LYME DISEASE

David E. FitzGerald, O.D.

ABSTRACT

An overview of Lyme disease is presented in order to acquaint the practitioner with its epidemiology, pathophysiology, serology, clinical manifestation and treatment. The ocular signs and symptoms are enumerated with special emphasis on the binocular system. Behavioral optometrists need to be aware of the general symptomology and reported instances of convergence dysfunctions associated with Lyme disease, since diplopia might be the reason for a new or previous patient to seek care.

KEY WORDS

Lyme disease, borrelia burgdorferi, ixodes species, conjunctivitis, optic neuritis, convergence insufficiency, blurred vision

Lyme disease is a relatively new disease to the United States.[1] It has been referred to as the "great imitator" for it has the ability to mimic many and varied illnesses.[2] The symptoms can range from flu-like to arthritis-like to neurological.[3] Clinical observations seem to advance the thinking that any compromised system in a person will be more readily affected and more prone to display its fragility.[4] The need for early diagnosis is essential because the longer the causative spirochete remains undetected the more serious becomes the stages of the disease. Frequently patients have had the tick-borne infection for months or even years before a proper diagnosis is made. Patient symptomology usually is then increased and the prognosis for successful treatment becomes more guarded. Thus it is of utmost importance for all health care providers to be aware of the many ramifications of the infection and the possible interweaving of symptoms.

The optometrist should be cognizant of the conjunctivitis that occurs in stage one as well as to the more involved eye infections and neurologically mediated eye involvements of the later stages. Of particular interest to the behavioral-functional optometrist is the potential alteration of one's binocular status. This point was made very evident by a colleague who consulted me regarding one of his patients. He realized that I had some firsthand information regarding the disease and his patient was suffering from it. The adolescent had come to him with symptoms of blurred vision even though he found the VA to be 20/20 and the fields and other neurological probes to be essentially negative. However, he noted that his patient was a successfully treated convergence insufficiency case and that now she had "fallen apart" and presented with a drastically receded nearpoint of convergence. Within a few days the patient began to display multiple sclerosis (MS) style optic neuritis symptoms and my colleague referred her back to her primary care practitioner and later to a neuro-ophthalmologist. This prompted me to query other doctors who practiced in high density Lyme disease communities. Though the sample was small, the response was that usually binocular status had been altered with a receded nearpoint of convergence being most often mentioned. Since cranial nerve involvements are common sequelae to this disease process some alteration of binocular status would be expected. Consequently we should be aware of the signs and symptoms of the undiagnosed Lyme's patient as well as those

under treatment. In the former, referral to an internist or an infectious disease specialist is crucial, while in the latter, disposition is based upon symptoms and clinical findings.

Historical Aspects

The disease, although not fully recognized, was first noted in Europe in 1909 by Afzelius, who described a tick-borne infection that caused the patient to have a skin lesion, erythema chronicum migrans (ECM).[5] Additional clinical findings were noted by Garin-Bujadoux[6] in 1922 and Bannevarth[7] in 1941. In 1975, the disease became prevalent in the area of Lyme, Connecticut and was manifested as a juvenile rheumatoid arthritis.[8] In 1977, a group at Yale Medical School linked the European reports, the ECM, the tick bite, and the subsequent disease process and treatment together.[9] In 1983, Willy Burgdorfer identified the spirochete, borrelia burgdorferi, in the vector tick.[8] The tick's genus varies by geographic location and slight species differences. Ixodes dammini is prevalent in the Midwest, the Northeast and as far south as Virginia. Ixodes pacificus is present on the West Coast while ixodes scapulars is present in the South and Southwest. The European species is ixodes ricinus while in the Soviet Union and the Orient the vector seems to be ixodes persulcaties.[10]

From the number of suspected tick species it becomes apparent that borrelia burgdorferi has spread throughout many regions of the world. Lyme disease has been reported in as many as 44 states with the Northeast corridor being the hot spot. Nearly 80% of the cases have occurred in Massachusetts, Rhode Island, Connecticut, New York, New Jersey and Pennsylvania.[11] Other areas of higher incidence are the Wisconsin-Minnesota areas, Texas and the Pacific Coast.[2] Besides Europe, the disease has been reported in Africa, Australia and Asia.[8] Recently four patients from the Caribbean and Central America have been found to be serologically positive to the spirochete.[12]

The Tick

The ixodes tick, frequently referred to as the deer tick or bear tick, has a three-phase life cycle over a two-year period. It progresses from a larva to a nymph to an adult with each stage having a blood feeding from a host. In the spring the adult lays her eggs, which hatch and feed once before the next spring. The host is usually the white-footed mouse; however, almost any warmblooded animal will suffice.[1] The majority of these larval ticks do not carry the spirochete but rather acquire it from their first host. The infected host has been most likely compromised by an infected deer tick in the nymphal stage.[2] During the following spring the larva molts into the nymph, which again prefers small mammals, especially the white-footed mouse, as its host. At this stage the nymph may attach to a human, as well as a bird. After this second blood feeding the nymph molts into the adult tick. This is accomplished during the late summer and its life cycle continues by attaching to larger mammals, especially the white-tailed deer. A subsequent feeding takes place and the female is now prepared to lay her eggs the next spring. Humans are liable to be bitten by either the nymph or the adult.[1] Each resides in low vegetation, ready to attach its legs to a host. The adult can transmit the infectious borrelia within hours of a bite, while the nymph may need as much as a few days to a week.[8] The tick usually drops off its host after it has fed. In the case of the adult, the female does the blood feeding while the male mates by passing sperm through her hypostome, a barb-like portion of the mouth used for sucking blood. The female then finishes the feeding and her engorged body is filled. She subsequently drops off her host and lays her eggs.

The tick as a larva is no larger than a period on this page. At its adult size it is viewed as a hard body spider-like creature about one-third the size of a dog tick. The adult female is orange-brown in color with a black spot near its head.

In conjunction with the tick's life cycle, certain periods of the year will have higher incidences of reported cases. The highest risk period is the summertime, when the nymphs are most active. The spring and the fall will present a moderately to moderately- high risk while the incidence will be the lowest in the winter.[10] However, the incidence usually rises during the winter thaw period. It should be realized that one can contact this disease at any time of the year and at any temperature. There have been cases reported in Minnesota when the temperature was as low as 17 F.[4] Other factors to keep in mind are that many mammals can act as hosts. These include birds, dogs, cats, horses, etc. These domestic animals, especially those who frequent wooded areas, can bring the tick home.

Pathophysiology

Borrelia burgdorferi enters the human host directly through the bite wound. Not everyone who is bitten will contract the disease.[1,8] This is dependent upon the host's immune system, the tick's stage, or when the tick was removed. The spirochetes pass into the circulatory system and spread throughout the body, causing havoc and symptoms. The spirochetes create many of the signs and symptoms found in syphilis, and proper laboratory testing should be done in order to avoid an erroneous diagnosis. The highest number of live spirochetes are found in the bladder, while the lungs are the second most frequent site.

Borrelia burgdorferi has a long and complex life cycle with periods of dormancy. It has few surface proteins and molecularly mimics our own body cells. This creates obstacles for treatment.[4] Basically the transmission of the spirochetes is direct, either via a bite, transfusion or transplacental. Breast milk may also present an avenue of transmission since the spirochete can be present in it.[4] There was one case reported where the disease was transmitted by a bite from a flying anthropod.[13]

Laboratory Findings

This area is probably best described by Dr. A. B. MacDonald,[14] who states that the "problems with presently available methods for antibody detection in Lyme borreliosis are lack of sensitivity (false negative results) and to a much lesser extent some lack of specificity (false positive results)." Part of this problem is caused by reagents that are used, how they are prepared and how the spirochetes are cultured.[14]

It should be kept in mind that serological tests are an indirect method of evaluating a person's immune systems. The IgM antibodies respond first while those of the IgG supply a long- lasting bodily reaction. The IgM response appears within three to six weeks after the

initial infection. If the involvement goes untreated, the IgM will decrease while the IgG slowly increases. Ideally, the patient who goes untreated will have an elevated IgG in stages two and three of the disease. However, this is not necessarily the scenario in Lyme disease. As mentioned before, the spirochetes have dormant phases as well as a cyclic life. Consequently, the patient may have an increased IgM response mirroring the return of the infection.[4] The methods used to detect antibodies are IFA (indirect immunofluorescence assay) and ELISA (enzyme-linked immunosorbent assay). Laboratories may report this as a total antibody count or as an IgM and IgG fraction. These results may also be altered if the patient received any medications during the initial stage, thus perhaps accounting for the estimated 50% false negative serological results.[1]

Because *borrelia burgdorferi's* highest concentration is in the bladder, a urine test should yield a direct count. However, this test is not very sensitive and of little advantage once treatment has been instigated. Other laboratory tests used are DNA probe, cultures, biopsies and T-cell tests. Each of these presents at least one of the following problems: unavailability, expense, quantity of spirochetes, and/or methodology.[4] It would seem that Lyme is more readily diagnosed on a clinical basis, for there are no truly valid tests for diagnosis. Similarly, there are no conclusive laboratory tests to determine when the patient is free of the *borrelia burgdorferi*.

Clinical Presentation

The clinical picture is varied and punctuated with seemingly unrelated signs and symptoms as well as recurring episodes. The dermatological presentation occurs in approximately 50% of the cases. The erythema chronicum migrans (ECM) can appear as a single bull's-eye-shaped lesion at the site of the bite or can arise as multiple transient eruptions removed from the original entry point.[1] The bull's-eye lesion is described as a flat or raised red area that slowly expands after a few days with partial central clearing. At times the ECM may present a blistering or scabbing in the center.[10] The center may also appear as a bluish color.[15] The rash may vary in diameter. It can appear as concentric rings,[1] or as a diverse geometric configuration.[4] The rash can be raised, warm, present some sensation, or even mimic poison ivy.[4]

Clinically the disease manifests itself in three stages but there are frequently overlapping signs and symptoms. The generally accepted first stage is that of the bite and the ECM. However, the ECM does not present itself in a good number of cases. When present, the rash may last for a week to 10 days and disappear.

The patient develops a flu-like[16] illness in this first stage. The symptoms can include headache, fever, chills, general malaise, stiff neck, arthralgia (painful joints), myalgia (aching muscles) and anorexia.[1]

The patient may also have symptoms which resemble a respiratory or gastrointestinal infection.[1] The clinical findings may include ECM, malar rash, erythematous throat, signs of meningeal irritation, regional (frequently neck and underarm) or generalized lymphadenopathy, hepatosplenomegaly and arthritis.[1] The main ocular findings are conjunctivitis, episcleritis and photophobia. The initial presentation appears to be self-limiting and goes away only to return after a period of dormancy.

Stage two may occur weeks or months after the original episode and presents itself as a neurological and cardiological type disease. The cardiac involvement is usually transient and results in a benign conclusion. A pacemaker may, however, be needed in order to mediate any heart block which could occur. The atrioventricular heart block causes a slowing down of impulse conduction resulting in a new set of symptoms.[1,4] They are manifested as lightheadedness, syncope, palpitations, chest discomfort and dyspnea.

As in syphilis the spirochete effects a neurological stage with many of the same results. The manifestations are quite varied and present major consequence. They may range from headaches to dementia.

At this time it is productive to associate some of the symptoms with the ongoing process. Bell's palsy, unilateral or bilateral, is a very common manifestation. When a patient has it bilaterally it is usually the result of distinct unilateral episodes that can occur weeks apart, on each side of the face. In stage two this can occur as a syndrome with radiculopathic (dealing with the posterior root of the spinal nerve) components. The associated pain is usually in the dermatomes. They are frequently more motor than sensory and involve C5 and T8 through T12. Aseptic meningitis gives rise to headaches, stiff neck, photophobia, nausea and vomiting. Encephalitis gives rise to poor memory, decreased concentration, lethargy, fatigue, emotional instability, irritability, dizziness, sleep disorders, psychosis, auditory hallucinations, seizures and dementia. Some patients present a syndrome which mirrors demyelinating type diseases varying from amyotrophic lateral sclerosis (ALS) to MS to carpal tunnel syndrome. Cranial neuropathies mainly affect CN III, IV and VI; however, V, VII and VIII have been implicated.[8] These latter three nerves will involve, in order, sensory aspects of the eye and jaw, facial palsy, and hearing and balance. The former group of cranial nerves are obviously all intimately involved with the eyes, vision and binocularity. Alterations in fusional abilities, as well as overt diplopia, can readily appear as a sign and symptom. CN III involvement provides the mechanism for varied binocular manifestations. Consequently, there certainly is an obvious relationship to convergence and its neurological center. Thus, it would appear that a receding of the near-point of convergence (CNP) would fit precisely into this level of the disease process.

In addition, it would seem possible to have accommodation affected since its fibers are intimately associated with CN II and CN III.[17] Nevertheless, the convergence mechanism appears to be more directly associated with the syndrome. Other ocular involvements of the disease will be discussed later in the article.

Stage three is characterized as a rheumatoid arthritic phase. This period may occur weeks or months after stage two. It is characterized by one or more episodes of mono or oligoarthritis, lasting from days to months. The knee is usually the most common joint involved. There can be marked swelling and pain. Musculo- skeletal joint discomfort, as well as tendon and bursae involvements, may occur.[1,9]

Stages two and three may interweave, giving credence to the possibility of a two-stage process, i.e., early and late. Thus

Burrascano[18] states: "The overlapping symptomatology of these stages has suggested, however, that this disease may be more practically considered to consist of two stages: an early stage and a late stage. The early phase is characterized by the appearance of the localized erythema chronicum migrans, whereas the later phase is marked by a disseminated infection that can involve the nervous, musculoskeletal and cardiovascular systems and the skin."

Ocular Signs and Symptoms

When Lyme disease ocular affects are enumerated they truly go from the front of the eye and a lid twitch to the occipital cortex. There is the initial stage of the conjunctivitis, episcleritis and photophobia. In the later stage the involvements become more dramatic. An exposure keratitis can be a sequelae of the Bell's palsy. There is the syphilitic type of corneal involvement as well as what is described as a Lyme keratitis. This is a stromal involvement characterized by a number of nebular focal opacities found at various depths. The process may lead to edema, neovascularization and scarring.[19]

Symptoms which are common to the patient are photophobia, blurred vision, floaters and pressure behind the eye. As each of the potential manifestations is considered it becomes evident that the symptomology is the product of several sources. Iritis,[8] granulomatous iridocyclitis, vitritis[20] and uveitis[9] are ocular manifestations of Lyme. Granulomatous keratitic precipitates, and posterior synechia may give the appearance of a pars planitis syndrome.[20] A temporal arteritis and its ocular implications has also been subscribed to the borrelia spirochete.[21] Panophthalmitis has been reported in one case,[22] as well as one Horner's Syndrome.[9] Argyll-Robertson pupils have also been described.[13]

Bialasiewicz et al.[23] reported a case where the patient manifested retinal perivasculitis, cystoid macular edema and papilledema. On further evaluation the patient was found to have demyelinating lesions. Thus MS style optic neuritis is seen as a sequelae of Lyme disease. Optic atrophy,[23] optic neuritis, cortical blindness,[3] cranial nerve palsies[20] and pseudocerebri tumor[15] have been reported.

Overall one can see the great variety of havoc that *borrelia burgdorferi* can cause. The ocular manifestations are of major concern not only for treatment but also as a diagnostic marker for the undiagnosed patient.

Treatment

The adage "the sooner the better" is certainly apropos in the treatment of Lyme disease. One might also include "the more aggressively the better." Early diagnosis and aggressive treatment yields the best results.[4] Consequently, it becomes of paramount importance that optometrists be aware of the various manifestations of this disease, not only the initial phases but the later stages because there are a good number of people who are walking around undiagnosed. One simply has to attend a Lyme support group meeting to hear the horror stories.

The medications prescribed fall basically into five categories. The first includes tetracycline, doxycycline and minocycline, and the second is the penicillins, i.e., oral amoxicillin and ampicillin. The synthetic penicillins comprise the third category. These cephalosporins include ceftin, suprax, rocephin and claforan. Erythromycin is the fourth category, and the experimental azithromycin is the fifth.

The initial stage is best treated with tetracycline and penicillin.[8] It should be noted that tetracycline has the limitations of not being able to cross the blood brain barrier and is contraindicated for small children and pregnant women.[24] Doxycycline and minocycline may be effective initially but they do present the problem of relapses.[4] When treatment is instituted the Jarish-Herxheimer reaction usually occurs. This reaction is highlighted by chills, fever, tachycardia, tachypnea, headache, general malaise and muscle weakness.[8] It will happen within the first week of treatment and is an indication of the cytosis of the pathogen. This reaction is cyclic and occurs about every four weeks. Consequently, if a medicated patient goes more than a month without the reaction it is indicative of a good prognosis. In this case, the body has most likely rid itself of all the active, and at times dormant, pathogens.[18] The Herxheimer reaction can be severe and at times the medications must be mediated. The penicillins can be administered either intravenously (IV) or orally. They provide a mechanism for destroying the outer cell wall of the spirochete and are a more narrow spectrum drug. The cephalosporins provide the same mode of treatment but are a more broad spectrum antibiotic. In order to avoid side effects, yogurt or acidophilus capsules should be taken in conjunction with the cephalosporins. This group of drugs does provide a vehicle in which the medication can be administered via a pump in a continuous manner. This is accomplished by means of an IV pump. For IV use, the cephalosporins are preferable to penicillin, which must be made fresh and administered at one time because it is unstable in solution.[4]

Erythromycin is frequently used in conjunction with amoxicillin. The erythromycin alters the metabolic process of the spirochete and provides a different mode of attack. Stomach upset is frequently a side effect of this medication. Azithromycin is an experimental medication which presently does not have FDA approval. One of the main disadvantages of this drug is that of unknown toxicity.[4]

The use of steroids is questionable and considered to be contraindicated by many clinicians. Nonsteroidal anti- inflammatory medications are of use in reducing some symptoms. Some patients have found fish oil and Vitamin C to be of benefit. Others have found the diuretic affect of high fluid intake to be of value. Conversely, alcohol and caffeine should be avoided.[4]

Differential Diagnosis

This area is summarized by Finkel,[8] who states: "Depending on the presentation, one should consider the following illnesses in the differential diagnosis: serum sickness, systemic lupus erythematosus, Rickettsial infections, periarteritis nodosa, Vogt-Koyanai-Harada disease, hepatitis B, central nervous system syphilis, microplasma, Behcet's syndrome, multiple sclerosis, infectious mononucleosis, viral encephalitis, leptospirosis, psychotic disorders, anorexia nervosa, Mollaret's meningitis, ...acute rheumatic fever, juvenile rheumatoid arthritis, septic arthritis and secondary syphilis."

Prevention

The behavioral optometrist, whose patients often include a large number of children, can be a factor in the prevention of Lyme disease by making parents aware of measures that can be taken.

Obviously the best means of prevention is not to be bitten. One should avoid tick infested areas. Light colored clothing is of value in monitoring for ticks. Long sleeves and pants with wrist and ankle bands are advised. The spraying of clothing with a tick repellent such as DEET or Permanone and a careful body check for ticks are also in order. If a tick is found, one should place fine-pointed tweezers at its head and gently but firmly pull to remove it. Save the tick in a covered jar of alcohol, thus providing a specimen. Wipe the bite with an antiseptic.[1] Sprays such as Permakill may be used to protect one's yard or community lands, as well as the use of Damminix, a small biodegradable cardboard tube filled with cotton balls that have been treated with the pesticide, Permethrin.[2] These suggestions seem to be simple and straightfoward; however, there are a number of suburban and rural areas where the deer live contiguously with the population. A walk in one's backyard or the petting of the neighbor's dog could be the beginning of an extremely unpleasant journey. There is an increasing need for funds to study the various means of controlling this potentially devastating disease. In areas of high incidence, Lyme is truly epidemic and is given high priority. Westchester Medical Center in New York has a walk-in Lyme disease clinic which operates essentially throughout the summer.[2] However, at this point, unless the various levels of government become more involved, the disease will only spread to a greater and greater number of the population.

Conclusion

Borrelia burgdorferi is a tick-borne spirochete that produces Lyme disease in man. The disease progresses in various stages with increasing body system involvement and gravity. The necessity of early diagnosis and treatment is paramount; however, many people go undiagnosed for periods of time. It is essential for the optometrist as a primary care provider to be aware of the ocular and visual signs and symptoms. In particular, the more functionally oriented practitioner should also be alert to the potential alteration in convergence and binocular status. More investigation and collection of data is certainly in order as is the need for funding to prevent and eradicate Lyme disease.

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Corresponding author:
David E. FitzGerald, O.D.
State University of New York
State College of Optometry
100 East 24th Street
New York, NY 10010

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