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COMPUTED TOMOGRAPHY IN NEUROCYSTICERCOSIS

A 10-YEAR LONG EVOLUTION ANALYSIS OF 100 PATIENTS WITH AN APPRAISAL OF A NEW CLASSIFICATION

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SUMMARY — Three hundred and fifty seven computed tomography (CT) from 100 different patients with neurocysticercosis (NC) were studied between 1979 and 1988. All patients were treated with praziquantel (PZQ). A new classification attempting to recognize the CT evolution profile in NC as well as assigning a possible link between CT findings and biological conditions of cysts is evaluated. It was possible to conclude that: intact cysts remain unchanged in consecutive CTs by 11 months and exhibit signs of degeneration in about 18 months after PZQ drug therapy; degenerating cysts can be detected by 10.5 months, disappear in 11 months and become nodular calcifications in about 25 months. Therefore, a time period of at least 36 months can be estimated for the complete evolution profile of cysts in the brain parenchyma.

Tomografia computadorizada na neurocisticercose: análise da evolução em 100 pacientes durante 10 anos e avaliação de nova classificação.

RESUMO — Foram estudados 357 exames por tomografia computadorizada do crânio (TC) de 100 pacientes com neurocisticercose, tratados com praziquantel (PZQ) entre 1979 e 1988. Foi utilizada nova classificação tomográfica, procurando estabelecer vínculo entre as imagens observadas à TC e a evolução biológica dos cisticercos. Considerando-se como estimador o valor das medianas em meses após o tratamento com PZQ, foi possível concluir que: vesículas íntegras permanecem inalteradas em exames consecutivos por período de 11 meses; apresentam sinais radiológicos sugestivos de processo inflamatório, geralmente associados à degeneração de cisticercos, em período de 18 meses; estas vesículas em degeneração podem ser detectadas durante 10,5 meses, desaparecem em 11 meses e evoluem para calcificações nodulares simples em 25 meses. De acordo com este critério, pode ser estimado período mínimo de 36 meses para o perfil de evolução de cisticercos no parênquima cerebral em pacientes tratados com PZQ.

Advances in the study of neurocysticercosis (NC) have been favoured in the last decade by the current use of computed tomography brain scan (CT). Cysts and calcifications were recognized as the two most common and important types of CT images suggesting the presence of the cysticerci in the brain parenchyma [9]. In this same period drug therapy for the aetilogical agent through praziquantel (PZQ) has been introduced, favouring interest on the study of CT images in NC. In fact, comparison among CT images before and after PZQ therapy has been often referred to evaluate the effectiveness of the drug [6,12,14]. However, such an interpretation may be hazardous since it is possible to admit that the disappearance of cysts might not be

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necessarily caused by the drug therapy [5]. A coincidence owing to the natural evolution of cysts should also be considered. Clinical studies shedding some light on this issue are subjected to several constraints. In the first place it is clearly unethical to maintain selection of paired control group with no PZQ therapy because first results strongly suggested an effectiveness of the treatment, mainly in the more severe forms of NC with no other alternative therapy [1,15,16]. In the second place, it is hard to determine, at least in an estimative fashion, the approximate time of central neurvous system (CNS) infection. Indeed, in Brazil for instance, nearly all patients studied are originally from endemic areas and show signs of multiple as well as not always simultaneous infection. A different number of classifications has been proposed for the study of CT in NC [2,6,9,10]. One of the most commonly cited classification was put forward by Sotelo et al.[13]: NC is divided into active and non-active forms. Based on the evolutive study of every individual cystic CT images in NC patients with a long follow-up our research group has proposed a new CT classification [4]. This classification endeavours to recognize the evolution profile of CT in NC as well as to assign a possible link between CT findings and the biological conditions of cysts within the CNS. This classification obbeys the natural biological evolution of NC.

In this paper are reported the results of an investigation endeavoured to determine the evolution profile of CT images in NC patients submitted to PZQ therapy, taking into account the analysis of clinical and CSF findings for each individual CT performed [17].

MATERIAL AND METHODS

Three hundred and fifty seven CT from 100 different patients with NC were studied in the period between 1979 and 1988. All patients were treated with PZQ. The protocol included an initial CT before therapy. After therapy, consecutive CT evaluations were performed. Time medians of 3, 6, 12, 18, 24, 36, 48 and 72 months were considered. The third month evaluation was possible only in 17 patients. The other subsequent CT evaluations were performed in a number of patients ranging from 29 to 39.

Changes of cerebral parenchyma and those of ventricular system were studied separatedly, according to the classification previously reported [4]. Parenchymal changes were classified into 4 different types corresponding to CT images of cysticerci. Type I CT images displayed no parenchymal changes and the diagnosis of NC was made possible through CSF analysis [3,4]. Type II CT images showed cysts with regular morphology, with no signs of either edema or inflammatory changes. Type III CT images showed parenchymal cysts associated to inflammatory signs and/or presence of cyst signs of degeneration: loss of sharpness,annular enhancement, nodular enhancement or localized edema are observed (Fig. 1). Type IV CT images showed single or multiple nodular calcifications. Changes of the ventricular system were considered separately and could be present in any of the 4 types described. Ventricular dilatation, asymmetry and deformity of ventricular system were considered. In view of epidemiologic and immunobiological characteristics of NC and considering the nature of the study, median values were regarded for all results and estimatives.

RESULTS

Table 1 contains a brief descriptive summary of CT findings in cerebral parenchyma. In the course of the study, 621 type II CT images were carefully accompanied: 269 vesicles previously reported were not seen in the next CT (median time of 18 months after treatment); 239 cysts remained unchanged in consecutive CTs (median time: 11 months); 113 cysts with regular morphology changed to type III CT images (median time: 17.5 months). There was no follow-up in 271 type II vesicles. In the same way, 287 type III CT images were analysed: 106 cysts previously reported were not seen in subsequent CTs (median time: 11 months); 20 have remained unchanged (median time: 10.5 months); 161 have changed to nodular calcifications (median time: 25 months). In 198 type III CT images there was no follow-up. Concerning type IV CT images, the emergence of new calcifications has been demonstrated in many patients, with a frequency histogram reaching a maximum at 26.5 months after treatment (median time: 20 months).

On the whole, favorable evolution could be ascertained in 66.7% of type II CT images patients and in 96.6% of type III CT image patients. In 65.6% of the patients with type IV CT images there has been a significant increase in the number of parenchymal calcifications.

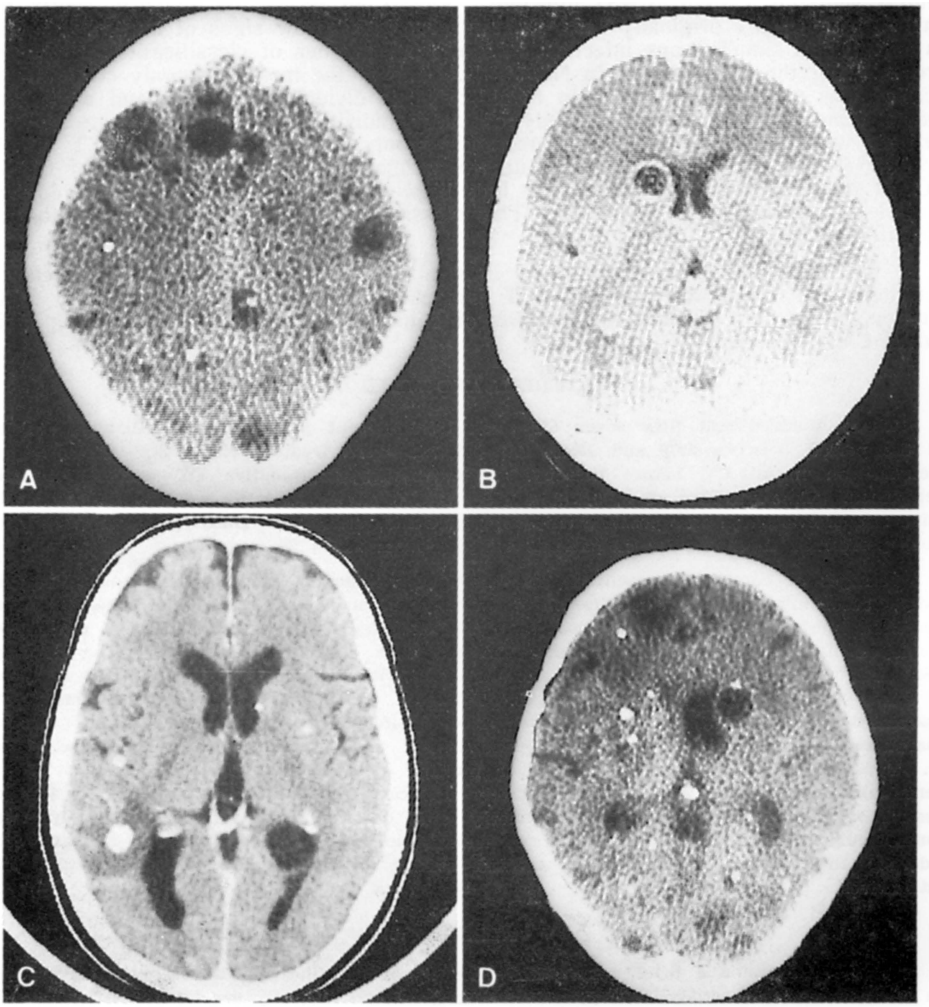

Fig. 1 — CT findings in neurocysticercosis. A. Typical neurocysticercosis CT with some evolutive phases: sharp vesicles; unsharp vesicles; vesicles with nodular scolex calcifications; some nodular calcifications. B. Detail of an annular enhancement: cysticercus with surrounding inflammatory signs, suggesting a degenerative phase. C. Detail of a nodular enhancement: vesicle with inner contrast captation; there is also a vesicle near the ventricular system, and some calcifications are present. D. Nodular calcifications; some vesicles and a nodular scolex calcification are seen also.

CT image	Type	Nr. of lesions	Average lesions/CT
Regular and sharp vesicles	II	892	12.7
Vesicles in degeneration	III	485	3.6
unsharp vesicles		96	9.6
localized edema		34	2.1
annular enhancement		70	2.1
nodular enhancement		285	3.7
Definite calcifications	IV	4324	23.5

Table 1 — CT images in patients with neurocysticercosis in brain parenchyma.

Step	CT image	Type	Estimated evolution time (months)
1	Regular and sharp vesicles	II	11 - 18
2	Degenerating vesicles	III	10.5 - 11
3	Unapparent vesicles or incipient calcifications	III/IV	14
4	Definite calcifications	IV	persistent

Table 2 — Sequential evolution profile of CT images in brain parenchyma of patients with neurocysticercosis.

Ventricular alterations were reported in 59.7% of CTs, dilatation (51.3%) and asymmetry (20.7%) corresponding to the most usual abnormalities observed. Changes in the ventricular system have shown signs of improvement only in 26.7% of CT images.

COMMENTS

The Sotelo et al.[13] active TC forms in NC comprise: arachnoiditis; hydrocephalus secondary to meningeal inflammation; parenchymal cysts; brain infarction secondary to vasculitis; mass effect due to a large cyst or cyst clumps; intraventricular cysts; spinal cysts. The inactive forms are: parenchymal calcifications; hydrocephalus secondary to meningeal fibrosis. Cases studied in the present investigation may be included among Sotelo active forms, as shown in table 1. Patients with one single or few calcifications or ventricular dilatation but with no inflammatory CSF reaction were excluded. Cysts lodged in basal cisterns or in the ventricular system were not considered in this evaluation: it is rather difficult to identify cysts in CSF system by CT, particularly in an evolutive fashion.

The accuracy of classification adopted in this investigation concerning biological evolution of cysts was double-checked against clinical and CSF results. Signs of increased intracranial hypertension or unexpected escape to anti-epileptic drug therapy often occurred particularly when previous sharp CT cystic images (type II CT images) changed to images of nodular or annular enhancement or localized edema. Other than that, significative clinical improvement was detected when CT cysts associated to inflammatory changes disappeared. This clinical and CT behaviour was often accompained by increase in the inflammatory changes in the CSF analysis, thus parelling clinical and CT evaluation[17]. In fact, many authors attempt to assign a link between CSF inflammatory changes exacerbation, clinical NC activity and degeneration of cysts in the CNS, as previously reviewed[2,3].

CT investigation about time taken by intact cysts to exhibit degenerative signs after drug treatment is very hard. In a disease as severe as NC, it is virtually impossible in clinical reserach to map the effective time lost by vesicles up to exhibit

degeneration signs. In view of these difficulties, the present study employs methodology that atempt to determine not the time lost by cysticerci up to degenerate, but how much time each vesicle remains unchanged in consecutive CTs. Intact cysts remained unchanged at about 11 months; signs of degeneration were detected at about 18 months after treatment. Degenerating cysts remained by 10.5 months; they have disappeared in CTs performed after 11 months and were replaced by nodular calcifications in CTs evaluated about 25 months. Therefore, by this study and by these methods, a time span of at least 36 months can be assumed for all the evolution profile of cysts in the brain for patients treated with PZQ (Table 2).

The evolution study of type III CT images (cysts in degeneration) brings particularly interesting data. Accepting that usual time spent for evolution of this particular type is about 10.5 to 11 months, and accepting that calcifications corresponding to these cysts became evident only in 25 months, there is an estimated period of 14 months with neither cysts nor definite calcifications. In this phase, CT often can be illusorily evaluated as normal or can exhibit incipient signs of calcification not always detectable in consecutive CTs.

It is rather important to emphasize that CT classification used allows one to diagnose the evolution phase of each individual cyst lodged in the brain parenchyma. These results are considerably different from those referred by several authors regarding the evaluation of effectiveness of drug therapy [8,11-14], particularly considered by CT criteria. These results are due possibly to the methodology employed, especially in CT evaluation paired with CSF and clinical long term evolution analysis.

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