

## Neurocysticercosis in cancer patients

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### Abstract

**Introduction:** Neurocysticercosis (NC) is considered as a public health problem. Meanwhile, cancer is the second cause of death around the world. The coexistence of both conditions had been scantily reported or studied. **Objective:** The objective of the study was to investigate and report the presentation of NC in patients with systemic cancer. **Methods:** Patients with confirmed cancer and NC at a referral center from January 2012 to June 2017 were included. Demographic, clinical, and radiologic findings were presented. **Results:** Eighteen cancer patients were diagnosed with NC. Within a mean follow-up period of 45.2 months, one died from complications directly related to NC, and seven had associated cancer progression. Headache and seizures were the most common symptoms that led to the diagnosis of NC. The number of lesions seen ranged from 1 to 100. **Conclusions:** The estimated incidence of NC and cancer is not low and should be considered a differential diagnosis of brain metastases, especially in developing countries.

**Key words:** Neurocysticercosis. Cancer. Epidemiology. Developing countries.

### Neurocysticercosis en pacientes con cáncer

#### Resumen

**Introducción:** La neurocisticercosis (NCC) es considerada un problema de salud pública. A su vez, el cáncer es la segunda causa de muerte alrededor del mundo. La coexistencia de ambas condiciones ha sido escasamente reportada o estudiada. **Objetivo:** Investigar y reportar la presentación de NCC en pacientes con cáncer sistémico. **Métodos:** Se incluyeron pacientes con cáncer confirmado y NCC vistos de enero de 2012 a junio de 2017 en un centro de referencia oncológico. Se presentan hallazgos demográficos, clínicos y radiológicos. **Resultados:** Dieciocho pacientes fueron diagnosticados con NCC. La media de seguimiento fue de 45,2 meses, un paciente falleció por complicaciones directamente relacionadas a NCC y siete fallecieron por progresión de su cáncer. Cefalea y crisis convulsivas fueron los síntomas más comunes que llevaron al diagnóstico de NCC. El número de lesiones variaron entre 1 a más de 100. **Conclusiones:** La incidencia estimada de NCC con cáncer no es baja y debe considerarse como un diagnóstico diferencial de metástasis cerebrales, especialmente en países en vías de desarrollo.

**Palabras clave:** Neurocisticercosis. Cáncer. Epidemiología. Países en vías de desarrollo.

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Date of reception: 11-06-2019

Date of acceptance: 17-07-2019

DOI: 10.24875/RMN.M19000092

Available online: 04-12-2019

Rev Mex Neuroci. 2019;20(6):262-265

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## Introduction

Neurocysticercosis (NC) is caused by the larvae or cysticerci of *Taenia solium*. One of the most striking features of NC is its heterogeneous clinical picture, which can range from asymptomatic to severe life-threatening neurologic syndromes<sup>1</sup>. The disease severity and clinical manifestations are indicative of infective burden, location, and the host's immune response<sup>2</sup>. In many developing countries, such as in our country, NC is a frequent medical condition, with reported frequencies as high as 9.1%<sup>3</sup>. The diagnosis of NC is made by neuroimaging techniques with either computer tomography (CT) or magnetic resonance imaging (MRI). Meanwhile, the lifetime probability of having invasive cancer is 39.7% for men and 37.6% for women. With an annual death rate of 168.3 per 100,000 population and an approximate cancer incidence of 418-502/100,000 population, cancer is one of the most common causes of mortality and morbidity<sup>4</sup>.

Information concerning NC and cancer is hardly found in medical literature. Some have suggested that the elicited chronic inflammatory reaction, evasive mechanisms, and molecular mimicry capacity of *T. solium* induce immunosuppression, which can be associated with cerebral gliomas<sup>1</sup> and hematologic malignancies<sup>5</sup>. A postmortem study reported that 21% of patients with NC had a malignancy<sup>6</sup>, and some have proposed the pathogenic mechanisms<sup>7</sup>. The purpose of this study was to report the presentation of NC in patients with systemic cancer.

## Methods

A database that was prospectively acquired from January 2012 to June 2017 was analyzed. All patients seen by the neuro-oncologic clinic of a referral cancer center (*Instituto Nacional de Cancerología*, Mexico City) were included. The demographic information, oncologic history, signs and symptoms, treatment, and median overall survival rates were collected. All patients had histopathologic confirmation of their primary cancer. The diagnosis of NC was made by a combination of clinical features and MRI. Active infection was diagnosed with the presence of active cysts in the vesicular, colloidal vesicular, and/or granular nodular stages on MRI. Overall survival was measured from the time of the first neuro-oncologic consultation until death or the last reported visit. The Institutional Ethics and Scientific Investigation Committees approved data acquisition and analysis.

**Table 1.** General characteristics of patients with NC

Patients characteristics	n = 18 (100%)
Gender	
Female	13 (72.2)
Male	5 (27.7)
Primary site of cancer and stage	
Breast	5 (27.7)
I (1)	
II (2)	
III (2)	
Ovarian	3 (16.6)
NE (2)	
IV (1)	
Gastrointestinal	2 (11.1)
III (1)	
IV (1)	
Urologic	3 (16.6)
NE (1)	
IV (2)	
Skin/Melanoma	3 (16.6)
NE (1)	
II (1)	
III (1)	
Lung	1 (5.5)
IV (1)	
Head and Neck	1 (5.5)
IV (1)	
Systemic metastases other than the CNS	
Present	4 (22.2)
CNS metastases	
Absent	18 (100)
Any clinical manifestation	10 (55.5)
Headache	6 (33.3)
Seizures	4 (22.2)
Intracranial hypertension	3 (16.6)
Visual impairment	2 (11.1)
Ataxia	1 (5.5)
Decreased awareness	1 (5.5)
None	8 (44.4)
Diagnosis of NC	
Before the diagnosis of cancer (100-140 months)	2 (11.1)
After the diagnosis of cancer (2-191 months)	16 (88.8)

NE: Non-specified

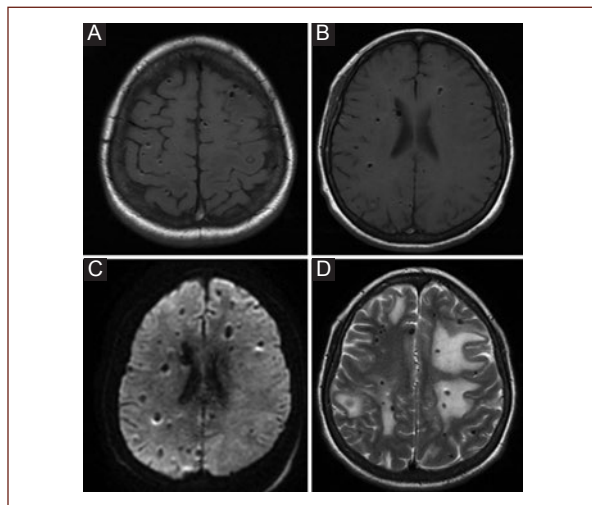
## Results

The general characteristics are presented in [table 1](#). Of the 18 patients included in this study, 13 (72%) were women. The mean age was 61 ± 15 years (range, 36-85 years) at the time of cancer diagnosis and 58 ± 15 years (range, 25-84 years) at the time of NC diagnosis. During the study period, no patient developed

**Table 2.** Characteristics of NC lesions

NC stage	No. of patients (%)	NC location (No.)	No. of lesions > 3 (5)	<3 (13)
Vesicular	9 (50%)	ES 3	0	9
		EI 1		
		I 5		
Calcified nodular	6 (33.3%)	ES 2	2	4
		EI 1		
		I 3		
Multiple (>2 stages)	3 (16.6%)	ES 1	3	0
		Both (E-I) 2		

ES: extraparenchymal subarachnoid; EI: extraparenchymal intraventricular; I: intraparenchymal; E: extraparenchymal. No patient had granular nodular, colloidal vesicular, or non-cystic phases; NC: neurocysticercosis.



**Figure 1.** A 61-year-old woman diagnosed with renal carcinoma with metastases to the mediastinum, lung, and suprarenal gland. She presented with seizures and walking impairment, and died 3 months later due to complications of cancer. **A** and **B**: Various phases of neurocysticercosis are shown on T1-weighted, **C**: Diffusion-weighted and **D**: T2-weighted, imaging sequences on MRI. The lesions resolved after treatment with steroids and albendazole.

Central Nervous System (CNS) metastases, and four patients developed metastases to sites other than the CNS (i.e., mediastinum, bone, lung, and suprarenal gland). The number of lesions seen on MRI was one or two in most patients ( $n = 13$ ) and  $\geq 3$  in 5 patients, of which one patient presented with >100 lesions.

The characteristics of the NC lesions are presented in [table 2](#). Three patients showed signs of intracranial hypertension; two of them were treated with decompression surgery and, if considered by the neurosurgical team, excision of the intraventricular

cysts, and one of them required three surgical interventions. During a mean follow-up period of 45.2 months (range, 1-147 months), eight deaths were reported. One patient who had a previous history of multiple NC reactivations developed NC recurrence and refractory status epilepticus; he died a month after the diagnosis. The other seven deaths were directly related to cancer progression. The median overall survival was 45 months (95% CI 21.7-68.6). [Figure 1](#) illustrates the NCC findings on MRI. All patients with active infection received steroids, followed by albendazole at 15 mg/kg per day.

## Discussion

*T. solium* cysticercosis is a globally reemerging disease, with an increasing number of cases in previously considered non-endemic countries, such as the USA, Canada, Australia, Japan, and Europe<sup>8,9</sup>. We presented 18 patients with NC who concurrently had systemic cancer; majority comprised women and had a mean age that was similar to that previously reported by others<sup>2</sup>. The most common symptoms that led to the diagnosis were headache and seizures. During follow-up, one of the patients died from NC-related complications, and seven died because of cancer progression. All patients were initially considered as having CNS metastases; MRI, other advanced techniques, such as positron emission tomography-computed tomography (PET/CT), and response to steroids/antiparasitic treatment helped in distinguishing NC from CNS metastases. MRI showed multiple NC lesions, and the most common finding was the vesicular stage.

Tapeworm infections have accompanied humans for more than 100,000 years. Characterization of the genomes of these parasites, as well as a deeper understanding

of their molecular markers and the host–parasite relationship<sup>10</sup>, has improved diagnosis, treatment, and prevention. The diagnosis of NC is made by neuroimaging techniques, such as CT or MRI. The characteristics of NC vary according to the phases of development, including non-cystic, vesicular, colloidal vesicular, granular nodular, calcified nodular vesicular, and colloid to calcified stages. One of the known features of NC is the presence of multiple phases in the same patient<sup>11</sup>. Some have proposed a serologic test to confirm the diagnosis. The most recommended study is the enzyme-linked immunotransfer blot because of its high specificity and sensitivity in the context of active lesions. It uses purified glycoprotein antigens from *T. solium* in either cerebrospinal fluid (CSF) or serum samples. Enzyme-linked immunosorbent assays are better for CSF than for serum samples, but these are not fully recommended because of the poor specificity and sensitivity<sup>12</sup>. These serologic diagnostic studies are not used frequently and are not currently required for the diagnosis of NC<sup>13,14</sup>.

Some limitations should be considered in the present study. There may have been selection bias because it was done at a single cancer referral center, the studied population was high-risk, and only patients who were referred for neuro-oncologic consultation were included. To avoid information bias, all data had strict definitions, and all information was evaluated by the main author (BC). This study was not a population-based report and did not aim to review all of the MRI studies done at the institution to establish frequency.

## Conclusion

In conclusion, although some have postulated that NC increases the risk of glioma and stroke, we consider that the relationship between NC and the development of CNS metastases is worth exploring, as the others have proposed<sup>15</sup>. In this study, none of the patients with NC developed simultaneous or asynchronous CNS metastasis. Perhaps, the excessive TH2 response seen in NC<sup>16</sup> is responsible for that effect, in some extent. A series of certain HLA haplotypes, which have been considered to affect the susceptibility to NC infection<sup>17,18</sup>, will now be studied further at our institution. The estimated incidence of NC and cancer is not low and should be considered a differential diagnosis of brain metastases, especially in developing countries.

## Conflict of interests

None to declare.

## Funding

None to declare.

## Ethical disclosures

**Protection of human and animal subjects.** The authors declare that the procedures followed were in accordance with the regulations of the relevant clinical research ethics committee and with those of the Code of Ethics of the World Medical Association (Declaration of Helsinki).

**Confidentiality of data.** The authors declare that they have followed the protocols of their work center on the publication of patient data.

**Right to privacy and informed consent.** The authors declare that no patient data appear in this article.

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