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IgE, IgA, IgD antibodies detection in human cysticercosis by ELISA test in Madagascar

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Abstract

Cysticercosis serological diagnosis available in Madagascar is only based on the IgG detection. Thus, we have planned to perform biological tests in order to detect different human antibodies isotypes (IgE, IgA, IgD) directed against *Cysticercus cellulosae* and to evaluate the performance of enzyme-linked immunosorbent assay (ELISA).

CS-50 antigen, extracted from *Cysticercus cellulosae* was used to quantify the rates of these isotypes in the serum and in the cerebrospinal fluid (CSF). After standardizing protocols, 80 patients with neurocysticercosis symptoms from the Neurology Department, Joseph Raseta Hospital Befelatanana, Antananarivo were analyzed.

Results showed high rate of IgD in the serum and high rate of IgA in the CSF. For each studied isotype Ig, ELISA test performance was low compared to ELISA-IgG test as well in the serum than in the CSF.

Key words: *Cysticercus cellulosae*; cysticercosis; ELISA; IgE; IgA; IgD.

1. Introduction

Cysticercosis is one of the public health concern in Madagascar. The prevalence of this disease is estimated to be over 10%, stating Madagascar among the most affected countries in the world [1, 2]. Despite the implemented medical imaging and serological tests, cysticercosis remains a serious disease with difficult diagnosis in the country. Moreover, these tests are only available in capital [3, 4].

Estimating the impact of cysticercosis in human health is difficult due to the variability of clinical manifestation, ranging from asymptomatic to severe headaches, epilepsy, and even death [5, 6]. Cysticercosis diagnosis were based on clinical symptoms [7]. Symptomatic treatment is performed to control clinical manifestations, particularly seizures or intracranial hypertension [8].

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Human cysticerci detection is typically done on computed tomography (CT) or magnetic resonance imaging (MRI). However, in endemic areas, access to imaging equipment remains difficult. Serological diagnostics, such as Enzyme Linked Immunosorbent Assay (ELISA) and Enzyme-Linked Immuno Transfer Blot (EITB) are available for human neurocysticercosis detection. Different antigens cysticercus, crude to purified, are used for antibodies detection in serological tests [9, 10, 11].

Cysticercosis involves a complex host-parasite relationship in which the immune response may play a decisive role [12]. Determination of immunoglobulin (Ig) class in passive immunization belong would be an important step in the overall understanding of immunity against larval cestodes [13, 14, 15].

Cysticercosis serological diagnosis available in Madagascar is mainly based on the IgG detection. Therefore, this study aims to perform biological tests detecting different human isotypes (IgE, IgA, IgD). Furthermore, epidemiological diagnosis of human cysticercosis could thus be carried out using ELISA test to detect antibodies (Ab-ELISA) based on cysticercus antigens. The purpose of this study is to develop an ELISA test considering IgE, IgA, and IgD for samples (sera and cerebrospinal fluids or CSF) using scanner as gold standard.

2. Patients, Materials and methods

2.1. Patients

Patients suffering from recent seizure or persistent and experiencing headache, consulting or hospitalized at the Neurology Department, Joseph Raseta Hospital Befelatanana, Antananarivo, were recruited for the study, whatever the final diagnostic. Aside these symptoms, patients who agreed for the study after informed consent and without contraindication for lumbar puncture were enrolled after a CT scan. When the volume of cerebro-spinal-fluid (CSF) obtained after the lumbar puncture was not sufficient for DNA extraction patients were excluded from the study. For registered patients a questionnaire was administrated including questions on clinical parameters and on the socio-economic context of the family. Ten milliliters of blood were also collected from peripheral veins.

CT-Scan was performed at the Radiology Unit, Military Hospital Soavinandriana, Antananarivo, before any biological analysis, and was examined by a trained specialist. It was done without and with contract enhancement. Localization of the lesions was noted as parenchymal of extra-parenchymal. The results and conclusions were established according to consensus of Del Brutto et al; 2001 [16], such as i) probable cysticercosis (vesicles or cyst plus scolex), ii) possible (cysts without scolex, annular lesions, round parenchymal calcifications, multiples round lesions with various age) or iii) non-confirmed cysticercosis (other lesions) or normal CT scan.

All the protocol was approved by the National Ethic Committee.

2.2. Antibody analysis

The antigen used was a glycozylated fraction of proteins obtained from the cysticercus according to Tsang et al.; (1989) [17]. After triturating of the cysticercus, centrifugation of the extract and filtration of the supernatant, proteins were desalted on Sephadex G25 (17-0031-01 GE healthcare) before affinity purification on a concanavalin-sepharose column (ConA Sepharose 4B, 17-0440-01, GE healthcare). After washing of the column, fractions were eluted with a methyl α-D-glucopyranoside (SIGMA M-9376) gradient and fraction obtained at 50mM was kept as the antigen (CS50). All the process was conducted on an automatic AKTA PURIFIER.

Enzyme Linked ImmunoSorbent Assay was performed on 96-wells plates (Immulon 2HB, 3455, Thermo scientific) coated overnight at 4°C with 1µg/ml of antigen diluted in phosphate-buffered saline (PBS) as already published for serum [3]. Saturation was done for 2 hours at 37°C with PBS-Tween (PBS-T) 0.2% - Casein 1%. After washing the plate with PBS-Tween 0.2%, serums diluted at 1/200 and CSF at 1/10 in PBS-T 0.2%- casein1% were incubated for 2 hours at 37°C. Revelation was done as previously described with peroxydase labeled anti-human IgG and standard o-phenylenediamine dihydrochloride (OPD) procedure.

For isotype detection, conditions were slightly modified. Dilution of serums was done at 1/20 and 1/200 for IgE and IgA or IgD respectively in PBS-T 0,05%- dry milk 0,5% and incubated for 2h at room temperature. Conjugates were used in the same line at 1/500 for anti-IgA and IgD and 1/1000 for anti-IgE in PBS-T 0,05% - dry milk 0,5%. Incubation was done for 2h at room temperature (RT).

Threshold of positivity calculated as the mean of negative sample plus three standard deviations.

3. Results

Table 1 Cut-off, Sensitivity (Se) and Specificity (Spe) (%), positive predictive value (PPV) and negative predictive value (NPV) (%) of ELISA in the detection of IgE, IgA, IgD Antibodies in serum and CSF samples using purified protein (CS50) of cysticercus of *Taenia solium*.

Antigen	Ig	Samples	Cut-off	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
CS-50	IgE	Sera	0.185	34.48	78.43	47.62	67.80
		CSF	0.075	13.79	88.24	40.00	64.29
	IgA	Sera	0.174	68.97	21.57	50.00	55.00
		CSF	0.084	41.37	72.54	46.15	68.51
	IgD	Sera	0.138	82.75	88.23	36.36	64.28
		CSF	0.071	27.58	17.64	57.14	68.18

Results obtained show that the performance of the ELISA for each Antibodies (Ig) class is different in the infection and during the cysticerci symptoms presentation. Also, the amount of Ig present in serum is quite different from that in the CSF.

Serum IgD is more sensitive (Se = 82.75%) compared the other classes of Ig studied, and the more-specific is IgE (Spe = 78.43%).

In the CSF, the sensitivities of the tests are quite low for the three Ig classes studied, with a slight superiority for the IgA (Se = 41.37%). For cons, the specificities of CSF are quite high with IgE-ELISA and ELISA-IgD which have approximately the same values (IgE-Spe = 88.24% and IgD-Spe = 88.23%).

4. Discussion

Immunoglobulin (Ig) are different in their function and specificity to an antigen [18, 15]. In *Taenia solium* infection, the humoral immune response is mainly provided by IgG. Some patients have IgM, IgA and IgE antibodies against cysticerci; however, subclass responses are less frequent than IgG. Antibodies production in biological fluids by setting supplements is one of the most effective factors in the mechanism of protection against cysticerci. Antibodies levels are detected in serum and CSF for neurocysticercosis (NCC), the correlation is often good for IgG [19]; often resulting diffusion of IgG in CSF but not their pathognomonic local production of CNS infections. Therefore, the comparative serological tests between CSF and serum are increasingly used to facilitate the diagnosis of cerebral infections [20, 21, 22].

Immuno- enzymatic methods such as ELISA and EITB are commonly used in medical research. ELISA test is especially appreciated for its simplicity and its sensitivity [21, 23].

For his performance in the serological ELISA -IgG diagnosis, we used the CS-50 antigen obtained after purification of the crude extract cysticerci for the standardization of ELISA-Ig techniques (A, E, D). During the development of the technique, different buffers and dilutions were tested to avoid non specific binding responsible for noise.

The results of the CT scan used as a reference test and the threshold of ELISA were used to identify positives or negatives patients, false positives and false negatives.

According to the analysis, the threshold values of serum tested are less than 0,200 and not exceeding 0,100 for the CSF. As the cut-off is calculated from the negative controls, these values could be due to the low absorbance of the negative controls. These results are confirmed by published studies on *Taenia crassiceps* showing thresholds (IgA) 0.070 in serum and CSF, whereas with the IgE class, these values are 0.135 for serum and 0.252 for CSF. A study with saline extract of *Taenia solium* cysticerci IgG gives thresholds 0.400 for serum and 0.078 with CSF [24].

The IgG class analyzed with our antigen CS- 50 present threshold of serum at 0.400.

Frequencies of true positive (TP), true negative (TN), false positive (FP) and false negative (FN) vary with the threshold. Higher the threshold is low, the greater the number of patients correctly identified (TP), but also greater will be the number of false positives. Conversely, higher the threshold is high, the greater the number of true negatives patients, but also the greater the number of false negatives. The low threshold will have the effect of increasing the sensitivity but lower specificity; on the contrary, a high threshold increase specificity but decrease sensitivity [25].

All diagnostic tests are not equivalent in terms of performance; this diversity often makes it difficult to interpret the results. The performance of a diagnostic strategy detects the proportion with a positive test is real sick and that of subjects with a negative test is really free of the disease.

Specificity and sensitivity of serological test differ from one to another laboratory [26]. This variability may be due to many factors, such as dilution of organic products, the threshold adopted, the biochemical nature of the antigen, the level of endemicity [27].

Sensitivities and specificities of ELISA tests were calculated from the positivity threshold for different Ig-classes on the same population.

For serum, the IgD threshold is smaller; this has the effect of increasing sensitivities, which is higher than 80 %, and lower specificities inferior than 20%.

In contrast, for serum IgE, with a threshold relative higher to other classes, the sensitivity is relatively low (less than 35%) but the sensitivities are higher (greater than 70%).

For CSF case, the IgA threshold is high with sensitivity more than 40% and low enough specificity that other classes. Different results were reported by other authors, the study by Espinoza *et al.* [28], on *Taenia solium* cysticerci showed a sensitivity of 25% (sera) and 13% (CSF) for IgA and for IgE, the sensitivities are 3% in both the serum and CSF highlighting the lack of interest of this isotype in terms of diagnosis.

The results showed higher level in IgD compared to the other two classes (IgA, IgE) in serum and IgA compared with IgD and IgE in CSF. The performance of the ELISA developed for each antibodies class studied is quite low in both the serum and CSF compared to ELISA IgG. Some authors have suggested that IgM, IgE and IgA are not involved in the immune response against the NCC [24]. However, other authors have been identified in the serum levels of immunoglobulin (G>M>E>A) [29].

Clinical manifestations and host immunological responses are presented based on the stage, number, size, and principally the localization of cysts [30, 31].

These results could be explained by the low quantity of these antibody classes in the body or by the fact that these antibodies appear at a certain stage of the infection.

Numerous studies have shown that cysticercosis antibodies are able to conferring immunity. Little information is available regarding the kinetics of antibody production, particularly during the spontaneous death of cysticercus. In addition to direct effects, it is possible that antibodies exert their antiparasitic action by other mechanisms. Moreover, antibodies have been found to modify the permeability cysticerci and interfere with their metabolisms.

It is possible that the most infected hosts produce these different classes of antibodies, which occur at different intervals after infection, in response to antigens released during development of the parasite [32]. To use isotypes to "date" the disease was developed for toxoplasmosis [33]; our results allow such an analysis for the rest. Similarly, the ratio of antibodies in serum and CSF can be studied for each subject although the ELISA protocol are different to their.

There is however, a case of NCC wherein serum antibodies are not detectable and a number cases of NCC unconfirmed wherein the antibodies against *Taenia solium* are detected [34].

The host immune response has been well studied over the years, identifying a general pattern of immunodominance based on NCC classification. Subarachnoid NCC patients are the most immunodominant [35], followed by parenchymal with viable multiple cysts. Immunodominance decreases depending on the number of cysts [36, 37], with single lesions being generally undiagnosed by common immunological tests. Finally, patients with calcified lesions have fewer detectable immune responses [38, 39, 40]. In this context, immunodiagnostic tools based on antibody and/or antigen detection could help to discriminate viable and/or severe infections for a confirmatory diagnosis and follow-up [41, 42].

5. Conclusion

Despite availability of medical imaging diagnosis, particularly computed tomography (CT scan) and established serological diagnosis, cysticercosis remains a serious disease that detection is difficult. However, in several countries, including Madagascar, CT scans remain unaffordable, leading to an overreliance on immunological diagnostic methods such as ELISA and EITB.

Thus, our work contributes to the study of immunoglobulin subclasses A, E, and D in human cysticercosis. The results obtained from our research, although still preliminary, have allowed us to develop ELISA protocols for IgE, IgA, and IgD ; to detect response of these three antibody against *Cysticercus cellulosae* ; and to determine the test's performance.

Although the ELISA technique is simple and easy to implement, comparison with other test such as EITB, which is more sensitive and specific, is essential.

In the future, we plan to evaluate the kinetics of these isotypes to better determine their appearance and the timing of the infection.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interests.

References

[1] Aubry P, Gaüzère BA. Cysticercosis : Actuality 2022. Médecine Tropicale 2022.

[2] Carod JF, Mauny F, Parmentier AL, Desmarets M, Rakotondrazaka M, Brembilla A, Dermauw V, Razafimahefa J, Ramahefarisoa RM, Andriantseheno M, Bailly S, Menard D, Dorny P. Hyperendemicity of cysticercosis in Madagascar: Novel insights from school children population-based antigen prevalence study. Plos One ; 2021.

[3] Andriantsimahavandy A, Ravaoalimalalala VE, Rajaonarison P, Ravoniarimbinina P, Rakotondrazaka M, Raharilaza N, Rakotoarivelo D, Ratsitorahina M, Rabarijaona LP, Ramarokoto CE, Leutscher P, Migliani R. Current epidemiological situation of cysticercosis in Madagascar. Arch Inst Pasteur de Madagascar 2003; 69 (1&2): 46-51.

[4] Carod JF, Dorny P. Cysticercosis in Madagascar. The Journal of Infection in Developing Countries, 2020; 14(9):931-942.

[5] Zoli A, Shey-Njila O, Assana E, Nguekam J-P, Dorny P, Brandt J, Geerts S. Regional status, epidemiology and impact of Taenia solium cysticercosis in Western and Central Africa. Acta Tropica 2003 87 (1): 35-42.

[6] Razafimahefa J, Ravelosaona F, Rahamefy O, Zodaly N, Jambou R, Tehindrazanarivelo A. Main clinical and radiological aspects of meningeal neurocysticercosis seen in the neurology department of Antananarivo. Neurological Review; April 2016. Vol 172 (1): A79 – A80.

[7] Willingham A.L. III. Control of *Taenia solium* cysticercosis/Taeniosis. In Parasitology 2006; 61: 509-547.

[8] Garcia H.H. Epidemiologia y control de la cisticercosis en el Perú. Peru Med Exp Salud Publica 2010 ; **27** (4) : 592-597.

[9] Tchamdja E. Development and study of the performance of ELISA test for the detection of antibodies directed against *Cysticercus cellulosae* in humans. Master of Science thesis in Tropical Animal Health. (Antwerp), Belgium: Prince Leopold Institute of Tropical Medicine, 2007; No. 77.

[10] Nativel P, Rahantamalala A, Ramiandrisoa S, Rasoamampianina V, Duchateau M, Chamot- Rooke J, Guebey R, Rasamoelina-Andriamanivo H, Jambou R. Bio-guided identification of proteins for the diagnosis of cysticercosis in swine. Veterinary parasitology; April 2016. Vol 220: 23-27.

[11] Rahantamalala A, Porphyre V, Rabenindrina N, Razafimahefa J, Rasamoelina-Andriamanivo H, Jambou R. Cysticercosis: a neglected disease. Cirad-Agritrop 2016.

[12] Flisser A, Pérez-Montfort R, Larralde C. The immunology of human and animal cysticercosis. Mexico, Bulletin of the World Health Organisation 1979; **57** (5): 839-856.

[13] Grogl M, Estrada JJ, Mac-Donald G, Kuhn RE. Antigen-antibody analyses in neurocysticercosis. Journal Parasitology 1985 Aug; 71(4): 433-42.

[14] Abdulssalam M, Gemmell MA, Griffiths RB, Grossklaus D, Kagan IG, Slais J, Soulsby EJL. Necessary research on taeniasis-cysticercosis. OMS 1976; 53 (1): 371-378.

[15] Suzuki LA, Rossi CL. Evaluation of cysticercus-specific IgG (total and subclasses) and IgE antibody responses in cerebrospinal fluid samples from patients with neurocysticercosis showing intrathecal production of specific IgG antibodies. Arq Neuropsiquiatr 2013 Feb; 71(2):106-9.

[16] Del Brutto OR, Rajshekhar V, White JAC, Tsang VCW, Nash TE, Takayanagui OM, Schantz PM, Evans CAW, Flisser A, Correa D, Botero D, Allan JC, Sarìi E, Gonzalez AE, Gilman RH, García HH. Proposed diagnostic criteria for neurocysticercosis. Neurology. 2001 Jul 24;57(2):177–183.

[17] Tsang VC, Brand JA, Boyer AE. An enzyme-linked immunoelectrotransfer blot assay and glycoprotein antigens for diagnosing human cysticercosis (Taenia solium). Journal Infection Disease ; 1989. 159(1):50-9

[18] Dahmani O, Belcaid A, Azzouzi OE, Hami HE. Immunoglobulins: structure and function. Biology course. 2009.

[19] Esterre P, Andriantsimahavandy A., Boissier P. Relationships between pathology and immunity in cysticercosis. *Arch Inst Pasteur Madagascar*, 1994; 61(1): 14-20.

[20] Sako Y, Takayanagui OM, Odashima NS, Ito A. Comparative Study of Paired Serum and Cerebrospinal Fluid Samples from Neurocysticercosis Patients for the Detection of Specific Antibody to Taenia solium Immunodiagnostic Antigen. Trop Med Health 2015 May 22;43(3):171–176

[21] Garcia HH, Seth EON, Noh J, Handali S. Laboratory Diagnosis of Neurocysticercosis (Taenia solium). Journal of clinical microbiology, 2018; 56 (9).

[22] Romo ML, Carpio A, Parkhouse RME, Cortéz MM, Rodríguez-Hidalgo R. Comparison of complementary diagnostic tests in cerebrospinal fluid and serum for neurocysticercosis. Heliyon, 2018; 4(12).

[23] Raveloson A. Cysticercosis in Madagascar. Doctoral thesis in Medicine. Faculty of Medicine, University of Madagascar, 1978; No 21.

[24] Bueno EC, Vaz AJ, Machado L.DR, Livramento JA. Detection of IgG, IgA and IgE antibodies in cerebrospinal fluid, serum and saliva samples by elisa with *Taenia solium* and *taenia crassiceps* antigens. Arq Neuropsiquiatr, 2000; 58(1): 18-24.

[25] Pawlowski Z, Allan J, Sarti E. Control of Taenia solium taeniasis/cysticercosis: From research towards implementation. International Journal for Parasitology, 2005; 35: 1221–1232.

[26] Rajaoarifetra J. systematic arterial hypertension symptomatic of cysticercosis. Doctoral thesis in Medicine; Faculty of Medecine, University of Antananarivo, 2003, N°6647.

[27] Razafindrahaja VT. Neurocysticercosis: epidemio-clinical and cost of treatment. Doctoral thesis in Medicine. Faculty of Medicine, University of Antananarivo, 2007; N° 7542.

[28] Espinoza B, Palacios GR, Tovar A, Sandoval MA, Plancarte A, Flisser A. Characterization by ELISA of the humoral immune response in patients with neurocysticercosis and its application in immunodiagnosis. J Clin Microbiol, 1986; 24: 536-541.

[29] Flisser A, Woodhouse E, Larralde C. Human cysticercosis: antigens, antibodies and non-responders. Clin Exp Immunol 1980; 39:27-37.

[30] Butala C, Brook TM, Majekodunmi AO, Welburn SC. Neurocysticercosis: Current perspectives on diagnosis and management. Front. Vet. Sci. 2021; 8, 615703.

[31] Pineda-Reyes R, White ACJ. Neurocysticercosis: an update on diagnosis, treatment, and prevention. Curr. Opin. Infect. Dis. 2022. 35 (3), 246–254.

[32] Dorny P, Brandt J, Zoli A, Geerts S. Immunodiagnostic tools for human and porcine cysticercosis. Acta Tropica, 2003; 87: 79-/86.

[33] Bessières MH, Chemla C. Difficulties in interpreting toxoplasmosis serology. Revue Francophone des Laboratoires, jun 2006. n° 383.

[34] Sahu PS, Parija SC, Narayan SK, Kumar D. Evaluation of an IgG-ELISA strategy using *Taenia solium* metacestode somatic and excretory–secretory antigens for diagnosis of neurocysticercosis revealingbiological stage of the larvae. Acta Tropica, 2009; 110: 38-45.

[35] Nash TE, O'Connell E M. Subarachnoid neurocysticercosis: emerging concepts and treatment. Curr. Opin. Infect. Dis. 2020; 33 (5), 339–346.

[36] Garcia HH, Castillo Y, Gonzales I, Bustos JA, Saavedra H, Jacob L. Low sensitivity and frequent cross-reactions in commercially available antibody detection ELISA assays for taenia solium cysticercosis. Trop. Med. Int. Health 2018b; 23 (1), 101–105.

[37] Channel IC, Damara FA, Ramdhani AN, Anton A. Letter to the editor. diagnosis of subarachnoid neurocysticercosis. Neurosurg 2021. *Focus* 50 (5), E24.

[38] Nash TE, Mahanty S, Loeb JA, Theodore WH, Friedman A, Sander JW. Neurocysticercosis: A natural human model of epileptogenesis. Epilepsia 2015; 56 (2), 177–183.

[39] Nash TE, Bustos JA, Garcia HH. Cysticercosis Working Group: Disease centered around calcified taenia solium granuloma. Trends Parasitol 2017; 33 (1), 65–73.

[40] Nash TE, Ware JM, Mahanty S. Natural history of patients with perilesional edema around taenia solium calcified granulomas. J. Infect. Dis. 2017b; 215 (7), 1141–1147.

[41] Deckers N, Dorny P. Immunodiagnosis of taenia solium taeniosis/cysticercosis. Trends Parasitol. 2010; 26 (3), 137–144.

[42] Zea-Vera A., Cordova E. G., Rodriguez S., Gonzales I., Pretell E. J., Castillo Y., et al. (2013). Parasite antigen in serum predicts the presence of viable brain parasites in patients with apparently calcified cysticercosis only. Clin. Infect. Dis. 57 (7), e154–e159.