion was either absent or atypical.[10] Other manifestations such as multiple nonspecific symptoms that affect different organ systems, including the joints, muscles, nerves, brain, and heart are also reported.

Lyme disease is a clinical diagnosis. Laboratory testing with a two-tier testing system is advocated by the Centers for Disease Control and Prevention (CDC), United States, which involves a positive screening test using an enzyme-linked immunosorbent assay or immunofluorescence assay, followed by positive western blotting. The two-tier system has a high specificity (99−100%); however, it has relatively poor sensitivity (50−75%).[11] Therefore, the tests used to diagnose Lyme disease should be used to support rather than replace the physician's judgment.[12] That is, the diagnosis is based on a possible tick exposure history, the emergence of specific clinical symptoms, and exclusion of other causes of the symptoms. The results of serological or other diagnostic tests are not essential. In most cases, Lyme disease can be treated successfully with oral forms of antibiotics and a parenteral regimen lasting 7−21 days, depending upon the different presentations of the disease.[5] However, 10−20% of patients have persistent or intermittent subjective symptoms (such as fatigue, arthralgia, myalgia, headache, neck stiffness, paresthesia, sleeplessness, irritability, and difficulty with memory, word finding, and concentration) after receiving an adequate course of antibiotic therapy. Lacking any alternative diagnosis, such patients are classified as CLD.[6] The mechanisms of CLD are not clear. Possible explanations include persistent infection with *B. burgdorferi* (although clinical or laboratory evidence of infection is not required),[6] postinfective fatigue syndrome, and autoimmune mechanisms. With the pathophysiological complexity of *Borrelia*, CLD is a controversial illness. Multiple body systems can be involved and they can be difficult to manage.[13] Prolonged antibiotic therapy has been used in patients who have CLD, but research suggests that such an approach is not warranted.[14−16]

Several adjunctive therapies including immune system therapy, ozone therapy, vaccination, and HBOT were previously mentioned. Among these therapies, HBOT has been recommended for treatment of Lyme borreliosis, especially for patients who have received antibiotic therapy but still suffer from Lyme-related symptoms.[17] HBOT, a treatment in which the patient intermittently breathes 100% oxygen while the treatment chamber is pressurized to a pressure greater than sea level (1 ATA), is increasingly used in many areas of medical practice.[18] Although the method of action of such a unique intervention is not satisfactorily understood, some mechanisms such as competing anaerobes by increasing tissue oxygen tensions, inhibiting bacterial metabolic functions by increasing the generation of oxygen free radicals, enhancing leukocytes to kill bacteria by facilitating the oxygen-dependent peroxidase system, and improving the oxygen-dependent transport of certain antibiotics have been determined to be efficacious.[7] Austin illustrated the effects of oxygen on *B. burgdorferi* in 1993 and showed that the ambient levels of O_2 and CO_2 can affect the infectious capacity of *B. burgdorferi*.[19] Thereafter, the effect of HBOT in CLD was reported by researchers at

Please cite this article in press as: Huang C-Y, et al., Hyperbaric oxygen therapy as an effective adjunctive treatment for chronic Lyme disease, Journal of the Chinese Medical Association (2014), http://dx.doi.org/10.1016/j.jcma.2014.02.001

Texas A&M University. There were 84.8% of treated patients ($n = 91$) who showed significant improvement of symptoms, including mental confusion, pain, depression and fatigue, with ~70% of patients who showed a lasting benefit upon follow-up examination.[20] CLD is a complicated illness. Although HBOT is not a regularly recommended therapy for CLD in Taiwan, HBOT might be an effective adjunctive treatment when a clinician is confronted with a patient with CLD.

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Please cite this article in press as: Huang C-Y, et al., Hyperbaric oxygen therapy as an effective adjunctive treatment for chronic Lyme disease, Journal of the Chinese Medical Association (2014), http://dx.doi.org/10.1016/j.jcma.2014.02.001