Podoconiosis: A Possible Cause of Lymphedema in Micronesia

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Abstract

Podoconiosis is a type of tropical lymphedema sharing some clinical characteristics with lymphatic filariasis. Also referred to as endemic non-filarial elephantiasis, podoconiosis is a non-infectious disease from barefoot exposure to irritant red clay soil of volcanic origins. Podoconiosis is most common in Ethiopia and has also been reported in many other countries, but not in the Pacific Islands. Lymphatic filariasis is endemic in the Pacific Islands and was historically reported as elephantiasis in Micronesia. It was considered to have been eradicated in Guam and the Northern Mariana Islands following World War II. A small number of patients in Saipan exhibited characteristics of lymphatic filariasis but were seronegative for filariasis. Clinical examination of these patients matched podoconiosis much more closely than filariasis. Moreover, these patients reported a history of chronic barefoot exposure to irritant red clay soil and a prodrome characteristic of podoconiosis. While this study is limited to several cases, the results suggest that podoconiosis could be considered a cause of non-filarial lymphedema in Saipan and perhaps other islands in Micronesia. Preventive patient education is focused on discouraging barefoot exposure to red clay soils, particularly in those with a family history of lymphedema. Early recognition of the possibility of podoconiosis would allow appropriate treatment and prevent progression to later debilitating stages of the disease.

Keywords

podoconiosis, lymphedema, filariasis, elephantiasis, Saipan, Micronesia

Abbreviations and Acronyms

LF = lymphatic filariasis
KCHC = Kagman Community Health Center

Introduction

The Kagman Community Health Center (KCHC) is a rural federally qualified health center in Saipan, Northern Mariana Islands, established in 2013. While serving as Medical Director of KCHC intermittently from 2013 to 2018, and as founder of the Sefin clinic in Chuuk, Federated States of Micronesia from 2016 to 2017, the author treated a number of patients previously diagnosed with presumptive lymphatic filariasis (LF), more commonly known as elephantiasis. These cases all presented in an advanced stage of lymphedema, with bilateral fibrotic swelling in the feet and legs. The patients had been given the standard antihelminthics without benefit. Moreover, laboratory tests were unremarkable and they were seronegative for filariasis. Intrigued with the possibility of a non-filarial cause of lymphedema in these patients, the author collected extensive histories and a more detailed physical examination of 8 cases. The results revealed a history and clinical presentation much more suggestive of podoconiosis than LF. However, podoconiosis has not been previously reported in the Pacific islands.

Lymphedema is the failure of lymph drainage, typically presenting with swelling in the extremities. Primary lymphedema is a genetic condition with incompetent or missing lymph valves, known as Milroy disease. Secondary lymphedema can result from many types of injury to the lymphatic system, including radiation, surgery, trauma, inflammation, and infection. The most common cause in the United States is radiation treatment for cancer.

In tropical countries, lymphedema usually results from infection by a parasitic worm (filaria, usually *Wuchereria bancrofti*) transmitted by the bites of infected mosquitoes. LF is endemic in 49 countries, with an estimated 120 million infections and 40 million disfigured by the disease. The Pacific region was endemic in American Samoa, the Cook Islands, Fiji, French Polynesia, Micronesia, Samoa, Tonga, Tuvalu, Niue, Papua New Guinea, and Vanuatu. Many of these have reported elimination.[1] During World War II, the elephantiasis presentation of lymphedema was commonly observed in the Northern Mariana Islands. Recalling his experience during the invasion, the United States Marine Corps Captain John C. Chapin wrote: "Physical conditions of many were pitiful. Every illness that we had been briefed on was observed [in the area]: leprosy, dengue fever, yaws and many cases of elephantiasis."[2] Following the war and transfer of the Northern Mariana Islands to a US Trust Territory, public health programs were considered to have successfully eradicated filariasis in Guam and the Northern Mariana Islands.[3]

Podoconiosis ("dust in the feet") presents as bilateral asymmetrical swelling of the feet and legs. It is a type of tropical lymphedema sharing some clinical characteristics with LF. Also referred to as endemic non-filarial elephantiasis, or "mossy foot," podoconiosis is a non-infectious disease arising from chronic barefoot exposure to irritant red clay soil of volcanic origins. The precise trigger is unknown, but this disabling condition is considered to be caused by an abnormal inflammatory reaction to the passage of microparticles of silica and aluminum silicates through the skin.[4] These particles are taken up by macrophages into the lymphatic system and result in an inflammatory process leading to fibrosis and obstruction of the vessels.

The disease process has 3 phases: prodromal, early, and advanced. Prodromal symptoms include itching of the skin of the forefoot and a burning sensation in the foot and lower leg, with variable chills or generalized joint pains. These symptoms may progress to the early phase of swelling and splaying of the forefoot and leakage of clear lymph fluid. The skin develops hyperkeratotic papillomata that resemble moss or velvet, giving rise to the African term "mossy foot." Acute episodes may cause

fever, rigors, and a rapid increase in pain and swelling of the leg. In the advanced phase, hard, fibrotic swelling develops in both legs and feet, though 1 is usually more severely affected than the other.[5]

Podoconiosis is most common in Ethiopia but is also widespread in tropical Africa, Central, and South America, Indonesia, India, and has also been reported in many other countries. It has not, however, been previously reported in the Pacific Islands.[6]

The purpose of this study is to consider whether podoconiosis may be a cause of non-filarial lymphedema in the Northern Mariana Islands.

Case Report

Detailed histories, physical examinations, and laboratory tests were collected on 8 patients in Saipan who presented with fibrotic bilateral lymphedema in the lower extremities. The age range was from 41 to 66 years, with 5 males and 3 females. All were Pacific Islanders: 5 of Chamorro (Guam and the Northern Mariana Islands) and 3 of Carolian (2 Chuukese, 1 Yapese) ancestries. All had a lengthy residence in Saipan of over 10 years and reported their symptoms began after residing in Saipan. There were likely other cases that did not come to medical attention. In Africa, "mossy foot" can cause great social stigma and is a "hidden disease" since the afflicted hide from sight, not wanting to suffer the social embarrassment of their disfigurement.[7] Several of the Saipan cases reported relatives with the condition who were reluctant to seek medical attention because they felt it was futile or feared surgery (amputations for gangrenous diabetic feet were very common).

Physical examination and laboratory results were unremarkable except for obesity, mild hypertension, or mild diabetes in several, but not all, cases. All were seronegative for microfilariae, *Wuchereria bancrofti* antigen, or specific IgG4 antibodies. All cases met the podoconiosis diagnostic standard: bilateral, asymmetrical lymphedema of the lower limb present for more than 1 year, with negative serology for LF, and a history of any of the associated clinical signs and symptoms.[8] These cases also reported the characteristic exposure and prodromal symptoms of podoconiosis, which differ from LF and other causes of lymphedema.

The most detailed history was obtained from the 41-year-old female, the youngest of the cases. In adolescence and early adulthood, she lived with her aunt in a simple dwelling with a dirt floor of hard red clay that she swept daily. She was barefoot almost all of the time. She states that she was healthy until her early 20s when she began to experience itching in her feet and burning pain and swelling in her left foot and leg. When the pain and swelling became acute, she sought medical attention and was given a short course of antibiotics with no benefit. The swelling was gradually progressive over several years, with the right foot and leg also affected. She developed severe fungal infections on her legs and weeping lesions of clear fluid that became malodorous and attracted flies. The pain was worse at night and partly relieved by uncovering her legs. She again sought medical attention and was treated with doxycycline and albendazole without improvement. She became increasingly homebound because of her difficulty ambulating and because she was embarrassed about her unsightly condition. She gained weight leading to obesity.

On examination, she was normotensive and did not have diabetes. Both feet and legs were grossly enlarged, hyperkeratotic, with non-pitting edema and evident areas of fungal infection (Figure 1). There appeared to be mild lymphatic or serous oozing. Her lower extremities had normal sensation and capillary refill, but it was impossible to detect peripheral pulses because of the edema and induration.

She was followed for 3 years and given manual decompressive therapy and trials of compression stockings and Unna boot, achieving only very modest improvement. Because of the advanced state of fibrosis, her only other therapeutic option would have been radical surgical debulking, which she declined.

Diagnosis

These cases show lymphedema that does not appear to have characteristic features of LF. However, it is difficult to rule out LF simply by the absence of microfilariae or seronegative antigen results. Microfilariae of *Wuchereria* and *Brugia* exhibit a nocturnal periodicity, and an accurate diagnosis is best achieved on smears collected at night (10:00 PM to 2:00 AM). In advanced stages, microfilariae may be absent. Because sensitivity for detecting microfilariae can be low and variable, immunoassay for circulating filarial antigens is a useful diagnostic approach. However, late stages of the disease are often seronegative. The distinction is, therefore, based mainly on clinical signs, symptoms, and characteristic exposure.

Podoconiosis typically has a prodrome of itching. Symptoms start in the foot and ascend to the knee, with swelling rarely above the knees, although there may be femoral node tenderness. The swelling is bilateral but asymmetric. Conversely, LF lacks the prodrome of itching or burning feet. Symptoms tend to start in the groin and are descending, with unilateral leg swelling. Podoconiosis requires chronic barefoot exposure to irritant red clay soil of volcanic origins, containing silica and aluminum silicates. Saipan has regions of this type of soil, notably in the area of the previous home of the described case.[9] In Africa, podoconiosis is found in highland areas (typically over 1500 m) where rainfall is higher (mean annual rainfall of over 1500 mm), which causes weathering of volcanic rock into silicate clays with particle size less than 2 μm. It is not found in the lower, more arid regions. In Africa, elevation is, therefore, a

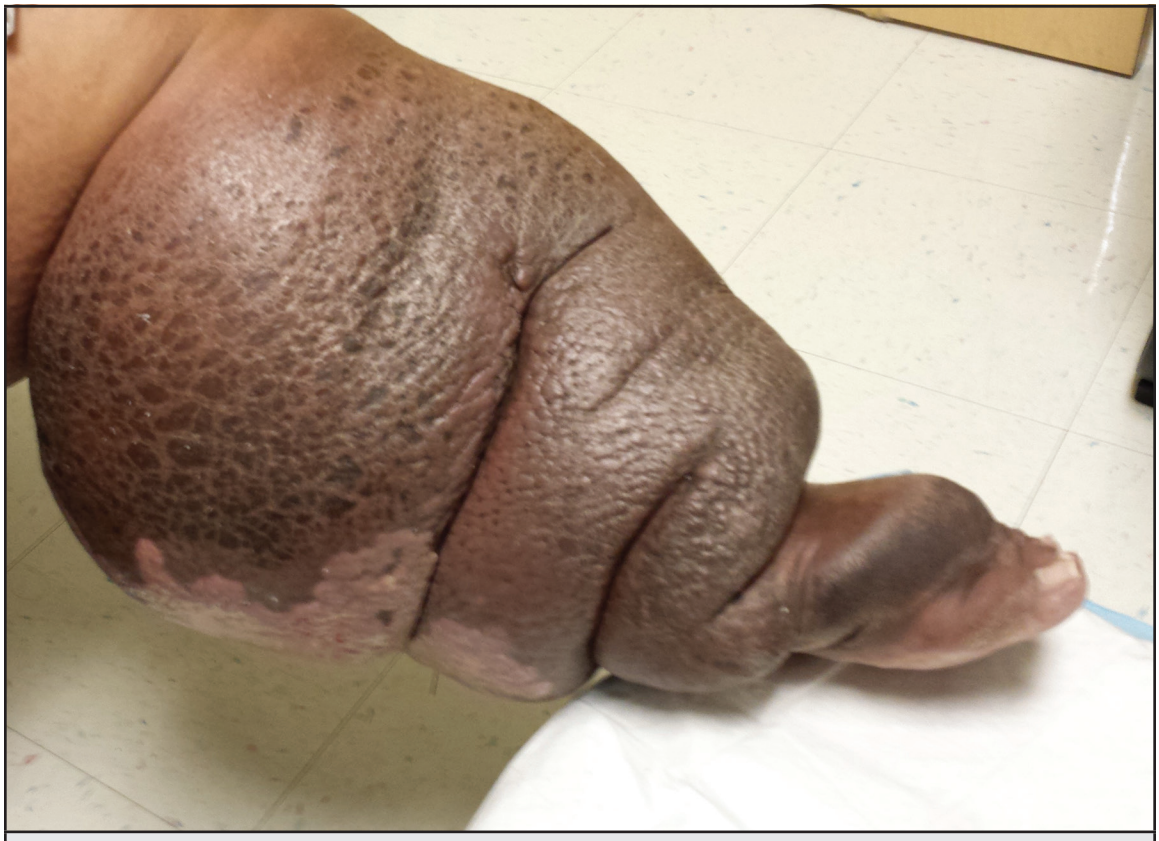

Figure 1. Photo of Lymphedema of Left Leg

criterion of podoconiosis exposure.[10] In Saipan, the regions of exposure are near sea level but exhibit a hot and humid environment with very heavy rainfall that is conducive to the weathering of volcanic soils.

A differential diagnosis of tropical lymphedema should also include leprosy, mycetoma pedis, and Milroy disease. Podoconiosis can be distinguished from leprosy by preserving sensation in the affected limb and the isolation of disease to the lower extremities. Mycetoma pedis (mycetoma of the foot), often referred to as Madura foot, is endemic in Africa, India, and Central and South America. It is caused by a bacterial or fungal infection and presents purulent exudate. Milroy disease typically has its onset of swelling and edema at birth or early infancy, although rare variants have a later onset. Each of these conditions differs in clinical presentation from podoconiosis.

Discussion

In 905 CE, the Persian physician Rhazes first recorded that elephantiasis "of the Greeks" was different from that "of the Arabs." The first likely referred to lepromatous leprosy, while the second is now considered to be podoconiosis. In the 1920s, persistently negative tests for filaria in Guatemala led investigators to suggest that the endemic form of elephantiasis was associated with walking barefoot rather than an insect vector. With the discovery in the 1970s of lymph nodes and macrophages laden with silicon, aluminum, and other soil metals, the term podoconiosis was proposed for this form of non-filarial elephantiasis. Podoconiosis is now thought to have been prevalent in Northern Africa (Algeria, Tunisia, Morocco, and the Canary Islands) and Europe (France, Ireland, and Scotland) but no longer found in these countries due to the widespread use of shoes. The global burden of podoconiosis is estimated at 4 million afflicted people in 32 countries, mainly in tropical countries of Africa, Central and South America, and Southeast Asia. Underreporting of podoconiosis is likely because of diagnostic challenges and a low index of suspicion.[11]

Podoconiosis is a non-communicable disease, easily prevented by avoiding exposure to irritant volcanic soils by good foot hygiene and the use of socks and shoes.[12] Late-stage disease can be treated with lymphatic decompression therapy, either with manual or pneumatic devices, and compression stockings, or Unna boot.[13] For very severe hyperplastic and verrucous elephantiasis, debulking surgery is an option. Early stages are reversible given good foot hygiene and protective footwear, whereas late stages result in considerable economic and social difficulties and, despite treatment, may never fully resolve.[14]

At the beginning of the author's work in Saipan, barefoot walking was commonly observed, even in the main villages and modern buildings. However, the island was rapidly developing with a burgeoning tourism industry. The increasing prosperity led to upgrades in dwellings. In 2015, typhoon Soudelor devastated a large part of the island. Extensive reconstruction created new housing and further hastened the transition to modern footwear. By the end of the author's tenure in Saipan in 2018, barefoot walking was seldom observed. It is interesting to note that all of the observed cases were middle-aged or older and in an advanced stage of the disease. None showed early signs. Economic development in Saipan may be responsible for the decrease in cases.

Conclusion

The purpose of this case series and review is to show that podoconiosis may be the cause of non-filarial lymphedema in Saipan and perhaps other regions of Micronesia and therefore encourage healthcare providers to be alert to this entirely preventable disease.

Conflict of Interest

The author has no relationship with any person or entity that could be viewed as presenting a potential conflict of interest.

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