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Cysticerci-related single parenchymal brain enhancing lesions in non-endemic countries

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Abstract

Objective—Review of case reports and case series of patients with single cysticercus granulomas in non-endemic countries to determine the characteristics of this form of neurocysticercosis in these regions.

Methods—MEDLINE and manual search of patients with single cysticercus granulomas diagnosed in non-endemic countries from 1991 to 2011. Abstracted data included: demographic profile, clinical manifestations, form of neurocysticercosis, and whether the disease occurred in immigrants, international travelers, or citizens from non-endemic countries who had never been abroad.

Results—A total of 77 patients were found. Of these, 61 (79%) were diagnosed since the year 2000. Thirty-four patients (44%) patients were immigrants from endemic countries, 18 (23%) were international travelers returning from disease-endemic areas, and the remaining 25 (33%) were citizens from non-endemic countries who had never been abroad. Most immigrants and international travelers became symptomatic two or more years after returning home. Countries with the most reported patients were Kuwait (n=18), UK (n=11), Australia (n=8), USA (n=7), Japan (n=6), and Israel (n=5).

Conclusions—A single cerebral cysticercus granuloma in a non-endemic country is not a rare event. As seen in endemic regions, these cases have a good prognosis although more surgical procedures are performed in non-endemic countries, likely reflecting a decrease of diagnostic suspicion for cysticercosis and an increased availability of surgical options. The mean age of the reported cases was 25 years, and immigrants most often developed the disease greater than two years after arrival into a non-endemic area, suggesting a significant delay between infection and

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symptoms. However, some may have been infected and developed the disease while residing in non-endemic countries.

Keywords

Cysticercosis; Neurocysticercosis; Single cysticercus granuloma

INTRODUCTION

Neurocysticercosis (NCC) is a rather common cause of neurological disease in most of the developing world, including Latin America, the sub-Saharan Africa, the Indian Subcontinent, and certain regions of Southeast Asia [1]. Migratory movements and overseas travel have increased the number of NCC cases in areas where this disease was considered a medical curiosity a few years ago [2,3]. The occurrence of NCC in non-endemic countries permits the study of some particular aspects of the disease, including its natural history and the mechanisms of disease acquisition. Two well-known examples of this approach are the description of NCC among British soldiers returning from India, where it was demonstrated that many patients only develop symptoms several years after the infection [4], and the epidemic of NCC among members of the Orthodox Jewish community in New York City, where it was shown that NCC is a disease mostly transmitted from person-to-person [5].

A particular form of NCC, the so-called single cysticercus granuloma, has received much attention in the literature. It is the most common form of presentation of the disease in the Indian subcontinent as well as a very frequent presentation in some endemic areas of Latin America. In addition, it is difficult to diagnose because their clinical and neuroimaging findings are non-specific [6,7]. The study of patients with single cysticercus granulomas diagnosed in non-endemic areas provides a unique opportunity to better understand some characteristics of this form of NCC. This report reviews patients diagnosed with single cysticercus granulomas in non-endemic countries over the past two decades to better understand some controversial aspects of this form of the disease, including the timing of symptom appearance in relation to the moment of infection.

METHODS

A literature search of case reports or case-series of patients with NCC presenting in the form of single parenchymal brain enhancing lesions (single cysticercus granuloma), diagnosed in non-endemic countries over the past 20 years (1991 to 2011), was performed using the electronic database of MEDLINE (National Library of Medicine, Bethesda, MD). Key words "*cysticercosis*", "*neurocysticercosis*", "*cysticercus granuloma*", and "*single enhancing lesion*" were combined with the name of each of the countries traditionally considered as non-endemic, including all Western European countries, African and Middle-East countries of the Arab World, Israel, some American countries (Argentina, Belize, Canada, Surinam, The United States, and Uruguay), Islands of the Caribbean Bassin (except Haiti and Dominican Republic), Australia and New Zealand, Japan, and some Muslim countries of Southeast Asia. Limits were not applied to the search; instead, abstracts, clinical notes without an abstract, and letters to the editor were reviewed to identify potentially eligible articles. The only language limitations were Japanese and Hebrew. Thereafter, a manual search that included the author's files as well as the list of references of cysticercosis books, position papers, and selected articles was undertaken, and relevant information was requested to colleagues and cysticercosis experts.

Selected studies included original data on patients with single cysticercal granuloma diagnosed in non-endemic countries. To be eligible, the patient must have had a single

parenchymal brain enhancing lesion on neuroimaging studies, and the information given in the text of the original publication must be clear enough to allow the inclusion of the patient as a definitive case of NCC according to accepted diagnostic criteria [8,9]. According to current knowledge, when a single parenchymal brain enhancing lesion fulfill a rigid set of clinical and radiological criteria, the diagnosis of NCC can be done with a sensitivity of 99.5% and a specificity of 98.9% [9]. Cysticerci-related enhancing lesions are smaller than 20 mm in diameter, are most often located supratentorially, and rarely cause displacement of the midline or focal neurologic deficits. When these lesions resolve spontaneously, either disappearing or transforming into a calcified nodule, the diagnosis of NCC is certain.

The articles were independently reviewed by two of the authors (O.H.D., H.H.G.), and disagreements in inclusion criteria or data abstraction were resolved through discussion and consensus. Besides clinical and neuroimaging findings, abstracted data of selected articles included the year and the country of origin of the publication, the demographic profile of reported patients, therapy, histopathological findings (when available), and whether the disease occurred in immigrants, international travelers, or residents of non-endemic countries who had never been abroad. For immigrants and international travelers, years of migration or time elapsed since their return home and the appearance of symptoms were also recorded.

RESULTS

The search detected 50 papers reporting patients with a single cysticercus granuloma [10–59]. Four of these papers were excluded, as two were written in Japanese [41,53], one in Hebrew [34], and the other could not be retrieved [50]. The remaining 46 articles, reporting a total of 77 patients, represented the basis of this study. Of these, only 16 patients were published during the last decade of the 20th Century, and the remaining 61 were published since the year 2000. Some other reviews and case series (mainly from the US and Spain) mention the occurrence of patients with single cysticercus granulomas, but provided only general information and data could not be abstracted [2,60,61].

The mean age of the 77 included patients was 25 ± 15.2 (age range 2 to 73 years), and 36 (47%) were women. Most patients came from Kuwait (n=18), UK (n=11), Australia (n=8), USA (n=7), Japan (n=6), and Israel (n=5). Thirty-four patients (44%) were immigrants from endemic areas and 43 were citizens of non-endemic countries. Eighteen of the latter had a history of traveling to endemic areas, and the remaining 25 had never been abroad. Locally acquired cases were more frequently female compared to immigrants ($p=0.007$, Pearson's Chi square) or to immigrants and travelers combined ($p=0.010$, Pearson's Chi square). Travelers were in general older than locally acquired cases, although it did not reach statistical significance ($p=0.082$, one way ANOVA) (Table 1).

Immigrants were originally from Asia (n=20), Africa (n=8), and Latin America (n=6). Most Asian immigrants moved into Kuwait, Australia, UK, and North America, and the majority of them came from India. African immigrants came from seven different countries and moved into Europe, UK, and Australia. Latin American immigrants came from five different countries and moved into the US, Spain, and UK. In 22 of the 34 cases occurring in immigrants, information on the time elapsed between arrival into a non-endemic country and appearance of symptoms was available, with a mean of 48.5 ± 72.2 months (range one month to 28 years, median 30 months), with nine patients (41%) residing in non-endemic areas less than two years before the clinical onset of the disease.

Sixteen of 18 international travelers journeyed to Asia, and the remaining two patients went to Africa. Duration of travel varied from three months to 12 years, with only four patients

being abroad less than one year. The period of time that elapsed before returning to non-endemic areas was only mentioned in 11 patients, and at least eight of these patients developed symptoms two or more years after returning home.

Seizures were the primary or sole manifestation of the disease in 68 patients (88%). Of the remaining nine patients, six had focal neurological signs, two had headache, and one was asymptomatic. EITB assay for the detection of anticysticercal antibodies in serum was performed in 32 patients, and gave positive results in 19; with a 41% rate of false-negative results. Ten patients had stool examinations, one of which was found to present *Taenia sp.* eggs. A direct source of infection was suspected in only 10 of the 25 citizens of non-endemic countries who had never been abroad; eight of them had immigrant servants, one had an immigrant neighbor, and the mother of the remaining patient was an immigrant from endemic areas.

Twenty-six patients (34%) underwent surgical resection of the brain lesion for diagnostic purposes. One additional patient had direct examination of the brain lesion as part of an autopsy procedure. Histopathological study of these 27 patients revealed: a viable cysticercus (associated with inflammatory changes in the surrounding brain parenchyma) in six cases, a degenerated (colloidal) parasite in 11, calcareous corpuscles with parasitic remnants in two, and non-specific inflammatory changes (parasite not visualized) in the remaining eight cases.

Twenty-four patients were treated with cysticidal drugs (either praziquantel or albendazole) with resolution of the brain lesion in all cases. Six patients received a trial with cysticidal drugs after surgical resection of the brain lesion. In 11 additional patients, the lesion disappeared spontaneously on follow-up neuroimaging studies. In general, information on outcome was available in 58 patients, 57 of whom recovered completely and one died after a prolonged seizure episode. There were no reported complications related to the surgical procedure in patients who underwent resection of the lesion. Exact length of follow-up could be retrieved in only 32 patients (mean, 16.1 ± 17.3 months).

DISCUSSION

This series demonstrates that patients presenting with a single cysticercal granuloma in non-endemic regions occurs with some frequency. Seventy-seven cases were found from 19 non-endemic countries, categorized as immigrants, travelers, and locally acquired infections. As seen in cases diagnosed in endemic regions, their overall prognosis was good and directly attributable mortality was rare (one case). On the other hand, their mean age of 25 years is considerably higher than most cases reported in the Indian subcontinent which are more frequently seen in children and young adults [62,63].

One third of the reported patients underwent surgical resection of the brain lesion. While this is obviously overrepresented (with histological findings motivating the publications), still most of these were unnecessary invasive procedures resulting from the unfamiliarity of attending physicians with this form of the NCC. A single brain enhancing lesion is a diagnostic challenge, but even so, proper application of the currently accepted set of diagnostic criteria for NCC (including a therapeutic trial with cysticidal drugs) would allow the correct diagnosis of most cases, obviating the need of surgery [9].

Almost all published studies on patients with a single cysticercus granuloma come from cysticercosis-endemic countries (mainly the Indian subcontinent and South America), where the date of infection cannot be traced. In contrast, the study of patients with this form of the disease presenting in non-endemic countries provides a good way to define the incubation period, i.e., the time elapsed between infection and appearance of symptoms. At least 34 of

the 77 patients (44%) were immigrants from endemic areas, and only nine of these patients had been living in a non-endemic country less than two years before the occurrence of symptoms. Most patients with a single cysticercus granuloma diagnosed in non-endemic countries (52, 68%) were immigrants or had a history of traveling to disease-endemic areas.

After the works of Escobar [64,65], it has traditionally been considered that when *Taenia solium* metacestodes enter the nervous system, they first transform into vesicular (viable) cysticerci. Vesicular cysts may remain viable for years or may experience, as the result of the immune attack from the host, degenerative changes that end with the transformation of the parasite into a calcified nodule. The first stage of involution (in which the vesicular fluid becomes turbid and the scolex shows signs of degeneration) has been called the “colloidal” stage, and then it collapses to become a “nodular” lesion. Both these stages are included as “cysticercal granulomas”. It has always been assumed that such degenerative changes usually occur years after viable cysts have been implanted in the central nervous system [4].

An alternative hypothesis proposes that cysticercal granulomas are not the result of a degenerated vesicular cyst that had been living for years in the brain parenchyma, but represent an early or recently established metacestode rapidly detected and destroyed by the host’s immune system [66]. This hypothesis is supported by a number of facts, including the higher prevalence of a single cysticercus granuloma in populations who are exposed to low parasite loads, the younger age of patients with cysticercus granulomas in endemic countries when compared with those with cystic lesions, and the low sensitivity of serological assays in patients with a single cysticercus granuloma [66]. Some case reports also support this hypothesis, including an expatriate who presented with seizures two years after treatment for a tapeworm. CT scans were initially negative but the patient developed three nodular lesions one year later; viable cysts never developed. Another patient presented with acute encephalitic neurocysticercosis; although nodular enhancing lesions developed, viable cysts were never documented [67].

Most cases reviewed in the present series do not seem to be “fresh” infections, but a late manifestation of a disease that had been acquired years ago. It was similar in migrants and in international travelers, since only three of 18 patients developed symptoms in the very few months after returning home.

Perilesional edema surrounding calcified cysticercus granulomas is frequently seen in patients who manifest seizures in endemic as well as in non-endemic areas [68]. These are end-stage granulomas and contains remnants of the parasite associated with varying degrees of inflammation [69], that are seen on neuroimaging studies as lesions showing abnormal enhancement around the calcification with varying degrees of edema. The pathophysiology is not known but it is likely due to inflammatory response to residual parasite antigens. Because calcifications are the most common neuroimaging finding of parenchymal brain NCC and they accumulate, the small proportion that present in this fashion represent a large number of individuals [29,32,40,46,52,70].

Some immigrants may also have acquired the disease after arrival to the non-endemic country. Human cysticercosis is a disease mostly transmitted from person to person. Therefore, *Taenia solium* carriers entering non-endemic countries every year—acting like *Trojan horses*—may cause locally acquired cases of cysticercosis without the need of infected swine. A common social phenomenon observed after mass population movements is that family members usually join pioneer immigrants some years after their settlement abroad. In the case of international travelers, they are infected after ingestion of eggs originating from a *Taenia* carrier or indirectly from contaminated food. Less likely, they

may develop taeniasis after ingesting infected pork, and self-infect themselves with eggs via fecal-oral, acquiring cysticercosis.

Interpretation of our findings requires some caution. Data provided in the reviewed publications are incomplete, and the nature of this series based on the international literature is probably quite partial, since many cases may have been reported in local journals or not reported at all. It is difficult to assume that seven cases represent a significant proportion of all single cysticercal granulomas seen in the US in the past 20 years, and clinicians in States with high numbers of immigrants refer to have attended multiple cases, most of which have not been individually reported. The real frequency will likely be many times more. To quote an example, there are at least six unreported patients seen at the National Institutes of Health (Bethesda, M.D.) with single cysticercus granulomas (T.E.N., personal communication). Publication bias may also have affected the type of cases, over-representing locally acquired cases because of the rarity of the event. On the other hand, immigrants presenting with NCC may have limited access to health care (and records).

In summary, the cases reviewed in this series were similar to those in the literature from endemic countries in regards to a good prognosis, and low sensitivity of serological diagnosis. On the other hand, these reported cases are younger than those reported from endemic countries, and a sizable proportion of them were subject to surgical procedures. Most cases became symptomatic years after their settlement in a non-endemic country. Some cases had an already calcified parasite, and others were infected while living in a non-endemic country through a taenia carrier who lives in their close environment. To avoid potentially unnecessary surgical interventions, it is important that physicians in non-endemic regions be aware that NCC can present as a single enhancing lesion that can be difficult to diagnose. Compulsory search of *Taenia* carriers among household contacts of patients with NCC will allow the detection of a potential source of infection, and will reduce further spread of the disease.

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Table 1

Reports of single cysticercal granuloma cases in non-endemic countries.

	Immigrants from endemic areas (n=34)	Travelers (n=18)	Locally Acquired (n=25)
Gender (male)	23 (67.6%)	10 (55.6%)	8 (32%)
Age (mean $\pm$ SD)	23.3 $\pm$ 14.5 (median 23)	28.0 $\pm$ 12.3 (median 26.5)	19.2 $\pm$ 18.0 (median 14)
Country of report	Australia (6), UK (6), Kuwait (5), USA (5), Italy (2), Spain (2), Canada, Denmark, Finland, France, Ireland, Malaysia, New Zealand, and Singapore (1 each)	Israel (5), Japan (4), UK (4), Australia (2), France, Germany and Qatar (1 each)	Kuwait (13), Arabia (3), USA (3), Germany (2), Japan (2), Qatar and UK (1 each)