Clinical, Cosmetic and Investigational Dermatology

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ORIGINAL RESEARCH

Morgellons disease: Analysis of a population with clinically confirmed microscopic subcutaneous fibers of unknown etiology

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Background: Morgellons disease is a controversial illness in which patients complain of stinging, burning, and biting sensations under the skin. Unusual subcutaneous fibers are the unique objective finding. The etiology of Morgellons disease is unknown, and diagnostic criteria have yet to be established. Our goal was to identify prevalent symptoms in patients with clinically confirmed subcutaneous fibers in order to develop a case definition for Morgellons disease.

Methods: Patients with subcutaneous fibers observed on physical examination (designated as the fiber group) were evaluated using a data extraction tool that measured clinical and demographic characteristics. The prevalence of symptoms common to the fiber group was then compared with the prevalence of these symptoms in patients with Lyme disease and no complaints of skin fibers.

Results: The fiber group consisted of 122 patients. Significant findings in this group were an association with tick-borne diseases and hypothyroidism, high numbers from two states (Texas and California), high prevalence in middle-aged Caucasian women, and an increased prevalence of smoking and substance abuse. Although depression was noted in 29% of the fiber patients, pre-existing delusional disease was not reported. After adjusting for nonspecific symptoms, the most common symptoms reported in the fiber group were: crawling sensations under the skin; spontaneously appearing, slow-healing lesions; hyperpigmented scars when lesions heal; intense pruritus; seed-like objects, black specks, or "fuzz balls" in lesions or on intact skin; fine, thread-like fibers of varying colors in lesions and intact skin; lesions containing thick, tough, translucent fibers that are highly resistant to extraction; and a sensation of something trying to penetrate the skin from the inside out.

Conclusions: This study of the largest clinical cohort reported to date provides the basis for an accurate and clinically useful case definition for Morgellons disease.

Keywords: Morgellons, subcutaneous fibers, pruritus, delusions of parasitosis, Lyme disease, skin lesions

Introduction

Morgellons disease is a poorly understood multisystem illness characterized by stinging, biting, and crawling sensations under the skin.[1] According to the Morgellons Research Foundation (MRF) website, more than 14,000 families are reportedly affected by this emerging disease.[2] Considerable suffering occurs as thread-like fibers work their way out of the victim's skin causing pain, itching, and open, disfiguring lesions (Figures 1 and 2). Unfortunately, patients are often dismissed as delusional by clinicians who are unfamiliar with the signs and symptoms of Morgellons disease.[3–5] There is a scarcity of literature on Morgellons disease due to its relatively recent description in the

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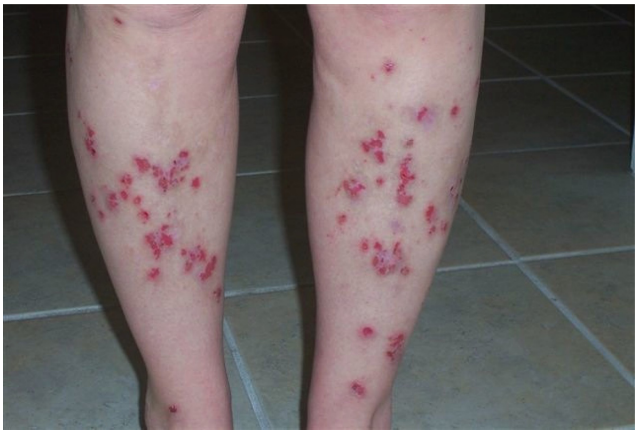

Figure 1 Morgellons patient's lower legs. Similar lesions covered her trunk and arms. There were no excoriations or secondary infections. Photo courtesy of Cindy Casey, Charles E Holman Foundation, Austin, Texas. Reproduced with permission.

modern medical literature, the reluctance on the part of the medical community to recognize it as anything other than psychopathology, and the lack of knowledge about its etiology and transmission.[6]

The distinctive feature of Morgellons disease is the presence of microscopic subcutaneous fibers[1] (Figures 3, 4, and 5). Observation of the skin with a lighted, handheld, 30 × to 60 × magnifier enables visualization of these red, blue, black, and white fibers that have the appearance of either straight hollow tubes or wiry tangled threads.[1] At times the fibers are seen above the dermis as loosely clumped "fuzz balls" or as black specks the size of coffee grains. Examination of the black specks by electron microscopy reveals that they consist of a tightly woven ball of black fibers.[6]

Biopsies performed on Morgellons disease patients have focused on fibrous material projecting from inflamed epidermal tissue, and this material is often labeled as "textile fibers" on pathologic examination.[7] However, a more thorough analysis of the fibers performed by the Federal Bureau of Investigation forensics laboratory has revealed that the fibers do not resemble textiles or any other manmade substance. In fact, the fibers are virtually indestructible by heat or chemical means, making analysis difficult by conventional methods.[6]

In order to identify a homogeneous population for research purposes, it is important to develop a clinically-based case definition for Morgellons disease. To this end, we studied a group of subjects selected for a unique inclusion criterion in order to describe demographic, comorbidity, and symptom characteristics common to the population of Morgellons patients.

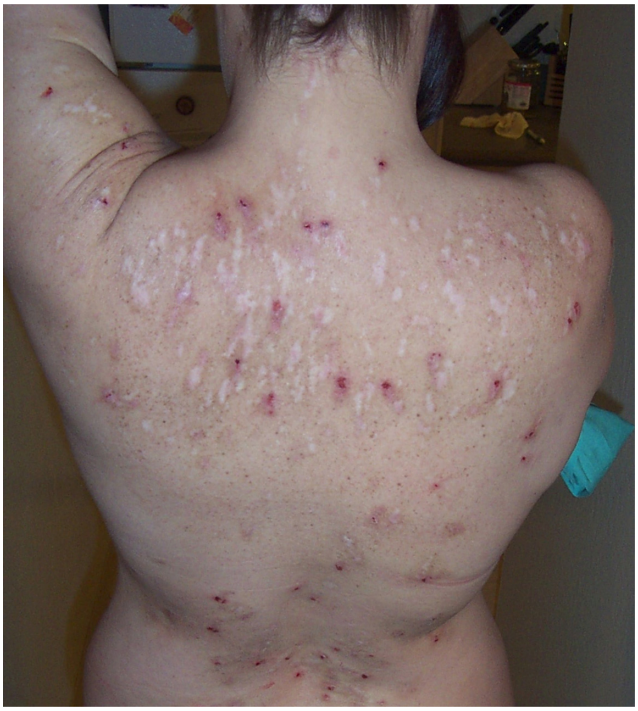

Figure 2 Morgellons patient's back. Note that lesions and scars occur in areas that could not have been reached by the patient. Photo courtesy of Cindy Casey, Charles E Holman Foundation, Austin, Texas. Reproduced with permission.

Materials and methods

Design and approval

The study was conducted using a one-group, retrospective design with one data collection episode. The Declaration of Helsinki protocols were followed, and approval for the study was obtained from the Case Western Reserve Institutional

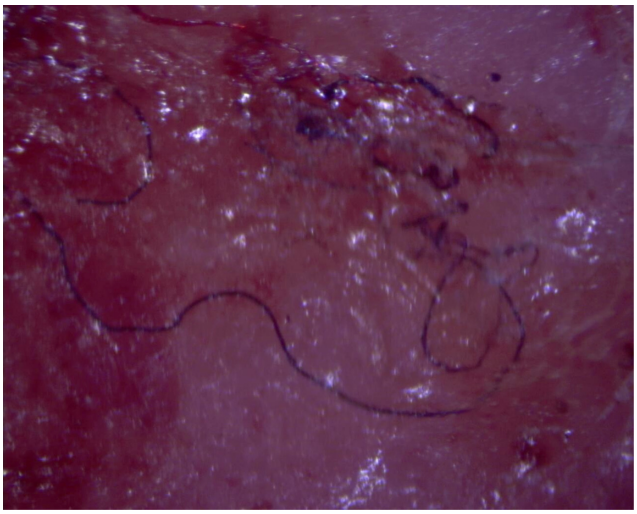

Figure 3 Close up of a leg lesion showing a twisted fiber just under the epidermis. Magnification 100 ×. Photo courtesy of Cindy Casey, Charles E Holman Foundation, Austin, Texas. Reproduced with permission.

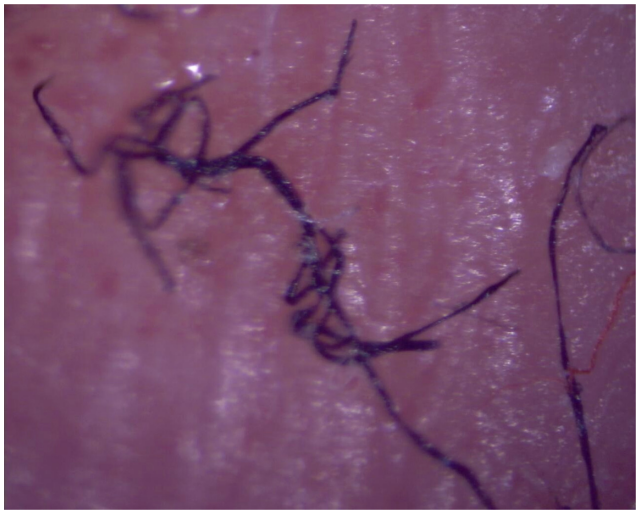

Figure 4 Black fibers and one red fiber, just under the epidermis of a healing lesion. Magnification 200 ×. Photo courtesy of Cindy Casey, Charles E Holman Foundation, Austin, Texas. Reproduced with permission.

Review Board, Cleveland, Ohio. Written informed consent was obtained from all study subjects for review of their medical records, and patient anonymity and confidentiality were strictly maintained. An epidemiologist provided input for the study design.

Patient sample

The convenience sample included all patients seen in the first author's San Francisco medical office who met the inclusion criterion. The subject inclusion criterion was a positive examination for microscopic subcutaneous fibers as visualized by the first author using a 60 × handheld lighted magnifier. There were no exclusion criteria for the sample group because the inclusion criterion was narrowly defined to promote a homogeneous sample.

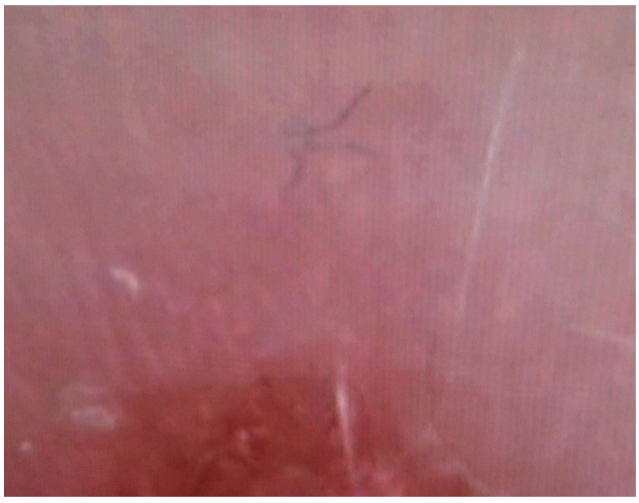

Figure 5 Fiber under epidermis (top) and separate from a skin lesion (bottom). Magnification 30 ×. Photo courtesy of Randy Wymore, Oklahoma State University Center for Health Sciences, Tulsa, Oklahoma. Reproduced with permission.

Intervening variables identified for the study were smoking, substance abuse, immunosuppressive therapy, clinical comorbidities, and prescription medications. These variables had been identified in a pilot study (n = 44) that was conducted by the first author in March of 2005 to gather preliminary information about Morgellons disease patients.

Procedure

Five content experts reviewed and agreed upon the demographic, health background, and symptom data extraction tools developed by the first author (see Appendix A). The experts included two internists, a family practitioner, an infectious disease specialist, and a psychiatrist. All had clinical experience with the diagnosis and treatment of Morgellons disease. The experts were provided with a list of variables to be recorded for each study subject and were asked to rate each variable for its relevance to the illness and the study population. The experts agreed with at least 80% consistency regarding the degree of relevancy of each variable in the data extraction tools for the Morgellons disease population.[8]

Medical records of all patients meeting the inclusion criterion were identified by the first author. Positive serologic testing for *Borrelia burgdorferi* or a high degree of suspicion for Lyme disease was noted on the patient questionnaire in the chart. Because Lyme disease testing is known to be insensitive,[9] the Centers for Disease Control and Prevention has recommended that the diagnosis be based upon the clinical judgement of the health care provider rather than the results of a laboratory test. Therefore, criteria for "a high degree of suspicion for Lyme disease" were agreed upon by a panel of three Lyme disease specialists, and included at least five of the following seven findings: history of tick bite and/or "bullseye" rash; strong exposure potential in a high-risk environment in an endemic area; an equivocal Lyme Western blot result or the presence of bands highly specific for *B burgdorferi* on an otherwise negative Western blot;[10] positive tick co-infection tests including babesiosis, ehrlichiosis, anaplasmosis, and/or bartonellosis:[11] a below-normal CD57 natural killer cell count;[12] an above-normal C4a complement protein;[13] and classic Lyme disease symptoms such as joint pain, exhaustion, and mental confusion.

A medical assistant in the first author's office photocopied the patient questionnaires, concealed the identities, numbered them for identification, and provided these to the first author. The first author then completed the data extraction tools for each study subject using information gathered from

these questionnaires. To validate reliability and consistency of data extraction, a volunteer medical assistant randomly checked 10 data collection tools against their corresponding questionnaires. Consistency of data extraction was verified. The Statistical Package for the Social Sciences, version 16, was used for data analysis.

When clinical results demonstrated that 97% of the study sample had evidence of coexisting Lyme disease, a questionnaire about prevalent symptoms in the fiber group was administered to 60 Lyme disease patients who had no complaints of skin fibers. The convenience sample of 60 volunteers was recruited by an email that was sent to 116 of the first author's current and former Lyme patients. All patients who volunteered were evaluated for symptom prevalence. Results of the Lyme group were tabulated and, to compare the symptoms of the two groups, a Friedman chi square analysis was performed using GraphPad InStat Version 3.0b software (GraphPad Software, La Jolla, CA).

Results

Patient characteristics

In the Morgellons group, the 122 subjects were predominantly female (n = 103, 84.4%) with a mean age of 47.8 years (SD = 12.13, range 22–85). The median age was 48.5 years and the mode was 45 years. Subjects (n = 110) overwhelmingly identified as white/non-Hispanic (90.2%). The only other races represented were Hispanic (n = 8, 6.6%) and African American (n = 4, 3.2%).

Of the 122 subjects, 23 different states of residence were represented and one foreign nationality, the United Kingdom. The states of residence most frequently reported were California (n = 58, 47.5%) and Texas (n = 24, 19.7%). There were six subjects from New York, four from Florida and one or two subjects from other states including Alabama, Arizona, Colorado, Illinois, Indiana, Louisiana, Maryland, Michigan, Minnesota, Missouri, North Carolina, New Jersey, Nevada, Ohio, Oregon, Tennessee, Utah, Virginia, and Washington.

The occupations of Morgellons subjects are shown in Table 1. The majority of subjects were unemployed (n = 54, 44.3%), including those who were homemakers, retired, involuntarily unemployed, or on disability leave. The next most frequent occupation (n = 15, 12.3%) was professionals who worked indoors, such as accountants, attorneys, and business managers. Following close behind in frequency were office workers, such as administrative assistants (n = 13, 10.7%) and health care workers, including nurses and massage therapists (n = 10, 8.2%). Other occupations represented in smaller numbers were, in descending order, sales, outdoor manual laborers, teachers, outdoor professionals, indoor manual laborers, and technical workers.

Table 1 Occupation of subjects at the time of presentation to the clinic (n = 122)

Occupation	Number (n)
Unemployed	54
Professional (indoor)	15
Office worker	13
Health care worker	10
Sales	9
Outdoor manual laborer	6
Teacher	6
Professional (outdoor)	4
Indoor Manual Labor	4
Technical Worker	1

Thirty-two percent (n = 39) of the sample reported smoking cigarettes. A history of previous substance abuse was reported by 12.3% (n = 15), but all subjects reported being in full recovery from substance dependence at the time of completion of their questionnaires. Five subjects (4.1%) reported being on immunosuppressive therapy at the time of their onset of illness. Eighteen percent (n = 22) of subjects indicated that at least one other family member shared similar symptoms.

Length of symptoms at time of presentation to the clinic ranged from one month to 624 months (52 years) with a median length of symptoms of 18 months and mode of 39 months. With the exception of two outliers (the subject who had been sick for 52 years and another who had been sick for 30 years), length of symptoms ranged from one month to 20 years.

Comorbidities

At the time of presentation to the clinic 28.7% (n = 35) of the sample was on treatment for depression and 22.1% (n = 27) had been diagnosed with hypothyroidism. Nineteen of the subjects (15.6%) reported problems with allergic rhinitis and/or asthma. Other comorbidities occurring at lower rates are noted in Table 2.

Sixty-four (52.5%) of the subjects had positive Lyme tests by Western blot. Another 44.3% (n = 54) were highly suspect for Lyme disease based on the presence of 5/7 of the defined criteria for a Lyme diagnosis, as outlined in the Materials and methods section. These results imply that 96.8% of the sample may have been infected with *B burgdorferi*, the spirochetal

Table 2 Comorbidities of subjects (n = 122)

Illness	Number (n)	% of sample
Lyme (+Western Blot)	64	52.5
Lyme (high suspicion)	54	44.3
Depression	35	28.7
Hypothyroid	27	22.1
Babesiosis	22	18.0
Allergic rhinitis/asthma	19	15.6
Hypertension	14	11.5
Anaplasmosis	13	10.7
Bartonellosis	12	9.8
Ehrlichiosis	12	9.8
Fibromylagia	8	6.6
Attention deficit disorder	8	6.6
Anemia	7	5.7
Sleep disorder	7	5.7
Chronic fatigue syndrome	5	4.1
Heart disease	5	4.1
Arthritis	4	3.3
Diabetes	4	3.3
Celiac disease (gluten intolerance)	3	2.5
H pylori infection	3	2.5
Autoimmune disease	3	2.5

Table 3 Medications taken by subjects (n = 122)

Medication	Number taking it	% of sample
Antidepressant	36	29.5
Thyroid	25	20.5
Antihypertensive	21	17.2
Antihistamine	14	11.5
Pain medication	14	11.5
Anxiolytic	13	10.7
Statin	5	4.1
Steroid	4	3.3
Glucophage	3	2.5
Attention deficit disorder medication	2	1.6
Anti-epileptic	2	1.6
Female hormones	2	1.6
Muscle relaxant	1	0.8
Retroviral	1	0.8
Ropinirole (restless leg syndrome)	1	0.8

agent of Lyme disease. Positive tests for tick-borne co-infections noted in the sample were *Babesia microti or Babesia duncani* (n = 22, 18%), *Anaplasma phagocytophilum* (n = 13, 10.7%), *Ehrlichia chaffeensis* (n = 12, 9.8%), and *Bartonella henselae* (n = 12, 9.8%).

The medications that subjects were taking at the time of their questionnaire completion are listed in Table 3. Of note is that 29.5% were on antidepressants and 20.5% were receiving thyroid supplementation. Precipitating events associated with the onset of symptoms are listed in Table 4. Although a variety of precipitating events was reported, in many cases (n = 29, 23.8%) subjects were unaware of an association of any event with the initiation of their symptoms. The most frequent events were, in descending order: an infestation of biting insects such as lice or fleas (n = 17, 13.9%); recent visit to a third world country (n = 15, 12.3%); a splinter, thorn, or dirty cut (n = 14, 11.5%); and working in dirt or exposure to dirty water (each n = 13, 10.7%). All of these risk factors involve exposure to unclean situations.

The diagnoses given to subjects for their presenting symptoms are shown in Table 5. The most common diagnosis was delusions of parasitosis (n = 55, 45.1%). Other diagnoses, in descending order, were: scabies (n = 20, 16.4%); atopic dermatitis (n = 15, 12.3%); impetigo (n = 12, 9.8%); stress reaction (n = 9, 7.4%) and miscellaneous diagnoses.

Specific and nonspecific symptoms and their frequencies

Symptoms common to the Morgellons group are shown in Table 6. A total of 19 symptoms were reported by more than 70% of patients in this group. Because 97% of the study sample had probable Lyme disease, a questionnaire about symptoms noted in the fiber group was administered to 60 patients with Lyme disease and no complaints of skin fibers. Although the Lyme sample was not expressly matched with the Morgellons group, the demographics proved to be similar. The Lyme patient sample was 87% female, 97% white, non-Hispanic (3% Hispanic) and the age range was 16–62 years with a mean age of 43 years.

Table 7 shows the symptom prevalence in the Morgellons and Lyme groups. Based on Friedman's chi square analysis, 26 symptoms were shown to be significantly more common in the patients with fibers, five symptoms were shown to be significantly more common in the Lyme disease patients, and five symptoms were not significantly different in the two groups (Table 8).

Following adjustment for symptoms that were not specific to the Morgellons group, the most common specific symptoms shared by more than 70% of the Morgellons patients were, in descending order of frequency: crawling sensations under the skin; spontaneously appearing, slow-healing

Table 4 Events precipitating initiation of subjects' symptoms (n = 122)

Event	Number (n)	% of sample
Unknown/not sure	29	23.8
Lice and flea infestation	17	13.9
Recent travel to third-world country	15	12.3
Splinter, cut or thorn	14	11.5
Exposure to dirty water	13	10.7
Working in dirt	13	10.7
Life stress	7	5.7
Tick/insect bite	6	4.9
Camping	6	4.9
Post surgical	4	3.3
Animal bite	3	2.5
Post severe burn	1	0.8
Initiation of steroid therapy	1	0.8
Exposure to a person with like symptoms	1	0.8

lesions; hyperpigmented scars when lesions heal; intense pruritus; seed-like objects emerging from skin; black specks appearing on the skin; "fuzz balls" on intact skin; fine, thread-like fibers of varying colors in lesions and intact skin; lesions with thick, tough, translucent fibers that are highly resistant to extraction; and a sensation of something trying to penetrate the skin from the inside out.

Discussion

The primary goal of our study was to identify the most common symptoms in patients with documented subcutaneous fibers who were seen in a medical practice. The study sample

Table 5 Diagnoses given to study subjects prior to presentation to first author's clinic (n = 122)

Diagnosis	Number (n)	% of sample
Delusions of parasitosis	55	45.1
Scabies	20	16.4
Atopic dermatitis	15	12.3
Impetigo	12	9.8
Stress reaction	9	7.4
Neurodermatitis	5	4.1
Self-mutilation	4	3.3
Lice	4	3.3
Folliculitis	4	3.3
Obsessive-compulsive disorder	2	1.6
Fungal infection	2	1.6
Acne	1	0.8
Psoriasis	1	0.8

Table 6 Symptoms of patients with a positive exam for subcutaneous fibers (n = 122)

% of sample	Number (n)	Symptom
98	118	Crawling sensations under the skin
95	116	Spontaneously-appearing, slow-healing skin lesions
91	111	Fatigue that interferes with activities of daily living
90	110	Sleep irregularities
89	109	Hyperpigmented scars when lesions heal
87	106	Intense pruritus, even before lesions appear
86	105	Brain fog (problems thinking, remembering, etc.)
84	103	Seed-like objects coming out of the skin
84	102	Black specks appearing spontaneously on the skin
82	100	Unusual irritability
80	97	Symptoms worse when hot
79	96	"Fuzz balls" (white or blue) on skin
78	95	Muscle pain
78	94	Joint pain
77	94	Weakness
77	94	Thin, thread-like fibers under or protruding from skin
77	94	Symptoms worse at night
74	90	Thick, tough, difficult-to-extract, white or clear fibers
71	87	Sensation of things poking through skin
69	84	Feeling of hopelessness
65	79	Awareness of tiny insects flying around head
62	75	New onset of anxiety or panic attacks
61	74	Fibers or filaments move
60	73	Slimy film on skin
59	72	"Sand" in bed upon awakening
57	70	Brown flakes in bed upon awakening
57	70	Fibers in mucous membranes (mouth, nose, eyes)
57	69	Awareness of objects racing across eyes
56	68	Soft mounds on head
56	68	Dramatic weight change
53	65	Fibers under finger and toe nails
53	65	Significant hair loss

(*Continued*)

Table 6 (*Continued*)

% of sample	Number (n)	Symptom
52	63	Deteriorating teeth or jaw (unexplainable by dentist)
45	55	Black tar-like fluid comes out through pores
40	49	Hair texture feels different, abnormal
37	45	No hair growth
30	37	Female problems (pelvic pain, irregular menses)
29	35	Bald patches on head

consisted primarily of middle-aged Caucasian patients, but because the first author's clinic does not accept insurance, the sample may have been biased toward an upper-middle class socioeconomic group. This in turn may have predisposed toward Caucasian race and older, more economically stable subjects.

The sample was predominantly female, which engenders speculation as to the reason for this prevalence. This finding differs from that of the MRF, which reports an equal number of males and females in their database of self-diagnosed Morgellons cases.[2] There are other illnesses, such as multiple sclerosis, hypothyroidism, and numerous autoimmune diseases that appear to affect primarily women. Furthermore, female predominance has been noted in patients with persistent symptoms of Lyme disease.[14] Gender differences in human disease susceptibility are usually attributed to either physiologic or sociologic causes. The physiologic causes are usually hormonal in origin.[15] Examples of sociologic causes are different exposure to pathogens because of gender-specific behavior and different tendencies to present for medical care, leading to the appearance of a skewed demographic.[15] Any of these factors are plausible in Morgellons disease.

It may seem surprising that a complaint of skin fibers was reported by only 77% of the sample. A plausible explanation is that the fibers typical of Morgellons disease are microscopic, and in many cases subjects had not employed a magnification system to visualize their skin. Of note is that the seed-like objects and black granules reported by these patients are visible on the surface of the skin without the use of magnification. This fact probably explains why these symptoms were reported more frequently than the presence of fibers.

Of the 122 study subjects, most were from California and Texas, possibly due to the fact that these are the two states where the first author had lived and practised. However, the MRF maintains that California, Texas, and Florida are the states where Morgellons disease is most prevalent, based upon registrants on the MRF web site.[2] A common feature shared by these states is that they have the most mileage of coastline, prompting speculation that the putative infectious agent of Morgellons disease could be water-borne. California and Texas are also two of the states with the highest number

Table 7 Comparison of symptom prevalence in Morgellons group (n = 122) and Lyme group (n = 60)

Symptom	Morgellons group (n[%])	Lyme group (n[%])
Crawling sensations	118 (98%)	19 (32%)
Skin lesions	116 (95%)	5 (8%)
Fatigue	111 (91%)	58 (97%)
Sleep irregularities	110 (90%)	60 (100%)
Hyperpigmented scars	109 (89%)	6 (10%)
Intense pruritus	106 (87%)	20 (33%)
Brain fog	105 (86%)	60 (100%)
Seed like objects	103 (84%)	0 (0%)
Black specks	102 (84%)	0 (0%)
Unusual irritability	100 (82%)	47 (78%)
Symptoms worse when hot	97 (80%)	19 (32%)
"Fuzz balls" on skin	96 (79%)	0 (0%)
Muscle pain	95 (78%)	57 (95%)
Joint pain	94 (78%)	58 (97%)
Weakness	94 (77%)	58 (97%)
Thin, thread-like fibers in skin	94 (77%)	0 (0%)
Skin symptoms worse at night	94 (77%)	15 (25%)
Thick, tough filaments	90 (74%)	0 (0%)
Sensation of poking	87 (71%)	3 (5%)
Hopelessness	84 (69%)	49 (82%)
Awareness of tiny insects	79 (65%)	5 (8%)
New onset anxiety	75 (62%)	40 (67%)
Fibers, filaments move	74 (61%)	0 (0%)
Slimy or waxy film	73 (60%)	0 (0%)
"Sand" in bed	72 (59%)	0 (0%)
Brown flakes in bed	70 (57%)	0 (0%)
Fibers in mucous membranes	70 (57%)	0 (0%)
Objects racing across eyes	69 (57%)	21 (35%)
Mounds on head	68 (56%)	2 (3%)
Dramatic weight change	68 (56%)	30 (50%)
Fibers under nails	65 (53%)	0 (0%)
Significant hair loss	65 (53%)	22 (37%)
Deteriorating teeth/jaw	63 (52%)	15 (25%)
Black, tar-like	55 (45%)	0 (0%)
Hair texture abnormal	49 (40%)	0 (0%)
No hair growth	45 (37%)	0 (0%)

Table 8 Chi square analysis of symptom prevalence in Morgellons group versus Lyme group

Significantly more common in the Morgellons group	
Symptom	***P* value**
Crawling sensations	<0.0001
Lesions spontaneously appear on skin	<0.0001
Severe itching	<0.0001
Hyperpigmented scars	<0.0001
Seed like objects coming out of skin	<0.0001
Black specks on skin	<0.0001
Symptoms worse when hot	<0.0001
"Fuzz balls" on skin	<0.0001
Thin thread-like fibers	<0.0001
Symptoms worse at night	<0.0001
Thick, tough fibers	<0.0001
Poking sensations through skin	<0.0001
Insects flying around head	<0.0001
Fibers move	<0.0001
Slimy film on skin	<0.0001
"Sand" in bed	<0.0001
Brown flakes in bed	<0.0001
Fibers in mucous membrane	<0.0001
Soft mounds on head	<0.0001
Fibers under nails	<0.0001
Black tar like exudates	<0.0001
Abnormal hair texture	<0.0001
No hair growth	<0.0001
Deteriorating teeth/jaw	<0.0008
Objects racing across eyes	0.0074
Significant hair loss	0.0407
Significantly more common in the Lyme group	
Joint pain	0.0005
Weakness	0.0005
Brain fog	0.0009
Muscle pain	0.0027
Sleep disturbances	0.0094
No significant difference between the two groups	
Extreme fatigue	NS
Irritability	NS
Hopelessness	NS
New onset of anxiety	NS
Significant weight change	NS

of Hispanic immigrants. It is not known whether this may have a bearing on the high prevalence of the disease in these states, but recent third-world travel was found in this study to be a risk factor for the development of Morgellons disease. Furthermore, California and Texas are among the states with the highest average yearly temperatures according to the National Weather Service (http://usaresearch.gov/search) and rarely, if ever, endure hard freezes in the winter. The resultant warm weather may sustain the ability of certain types of pathogens to survive. The definitive reason for the high prevalence of Morgellons disease in Texas and California remains to be determined.

Of note is the high percentage of subjects (32%) who reported smoking cigarettes. According to 2006 statistics from the Centers for Disease Control and Prevention's National Center for Health Statistics, 17.8% of a similarly-matched population of adult females smoke cigarettes. Smoking can impair immune function, particularly in areas heavily perfused by microvasculature, such as the skin.[16] Smoking may also have been more prevalent in the study population as a result of the extreme emotional stress that Morgellons patients endure. Our data did not differentiate between those who had been smoking before their illness and those who began smoking as a result of it.

According to a 2003 National Survey on Drug Use and Health, an estimated 5.9% of women over 18 years met criteria for substance abuse within the year prior to the survey's data collection. Slightly more than twice that percentage of the study sample (12.3%) reported a history of substance abuse. It is known that taking certain drugs such as amphetamines or withdrawing from them may cause sensations of "bugs crawling on the skin", and the sample's relatively high percentage of subjects with a history of substance abuse could be used to support the argument that Morgellons disease is simply a psychologic or drug-induced state. However, it is equally important to note that 87.7% of study subjects had no history of substance abuse.

Most patients reported no symptoms in their loved ones despite the fact that they continued to sleep with their spouses and care for their children throughout their illnesses. However, 18% of this sample (n = 22) reported at least one family member with similar symptoms. For most of these 22 subjects, the pre-illness exposure that they reported could have been a common exposure for other family members. Furthermore, family members reported as having symptoms were not interviewed or examined by the first author and may not have actually had Morgellons disease. It remains unclear as to whether there is a contagious component to Morgellons disease or whether symptoms shared by family members imply a common exposure source.

Depression was reported by 28.7% of the study sample and antidepressants were the most common medications

taken. The lifetime prevalence of depression in the US is estimated to be as much as 17% of the general population,[17] so the rate of depression seen in this population does not appear to be particularly high considering that subjects were suffering from a misunderstood and debilitating chronic medical condition. Furthermore, since many patients with Morgellons disease are referred to psychiatrists, significantly more patients with psychological diagnoses would be expected in this group.

The prevalence of delusional disorder in the US is estimated to be about 0.03%, and a similarly low prevalence is found in other societies.[18,19] A review of the backgrounds of 3,000 self-reported cases of Morgellons disease found preexisting delusional disorders to be no more prevalent than would be expected in the general population.[20] Nevertheless, patients with symptoms of Morgellons disease are routinely dismissed as delusional.[7] The present study reinforces the fact that Morgellons patients appear to be distinct from patients with delusional disorders in terms of demographics and symptomatology.

Thyroid medication was the second most common medication taken by the study subjects (20.5%) and 22.1% of the sample claimed to have been diagnosed with hypothyroidism. Considering that about 3% to 8% of adults in the general population are hypothyroid,[21] this prevalence in the study group appears to be high. The predominantly middle-aged, female demographic of the study group may have influenced this finding, since hypothyroidism is more prevalent in females than in males and in older adults than younger adults.[21]

Should future research duplicate the finding of a high prevalence of hypothyroidism in Morgellons patients, it would be worthwhile to distinguish between those who were hypothyroid before their Morgellons disease symptoms appeared and those who developed it afterwards. Thyroid antibody testing would also be helpful in order to differentiate those who are hypothyroid due to autoimmune thyroiditis. Infections may play a role in autoimmunity,[22] suggesting that hypothyroidism could be a consequence of infection with the putative agent of Morgellons disease. Because we did not differentiate between Morgellons patients and Lyme patients with regard to hypothyroidism, *B burgdorferi* infection may have played a role in this comorbidity as well. Homologies between thyroid antigens and borrelial proteins have been described,[23] suggesting that coexisting Lyme disease may trigger thyroid dysfunction in genetically susceptible Morgellons patients.

A provisional case definition for Morgellons disease consisting of nine symptoms has been developed by the MRF based on self-reported cases.[2] Based on the findings of the current study, five of the symptoms in the MRF provisional case definition for Morgellons disease appear to be nonspecific. These five symptoms are severe fatigue, problems with cognition, musculoskeletal pain, aerobic limitation, and behavioral changes. Of note, these symptoms are frequently reported in patients with chronic Lyme disease (Table 7). Thus the symptoms may reflect the presence of both conditions rather than being specific markers for Morgellons disease.

The high rate of tick-borne diseases in our sample is intriguing and prompts speculation as to whether the putative agent of Morgellons disease could be tick-borne.[24] Another possibility is that infection with *B burgdorferi* may predispose a victim to other illnesses such as Morgellons disease. This phenomenon is observed, for example, in the prevalence of virally-induced (and otherwise rare) Kaposi's sarcoma in patients with acquired immune deficiency syndrome.[25] The association between Morgellons diseae and Lyme disease merits further study.

Summary

The primary purpose of this study was to elucidate the symptoms common to patients with a positive examination for subcutaneous fibers in order to develop an accurate and clinically useful case definition for Morgellons disease. After adjusting for symptoms that were nonspecific to the fiber group, the most common symptoms shared by more than 70% of the study sample were: crawling sensations under the skin; spontaneously appearing, slow-healing lesions; hyperpigmented scars when lesions heal; intense pruritus; seed-like objects and black specks coming out of the skin; "fuzz balls" on intact skin; fine, thread-like fibers of varying colors in lesions and intact skin; lesions with thick, tough, translucent fibers that are highly resistant to extraction; and a sensation of something trying to penetrate the skin from the inside out.

Other significant findings in the study sample that warrant further investigation are the association with tick-borne diseases and hypothyroidism, high numbers from two states (Texas and California), high prevalence in middle-aged Caucasian women, and a higher-than-average history of substance abuse.

This is the first group of clinician-defined Morgellons subjects to be described in detail. The strength of the study lies in the size of the sample and the unique and clearly defined inclusion criterion that virtually rules out confounding variables. Further study of etiological factors

and symptom prevalence in this emerging multisystem illness is warranted.

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Disclosures

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Appendix A

I. Demographic data extraction tool.

Completed by the primary investigator.

Subject ID # _____

Gender: Male = 0 Female = 1

Age in years: _____

Ethnicity:

1. Caucasian
2. African-American
3. Hispanic
4. Asian

State of Residence _____

Postal Code for State: _____

Occupation at time of illness onset: _____

Circle appropriate type of occupation based on above:

1. Unemployed, retired or on disability
2. Office worker
3. Health care worker
4. Professional
5. Outdoor manual lab
6. Indoor manual labor
7. Sales
8. Teacher
9. Technical
10. Other

II. Health background data extraction tool.

Completed by the primary investigator.

Smoker? NO = 0 YES = 1

Substance abuse problem: NO = 0 YES = 1

On immunosuppressive therapy? NO = 0 YES = 1

Family members with same symptoms? NO = 0 YES = 1

Length of time in months the patient had symptoms before initial visit?

_____years _____ mos TOTAL TIME IN MONTHS (with 0 fill) _____

COMORBIDITIES:	**Circle: 0 for NO**	**1 for YES**
Anaplasmosis	0	1
Anemia	0	1
Allergic rhinitis/asthma	0	1
Autoimmune disease	0	1
Babesiosis	0	1
Bartonellosis	0	1
Chronic fatigue syndrome	0	1
Depression	0	1
Ehrlichiosis	0	1
Fibromyalgia	0	1
Heart disease	0	1
Hypothyroid	0	1
Lyme (+ test)	0	1
Lyme, highly suspicious	0	1
Sleep disorder	0	1
Other (20 sp) _____		

MEDICATION(S):	**Circle: 0 for NO**	**1 for YES**
Antihypertensive	0	1
Antidepressant	0	1
Antihistamine	0	1
Antiepileptic	0	1
Other (10 sp) _____		

PRECIPITATING EVENT(S):	**Circle: 0 for NO**	**1 for YES**
Camping	0	1
Exposure to dirty water	0	1
Lice, flea infestation	0	1
Life stress	0	1
Post-surgical	0	1
Splinter, cut, thorn	0	1
Working in dirt	0	1
Unknown	0	1
Other (20 sp) _____		

Diagnoses given for current symptoms:	**Circle: 0 for NO**	**1 for YES**
Delusions of parasitosis	0	1
Scabies	0	1
Impetigo	0	1
Folliculitis	0	1
Atopic dermatitis	0	1
Neurodermatitis	0	1
Drug-induced formications	0	1
Cutaneous sensory disease	0	1
Other (20 sp)_____		

III. Symptom data extraction tool.

Completed by the primary investigator.

To the left of each symptom put a "0" if it was left blank in the original questionnaire and a "1" if it was checked off as present

1____ Disfiguring lesions on skin which start like tiny pimples
2____ Intense itching, even before the lesions appear
3____ Feeling of crawling, biting and stinging under skin
4____ Feeling something trying to poke through the skin from the inside
5____ Lesions heal slowly and form brownish scars
6____ Bald patches on your head
7____ Hair loss
8____ Hair that does not grow (same length for a long time)
9____ When hair grows back on head it does not feel like it is yours
10____ Hair-like filaments from "wiggle" and move once extracted
11____ Hair-like filaments in tongue, throat, nose, ears, eyes (circle which)
12____ Black specks on skin, which when brushed aside, reappear

13___ Film on skin (greasy, slimy)
14___ Soft mounds on skull, sometimes filled with fibers
15___ Tough, white, hard-to-extract filaments coming out of lesions
16___ Thin white filaments protruding through skin
17___ Tough filaments under finger and/or toe nails
18___ Black, tar-like exudates on the skin
19___ "Fuzz balls" on skin – blue, white, red or orange (circle which)
20___ Sensation of things racing across your eyes, affecting your vision
21___ Dried brown flakes on your bed sheets
22___ Sand-like objects present in bedclothes upon awakening
23___ Frequent awareness of tiny flying insects around you
24___ Seed-like or granule-like objects associated with skin or lesions
25___ Dramatic increase in skin symptoms when hot or sweating
26___ Symptoms worse at night
27___ Deteriorating teeth or jaw
28___ Extreme fatigue
29___ Brain fog, memory problems, inability to concentrate or think
30___ Muscle aches
31___ Weakness
32___ Joint pain
33___ Disrupted sleep
34___ Disturbed menstrual cycle
35___ Weight change that you cannot control (gain or loss)
36___ Unusual irritability or new onset of depression
37___ New onset of anxiety or panic disorder
38___ Feelings of hopelessness or suicide
39___ Other (write in): _____