BAOJ Neurology

Almeida ID, et al., BAOJ Neuro 2015 1: 2
1: 006

Research Article

Systematic Review of Magnetic Resonance Imaging Signs in Patients with Epilepsy

Almeida ID[1*] , Silva Bissaco M A[2] and Pereira de Souza L[3]

[1] Paulista University(UNIP) Unyleya(W-Pós), Brazil
[2] Mogi das Cruzes University (UMC), Brazil
[3] Cruzeiro do sul University (UNICSUL), Brazil

Abstract

Epilepsy is a disorder of the brain characterized by a predisposition to produce lasting seizures. For diagnosis, imaging methods and specifically magnetic resonance imaging (MRI) have been used. Therefore, the aim of this research was to gather information about possible changes in brain tissue observed using MRI.

Methods: We did a literature search of online databases (Lilacs, Medline, Pubmed, Bireme and Capes journals Portal) and also of specific sites, such as Google Scholar and Google Books to find scientific articles and books related to the following topics: epilepsy, neuro imaging, MRI and Diagnostic Imaging. Althougharticles publishedbefore 2010alsohavescientific relevance in this research wefocused onlyon the latest articles published in the Englishlanguage about thementionedtopics.

Results: Among the50articles found, which were published between 2010 and 2015, only 20 metthe inclusion criteria, of which 16 reported changes in the hippocampus, 7 reported brain atrophy, 4 reported tumors, 3 reported thalamus and basal nuclei signs, 2 reported gliosis and 1 reported amygdala change. Compared to the total sample of patients with a sign on the MRI, this corresponds to 26.2%, 9.6%, 3.4%, 0.1%, 0.1% and 0.1% respectively.

Conclusion: Several signs of epilepsy are possible to study using MRI, but in some cases, epilepsy does not show the characteristic signals. Other associated signs presented in this study can improve the understanding of epilepsy and its diagnosis.

Keywords: Epilepsy; MRI; Neuroimaging.

Introduction

Epilepsy is characterized as a group of neurological disorders culminating in recurrent seizures [1]. Structural or functional brain disorders stop cortical activity causing sudden and excessive neuronal discharges that cause seizures. The International Classification of Diseases for epilepsy is classified as ICD-10 G40 [1, 2, 3]. This complication was defined as a disease of the brain characterized by an enduring predisposition to produce seizures [4]. The Greek physician Galen was the first to recognize that epilepsy is a disease of the brain and the separation of the three types: (1) brain epilepsy;(2) epilepsy reflected cardiac disorders in the brain; and (3) seizures related to body parts that reflect in the brain [5]. The first epilepsy references dating back three thousand years and the manuscripts are in the Museum of London [5, 6]. Currently, epilepsy ratings are documented by the International League Against Epilepsy (ILAE). The update was released by the ILAE in 2010 and recognizes the mesial temporal lobe epilepsy (MTLE) with hippocampal sclerosis (HS), which were not included previously [7, 8]. The prevalence of epilepsy in developed countries ranges from 4 to 10 cases per 1000 people and in tropical countries the prevalence of epilepsy ranges from 14 to 57 cases per 1000 [9]. With the systematization of new approaches to research and diagnostic clarification in many areas of science, there was and evolution of therapy with non-invasive imaging studies of brain scans known as computed tomography (CT) performed in 1971 [10, 11]. The research evolved and in 1976, the first MRI was presented with axial slices. MRI is one of the best methods for brain imaging. This method is very widespread in the clinical practice for several decades. MRI shows progress in different areas of medicine, particularly to neurology [12, 13]. MRI allows for the observation of brain structures and evidence of possible abnormalities that may explain the presence of seizures [14]. Considering this context, this research aims to gather current information on changes in brain tissue observed by MRI.

Methods

To achieve the aim of this research, a systematic review was carried out regarding articles published about changes in the brains of people with epileptic seizures. We did a literature search of online databases (Lilacs, Medline, Pubmed, Bireme and Capes journals Portal) and also of specific sites, such as Google Scholar and Google Books to find scientific articles and books related to the following topics: epilepsy, neuroimaging, MRI and Diagnostic Imaging. Afterwards, the articles that met the inclusion criteria were organized in chronological order and grouped into table and graphs and discussed below after careful reading with respect to the MRI signs observed. The inclusion criteria taken into consideration are: scientific articles published between 2010 and 2015 in the

***Corresponding author:** Almeida ID, Paulista University(UNIP) Unyleya (W-Pós), Brazil; e-mail:dr_igor@outlook.com

Sub Date: March 23, 2015, **Acc Date:** May 27, 2015, **Pub Date:** June 1, 2015

Citation: Almeida ID, Silva Bissaco MA, Pereira de Souza L (2015) Systematic Review of Magnetic Resonance Imaging Signs in Patients with Epilepsy. BAOJ Neuro 1: 006.

English language in which there is the presence of some change in MRI images of the brains of people with epilepsy. Although articles published before 2010 also have scientific relevance, in this research we focused only the latest articles published in the English language about the mentioned topics. Thus, among the 50 articles found, which were published between 2010 and 2015, only 20 met the inclusion criteria, whereas the other 30 articles were excluded because they were not published in English or were published in a period before 2010. After the selection of scientific articles that met the inclusion criteria, a careful reading was performed in order to find signs such as hippocampal sclerosis, brain atrophy and cortical malformation.

Results

(Table 1) shows the selected scientific articles for this review that are grouped in chronological order, from 2010 to 2015. This table contains information about each study, such as its purpose, the number of samples used and the signs found in the MRI, which are reviewed in this study. The number of patients studied in all the articles1639 and the total number of patients with imaging signs was 824 (Figure 2(B)). (Figure 1) shows 16 articles with signs of hippocampal sclerosis and corresponds to 54% of the signs shown in the 20 articles. Of the 20 articles selected, as shown in (Figure 1), 16 articles reported changes in the hippocampus; 7 reported changes in brain atrophy; 4 reported changes in tumors and in the white matter; 3 reported changes in the thalamus, basal nuclei, gray matter, cortical malformation and cysts; 2 reported changes in gliosis and gray matter; and 1 reported changes in the amygdale, brainstem and cerebellar atrophy. (Figure 1) shows a distribution of articles for signs detected by MRI. Note that signs are present in all the aforementioned articles, but not all patients have described image signs.The graph of (Figure 2(A)) reported the percentage of signs related to all patients in the articles studied. It is observed that the hippocampal sclerosis corresponds with more than 50% of signs. Change in the hippocampus corresponds to 26.2% of all patients, brain atrophy corresponds to 9.6% of all patients, tumors corresponds to 3.4% of all patients, thalamus and basal nuclei change corresponds to 0.1% of all patients, gliosis corresponds to 0.1% of all patients and amygdale change corresponds to 0.1% of all patients.

Table-1 Main characteristics in MRI in articles between 2010 and 2015.

Study	Purpose	Sample	MRI Signs
Lee et al. 2010	The authors compared data before and after of the surgery	1	Signs; Hippocampal sclerosis and cortical displasy in MRI signs, but after surgery only hippocampal sclerosis
Conzet al. 2011	The authors evaluated progression of hippocampal atrophy in patients with sporadic epilepsy at the mesial temporal lobe	68	Only 52 patients had hippocampal sclerosis
Amirsalari 2012	The author studied children with epilepsy by MRI and their relationship with clinical and demographic findings	200	Only 57 patients showed alterations in MRI: 20 brain atrophy, 18 alteration in white matter, 10 cysts, and 9 tumors
Jalaluddin et al. 2012	The authors determined the normal volume of the hippocampus in healthychildren and adolescentsin Malay.	81	The authors did not study dysfunction of the hippocampus
Kaprelyan et al. 2012	The author evaluated the importance of MRI for detection of brain lesions associated with refractory epilepsy	49	The MRI brain signs were detected only in 27 patients: 20 brain tumors, 3 hippocampal sclerosis, 2 cortical malformation and 2 cysts
Sgarbi, Telis 2012	The authors carried out a trial with findings of MRI in a group of patients with refractory epilepsy	43	The study showed temporal sclerosis in 4 patients, alteration in grey matter 3 in patients, gliosis 3 in patients and tumor 6 in patients
Baldissin,Souza 2013	The authors evaluated the texture in regions of interest of the limbic system and compared them with the same areas in healthy people	40	This study showed 20 patients with refractory epilepsy and 20 normal people
Singh et al. 2013	The authors evaluated and compared the hippocampus in patients with refractory epilepsy	30	Only 17 patients showed hippocampal sclerosis
Winston et al. 2013	The authors evaluated MRi image with field intensity of 1.5T to 3T	505	In 505 patients studied, 101 showed hippocampal sclerosis, 61 Cortical malformation48 brain atrophy, 29 white matter alteration and 20 patients showed tumors
Cendes 2013	The case report submitted to resection of anteromedial region in the temporal lobe	1	This study showed hippocampal sclerosis of left side

Lain et al. 2013	The authors defined the neuropathological findings of pulvinar degeneration observed epileptic seizure of long duration	1	The MRI image was normal, but in necropsy study showed hippocampal sclerosis and pulvinar lesion
Jang et al. 2013	Patient case report submitted to resection of anteromedial, region in the temporal lobe	1	The patient had lesions in the brainstem, thalamus, basal nuclei and temporal mesial region (hippocampus)
Winkler et al. 2013	The authors document MRI changes in people with different types of epilepsy	32	The results showed 11 patients with generalized atrophy, 9 Hippocampus sclerosis, 5 gliosis and 2 cysts
Ding et al. 2014	Associated the cognitive comportment with subcortical atrophy in patients with TLE	74	All the patients showed generalized atrophy.
Strandberg 2014	The author evaluated the use of MRI in the improvement of epilepsy surgery results	25	The study showed 10 cases with cortical malformation, 3 hippocampal sclerosis, 1 gray matter, 1 white matter and 1 generalized atrophy
Saute et al. 2014	The authors correlated the neuroanatomical findings in children with epilepsy and attention deficit	100	The study showed 1 child with hippocampus changes, 1 with basal nuclei, 1 white matter, 1 brainstem and 1 showed lesion in thalamus and cerebellum
Coan et al. 2014a	The authors studied the changes in the brain of patients with mesial temporal lobe epilepsy and hippocampal sclerosis with functional MRI or only MRI	29	Only 14 patients showed hippocampal sclerosis and sclerosis of temporal lobe
Goldberg et al. 2014	The authors evaluated and compare the brain atrophy in patients with epilepsy and healthy people	41	Only 1 patient showed hippocampal sclerosis, 1 amygdala and 1 basal nuclei alteration
Coan et al. 2014b	The authors studied hippocampal sclerosis by MRI	203	Only 125 patients had hippocampal sclerosis
Keller et al. 2015	The authors analyzed the cortical thickness of patients with temporal lobe sclerosis	115	Only 80 patients showed hippocampal sclerosis

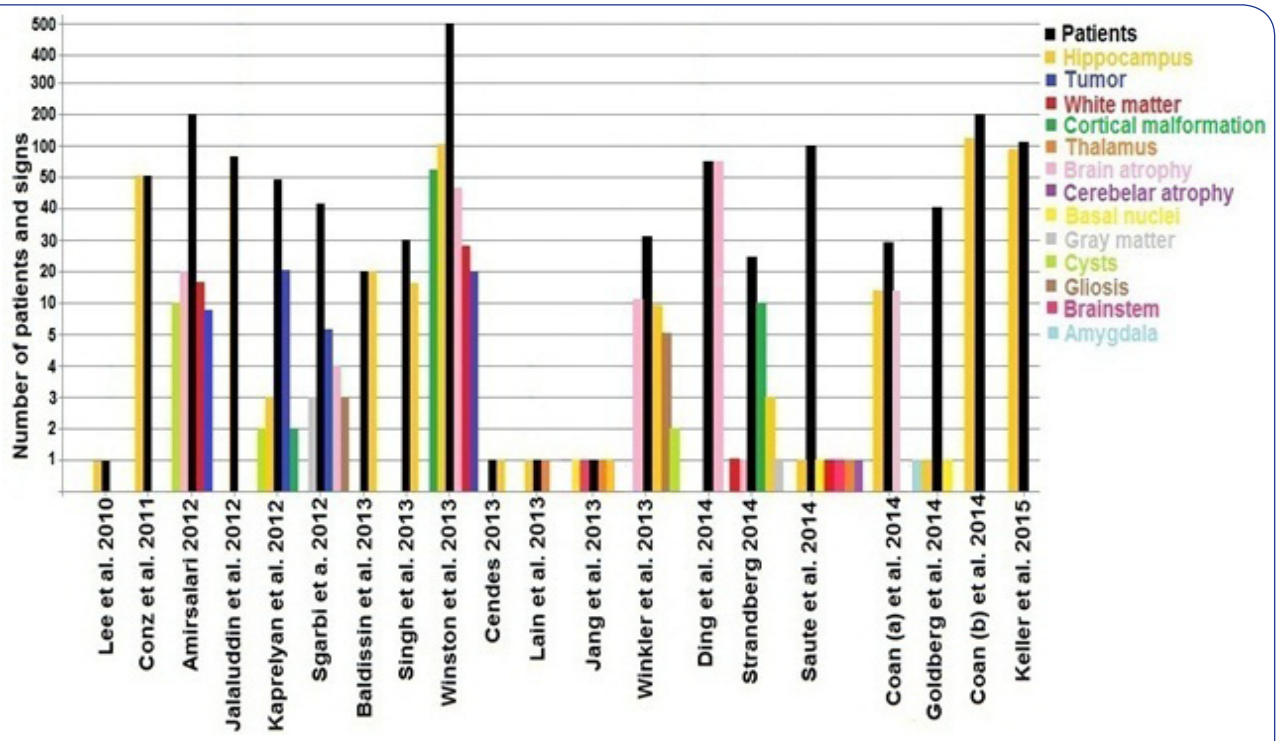

Figure-1 : Number of signs found in the articles reviewed. Relationship between the number of patients and the signs observed in their images acquired using MRI.

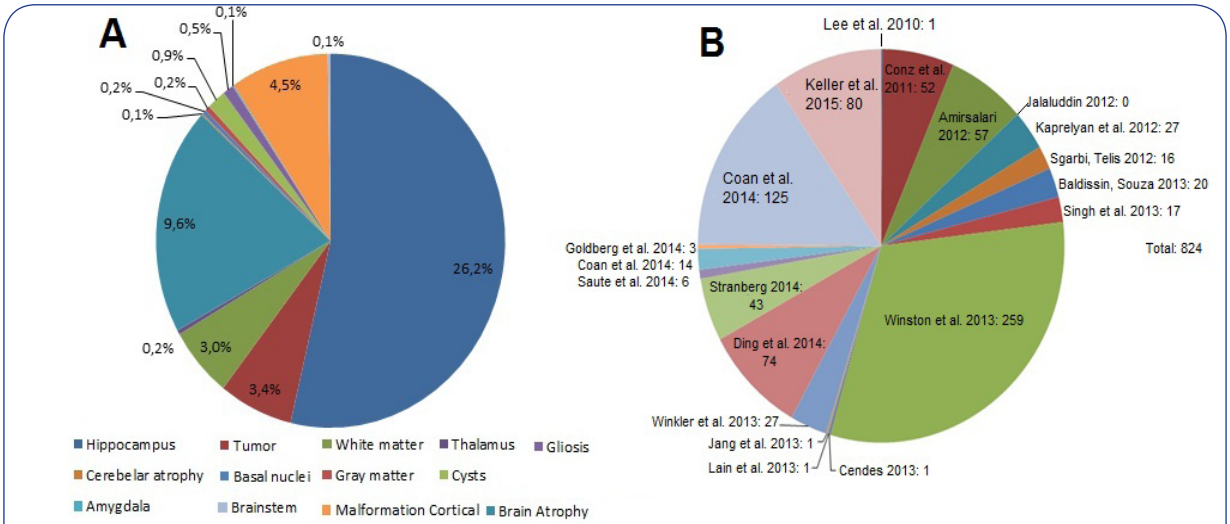

Figure-2: Percentage of each sign found in MRI of patients with epilepsy relative to that observed in all documents selected for this study.The numbers take into account the sample size with respect to (A) the total number of patients (1639 patients), and (B) the total number of patients whose MRI showed variation signs i.e. a total of 824 patients.

Discussion

We conducted a bibliographic study comprising about 50 articles, of which only 20 were selected after applying the inclusion and exclusion criteria. These articles were grouped in table 1 and contain features consistent with the research, i.e., at least a sign of interest. The graph of Figure 2 reported the percentage of signs related to all patients in the articles studied. It is observed that the hippocampal sclerosis corresponds with more than 50% of signs, corroborating with the literature as a common sign, but other signs also need attention by significant incidence as brain atrophy and cortical malformation. The graph in (Figure 1) allows us to observe the imaging results by number of patients. It is possible to check the incidence of hippocampal changes as the largest sign detected in MRI, i.e., has the highest occurrence at 26.2% relative to the total number of samples and includes 430 patients. The high incidence of signs related to the hippocampus was expected because it is an organ belonging to the limbic system and memory functions in addition to being brain region that can activate or develop different patterns of behavior [35]. The hippocampal sclerosis is much described in the literature as a sign of the presence of epileptic seizures. This sign as seen by MRI is essential for the diagnosis and treatment protocol which consists of coronal sections [24]. In this cut it is possible to study the volume of the hippocampus and surrounding structures but one should not exclude other sections because these provide image signs as Lee et al. [15] showed abnormal sign intensity in the left temporal lobe considering the coronal and axial sections.With the same cuts, Sgarbi et al. [20] observed tumors in 6 of 43 patients. The tumors appeared in the 4th highest position in the rank order of the signs reported (Figure 2).

These changes are evidenced by coronal and axial slices [29]. Lain et al. [25] did not find changes on MRI, but after the evaluation of the autopsy was possible to observedpulvinar changes.According to Machado [36] the pulvinar is the largest nucleus in the human thalamus and has connections to the association area of the temporoparietal cortex. Brain atrophy was reported in 6 studies (Figure 1) and is ranked in the 2nd highest position of image signs in MRI as shown in (Figure 2). Brain atrophy is present in 138 patients representing 9.6% of the total number of samples.Among the articles which related to brain atrophy, Ding et al. [28] reported generalized atrophy and extra-hippocampal atrophy in regions that contribute to memory problems. Saute et al. [30] reported atrophy of the brainstem in children with epilepsy associated with attention deficit. Jang et al. [26] reported changes in the cerebellum. Many scientific studies correlate the cerebellum as motor functions, but Koziol et al. [37] suggested the importance of the cerebellum in behavior modulation. Therefore, the changes of the cerebellum can be an important sign of the presence of epilepsy. The basal nuclei have importance in motor control, emotional and cognitive aspects [38]. The graph of Figure 1shows that 3 articles discussed relate changes in the basal nuclei [26, 30, 32]. These changes correspond to 0.2% of the total number of sign samples with 3 patients as reported in (Figure 2(A)). This suggests that basal nuclei lesions may trigger epileptic seizures. This statement is reinforced by Tedrus et al. [39] who did a retrospective study using CT images on the calcification of the basal nuclei and reported a patient subjected to the test for seizures. These changes on basal nuclei should also receive attention when investigating the causes of epilepsy in MRI.

Conclusion

Based on the analyzed articles in this study we highlight that the most reported signs of epilepsy present a change in the

hippocampal region. The recognition that this is one of the brain regions showing more changes in images indicates an area of attention when investigating the origin of epilepsy. However, we must consider the other signs shown in this review, since many cases of epilepsy have no image signs [25, 40] and any sign in the areas shown in (Figure 1) may be indicative of changes in brain structures that develop epilepsy. The results suggest that various forms of epilepsy are possible of study by MRI and other signs observed can help professionals and students to have an overview of the theme of epilepsy, in order to promote the diagnosis with more security.

References

1. Stokes T, Shaw E, Juarez-Garcia A, Camosso-Stefinovic J, Baker R (2004) NICE Clinical Guidelines and Evidence Review for the Epilepsies: diagnosis and management in adults and children in primary and secondary care. London: Royal College of General Practitioners.

2. Oliveira J, Gouveia O (2003). Transtornos psiquiátricos associados à epilepsia. Rev. Psiq. Clín, 30 (5):160-164.

3. ICD-10 - International Classification of Diseases. Available in:www.icd10data.com/ICD10CM/Codes/G00-G99/G40-G47/G40-.Accessed at: 12/03/2015.

4. Fisher R, Acevedo C, Arzimanoglou A, Bogacz A, Cross H et al. (2014) A Practical clinical Definition of Epilepsy. Epilepsia, 55 (4): 475-482.

5. Magiorkinis E, Sidiropoulou K, Diamantis A (2011) Hallmarks in the History of Epilepsy: From Antiquity Till the Twentieth. ISBN 978-953-307-678-2 Hard cover, 338 pages. Naval Hospital of Athens, Greece.

6. Kinnier W, Reynolds E (1990) Translation and analysis of a cuneiform text forming part of a Babylonian treatise on epilepsy. Med Hist, 34(2): 185–198.

7. Gastaut H (1969) Clinical and electroencephalographical classification of epileptic seizures. Epilepsia, 10:Suppl:2-13.

8. Berg A, Berkovic S, Brodie M, Buchhalter J, Cross JH, et al. (2010) Revised terminology and concepts for organization of seizures and epilepsies: report of the ILAE Commission on Classification and Terminology. 2005-2009. Epilepsia, 51(4): 676–685.

9. Carpio A, Hauser W (2009) Epilepsy in the developing world. Curr Neurol Neurosci Rep, 9(4): 319–326.

10. Baudewiga J, Bittermann H, Paulus W, Frahma J (2001) Simultaneous EEG and functional MRI of epileptic activity: a case report. Clin Neurophysiol, 112(7): 1196-1200.

11. Soares F, Lopes H (2000) Tomografia.Computadorizada. CEFET/ SC, Florianópolis.

12. Lenz M, Greess H, Baum U, Dobritz M, Kersting-Sommerhoff B (2000) Oropharynx, oral cavity, floor of the mouth: CT and MRI. Eur J Radiol, 33(3): 203-215.

13. Higgins L, Pomper M (2011) The evolution of imaging in cancer: current state and future challenges. Semin Oncol, 38(1): 3–15.

14. Trentin A, Teive H, Tsubouchi M, Paola L, Minguetti G (2002) Achados tomográficos em 1000 pacientes consecutivos com antecedentes de crises epilépticas. Arq. Neuro-Psiquiatr, Vol.60: no. 2B.

15. Lee J, Kim K, Kim K, Choi M, Lee Y (2010) A case of hippocampal sclerosis diagnosed as cortical dysplasia due to preoperative brain MRI finding. Korean J Pediatr, 53(1): 106-110.

16. Conz L, Morita M, Coan A, Kobayashi E, Yasuda C (2011). Longitudinal MRI volumetric evaluation in patients with familial mesial temporal lobe epilepsy. Front Neurol, 2: 5.

18. Jalaluddin S, Jusoh N, Basahai I, Abdullah M, Karim A (2013) Normalised MRI Volumetry of the Hippocampus among Normal Malay Children and Adolescents. Malays J Med Sci, 20(1): 31-38.

19. Kaprelyan A, Minchev D, Tzoukeva A, Grudkova M, Georgiev R (2012) Use of structural MRi in patients with medically refractory seizures. Journal of IMAB - Annual Proceeding, vol. 18: book 3.

20. Sgarbi N, Telis O (2012) Refractory focal epilepsy: findings by MRI. E II, Vol. XV.Nº 2.

21. Baldissin M, Souza E (2013) Investigation of magnetic resonance imaging texture analysis as an aid tool for characterization of refractory epilepsies. Arq Neuropsiquiatr, 71(12):920-924.

22. Singh P, Kaur R, Saggar K, Singh G (2013) Qualitative and Quantitative Hippocampal MRI Assessments in Intractable Epilepsy. Biomed Res Int, 2013:480524.

23. Winston G, Micallef C, Kendell B, Bartlett P, Williams E (2013) J. The value of repeat neuroimaging for epilepsy at a tertiary referral centre: 16 years of experience. Epilepsy Res, 105(3): 349-355.

24. Cendes F (2013) Neuroimaging in Investigation of Patients With Epilepsy. Continuum, 19(3): 623–642.

25. Lain A, Hedley-Whyte E, Hariri L, Molyneaux B, Nagle K, et al. (2013) Pathology of bilateral pulvinar degeneration following long duration status epilepticus. Seizure, 22(10): 901–904.

26. Jang H, Park H, Mun J, Hwang K, Kim J et al. (2013) Surgical Treatment of Mesial Temporal Lobe Epilepsy in a Patient with Neurofibromatosis Type 1. J Epilepsy Res, 13(1): 35-38.

27. Winkler A, Friedrich K, Velicheti S, Dharsee J, König R, et al. (2013) MRI findings in people with epilepsy and nodding syndrome in an area endemic for onchocerciasis: an observational study. Afr Health Sci, 13(2): 529-540.

28. Ding K, Gong Y, Gupta P, Frol A, McColl R, et al. (2013) Regional atrophy in temporal lobe epilepsy: correlations with cognitive impairment. J. Neurol Disord Stroke, 2(3): 1053.

29. Strandberg M (2014) Advanced clinical MRI for better outcome in epilepsy surgery. Doctoral Dissertation. Neurocentrum, Lund, Sweden.

30. Saute R, Dabbs K, Jones J, Jackson D, Seidenberg M (2014) Brain Morphology in Children with Epilepsy and ADHD. PLoS One, 9(4): e95269.

31. Coan A, Campos B, Beltramini G, Yasuda C, Covolan R et al. (2014 a) Distinct functional and structural MRI abnormalities in mesial temporal lobe epilepsy with and without hippocampal sclerosis. Epilepsia, 55(8): 11 87–1196.

32. Goldberg H, Weinstock A, Bergsland N, Dwyer M, Farooq O (2014) MRI segmentation analysis in temporal lobe and idiopathic generalized epilepsy. BMC Neurology, 14:131.

33. Coan A, Kubota A, Bergo F, Campos B, Cendes F (2014 b) 3T MRI Quantification of Hippocampal Volume and Signal in Mesial Temporal Lobe Epilepsy Improves Detection of Hippocampal Sclerosis. AJNR Am J Neuroradiol, 35(1): 77– 83.

34. Keller S, Richardson M, O'Muircheartaigh J, Schoene-Bake J, Elger C et al. (2015) Morphometric MRI Alterations and Postoperative Seizure Control in Refractory Temporal Lobe Epilepsy. Hum Brain Mapp, 36(5): 1637-1647.

35. Guyton C, Hall J (2011) Textbook of medical physiology. 11 th. Elsevier.

36. Machado A (2005) Neuroanatomiafuncional. 2 ed. Rio de Janeiro. Atheneu.

37. Koziol, Leonard F, Budding, Deborah Ely (2009) Subcortical structures and cognition. Implications for neuropsychological assessment.

38. Packard MG, Cahill L (2001) Affective modulation of multiple memory systems.Curr Opin Neurobiol, 11(6): 752-756.

39. Tedrus GM, Fonseca L, Nogueira E (2006) Calcificação nos núcleos da base na tomografia computadorizada. Correlação clínica em 25 pacientes consecutivos. ArqNeuropsiquiatr, 64 (1): 104-107.

40. Salmenpera M, Duncan J (2005) J Neurol Neurosurg Psychiatry, 76 (3): iii2–iii10.