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How We Approach Epilepsy In Our Medical Group

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Introduction

Epilepsy is a chronic, non-contagious brain disorder that affects people of all ages [1]. Some clinical and epidemiological studies state that approximately 70 million people suffer from some type of epilepsy.

In the United States, 19,181,650 people are affected; in the United Kingdom, it is estimated that 2% develop epilepsy, and up to 30% have a family history of the disease.

According to the 2019 epidemiological health census in Mexico, epilepsy has a prevalence of 10.8–20 cases per 1,000 inhabitants, representing 1.08–2% of the total population [2], meaning an average of 3 million Mexicans suffer from epilepsy.

Sixty percentage of patients respond to first-line anticonvulsant treatment. Approximately 20–25% progress to refractory epilepsy

Our medical group has a national presence with more than 750 offices throughout Mexico. We have more than 34 magnetic resonance imaging (MRI) machines of 0.5 and 1.5 Tesla. All of them comply with current standards. There is an average of two MRI machines in each state and more than five in Mexico City (CDMX) and the surrounding metropolitan area, as well as three PET-CT scanners distributed to provide coverage across the country. We are the largest diagnostic company in Mexico.

Historical memory

Epilepsy can be defined as intermittent damage to the nervous system presumably due to a sudden, excessive, and disordered discharge of brain neurons. The discharge results in an almost instantaneous disturbance of sensation, loss of consciousness, and impairment of mental function, convulsive movements, or a combination of these. A terminological difficulty arises from the diversity of clinical manifestations.

The history dates to Hippocrates [4,5] and the description of different types of seizures was attempted in 1964, and more recently in 2010 and 2017.

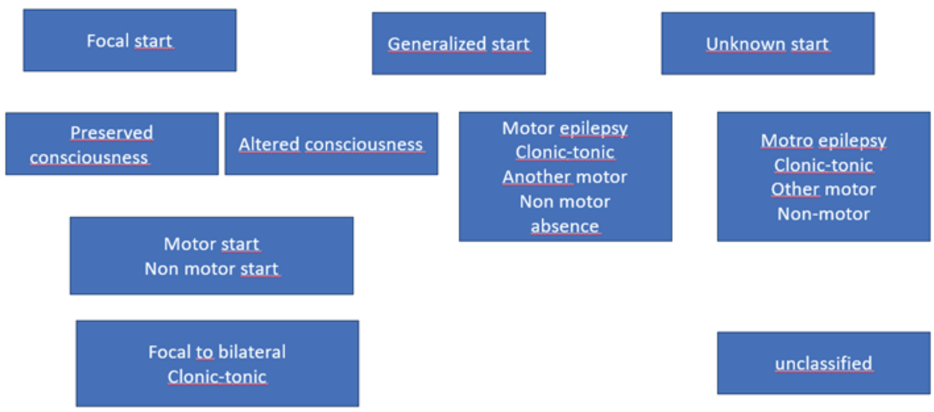

***Table 1**. Summary classification for epilepsy from the league against epilepsy (ILAE)*

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Seizures are defined as the transient appearance of signs and symptoms due to excessive or synchronous neuronal activity in the brain [6]. The first clinical task for experts is to determine whether the event has the characteristics of an epileptic seizure and not a seizure-mimicking clinical case, to define the type of seizure [7].

The classification is useful, firstly, so that physicians speak and understand the same language regarding the patient and their condition. Secondly, it allows for proposing treatment based on seizure type. Thirdly, it helps associate syndromes with seizures, for example, gelastic seizures with hypothalamic hamartoma or epileptic spasms with tuberous sclerosis. Fourthly, it provides patients and their families with a better understanding of their illness. Table (1) corresponds to the operational classification of the International League Against Epilepsy.

Epilepsy study protocol

Magnetic resonance imaging (MRI) helps us to accurately identify the specific focus or foci in order to aid in functional epilepsy surgery. As a definition for consideration in the clinical diagnosis of epilepsy, at least two unprovoked seizures, separated by more than 24 hours, must be present. An unprovoked seizure and a probability of seizure recurrence are also required after two seizures occurring within a 10-year period [8]. Imaging methods include MRI with hippocampal volumetry, proton spectroscopy (PSS), diffusion-weighted imaging, perfusion imaging, and magnetic susceptibility testing. SPECT, PET-CT

Some advantages of identifying the epileptogenic focus using MRI, MRI, electroencephalogram, or videoencephalogram (EEG and VEEG) include the possibility of surgical seizure resolution. A poor prognosis is indicated in patients for whom, despite MRI, MRI, EEG, and VEEG, the epileptogenic focus cannot be located [9], requiring the patient to undergo a second and third course of anti-seizure medication. PET-CT (positron emission tomography using the radiopharmaceutical 68-deoxyfluoroglucose) should be performed during an interictal period, between pathological electrical discharges. PET-CT and PET-MRI are highly sensitive in detecting epileptogenic foci, allowing for precise localization and lateralization, especially in extratemporal locations not demonstrated by other diagnostic methods. They are also useful in patients with failed or newly appearing epileptogenic foci after functional epilepsy surgery. The method's specificity is 95%, while for frontal lobe epilepsy in children it is 92% [10].

How do we do it?

In the medical diagnostic group, the study for diagnosing epilepsy uses EEG, morphological and functional MRI, and PET-CT.

When we exhaust the information on brain anatomy, physiological brain exploration begins with diffusion-weighted imaging (DWI), bold oxygenation level dependent (BOLD) hemoglobin deoxygenation, or glucose concentration using PET-CT. We typically use an imaging protocol with different pulse sequences using T1-weighted, T2-weighted, FLAIR, temporal lobe volumetry, and single- and multivoxel MRI with angulation parallel to the brainstem. (HARNESS-MRI) with approximate exploration of 25 minutes fMRI has been successful in obtaining new forms of contrast between brain parenchyma and lesions, especially in memory and language.

The images are evaluated within the clinical context, EEG findings, and the presence or absence of other abnormalities [11].

We perform coronal T2-weighted images, high-contrast images angled parallel to the clivus, in addition to volumetric T1-weighted images. These have been highly successful in diagnosing mesial temporal sclerosis (MTSS), with a sensitivity of over 90%.

In 71% of patients, we have successfully identified a structural lesion.

Unfortunately, normal MRIs are seen in patients with subtle abnormalities or refractory epilepsy.

In brain PET-CT with 18FDG, there is a decrease in metabolism [12].

In clinical practice, we use this supportive tool specifically, the measurement of the hippocampal asymmetry index—in cases where laterality is in question regarding neurological and/or psychiatric conditions [13]. The formula used is:

$$AI = (VL - VR) / (VL + VR) / (2) \times 100\%$$

The hippocampal asymmetry index is very useful for determining temporal lobe volume

Proton magnetic resonance spectroscopy (PMRS), a non-invasive technique that complements magnetic resonance imaging (MRI) to localize and lateralize epileptogenic foci, has been used primarily in temporal lobe epilepsy. This technique is used to evaluate the brain's biochemical and metabolic content using single- or multi-voxel imaging. We primarily focus on N-acetyl aspartate (NAA), a marker of neuronal health. In patients with epilepsy, NAA levels are often decreased. Choline reflects membrane synthesis or cell turnover; elevated choline peaks are commonly found in areas of gliosis in the temporal lobe. Finally, we calculate the NAA/Choline+(Creatine) This metabolic relationship is one of the most consistent indicators for successfully identifying laterality and determining the affected side and is used in follow-up to the electroencephalogram (EEG) [13].

logical optimization of detonation-gas spraying modes. To obtain high-quality nanocoatings, the problem of analyzing an adequate mathematical model was solved, taking into account a complex of technological and operational factors and their impact on the optimization process. Optimal spraying regimes were implemented for parameters such as particle size distribution and loading depth, barrel filling degree, working gas ratio, spraying distance, justification of the carrier gas, and detonation frequency (number of shots per second), etc. [7].

Thus, by controlling the optimal technological process of forming nanocoatings based on magnesium compounds, it was possible to reproduce not only the intended chemical composition but also to obtain a predicted structure possessing an optimal complex of properties that ensure the stability of the structural adaptability phenomenon. Concurrently, reliable quality in the strength and plastic properties of the nanocoatings was achieved, with variations within a single batch of samples remaining stable at 5–10%.

As can be seen from the comparative research results (Fig. 1), the reference coatings are significantly inferior in terms of tribological characteristics compared to the self-lubricating nanocoatings based on magnesium compounds developed by the authors. Thus, detonation nanocoatings based on magnesium-containing compounds possess high antifriction properties and vastly surpass widely used tungsten-containing tribological materials. As promising coatings, they feature significant adhesion strength and an ability to provide high antifriction behavior through their composition, which, along with self-lubricating properties, opens up possibilities for their application in minimizing wear.

Taking into account the results obtained in papers [8, 9], the developed composite magnesium-containing nanocoatings can be considered for increasing the reliability and operational resource of parts operating under extreme conditions. Their application is justified for improving efficiency at repair enterprises when restoring worn components, which will significantly increase their wear resistance and solve the problem of restoring previously non-repairable parts [10]. As test results indicate, the proposed coatings ensure the operational reliability of tribological joints in accordance with the conditions imposed on new competitive materials obtained by the detonation method [11]. The developed magnesium-containing composite nanocoatings can be considered an alternative to promising materials for service in modern machinery units, including aerospace applications.

Studies on the friction and wear patterns of magnesium-containing composite nanocoatings demonstrate the feasibility of their application to increase the operational reliability and durability of friction parts. It can already be stated that their practical implementation will improve reliability and technical lifespan, and reduce repair costs in the event of operational damage. Components subject to strengthening and restoration include compressor and fan blades, rotor supports, bearing units, crankshafts, seats, disk and oval surfaces, cam mechanisms, sliding bearings, reciprocating pairs, and high-speed, heavily loaded units where the use of traditional lubricants is undesirable.

The presented work is motivated by a growing practical interest in producing coatings from new materials with a controlled phase composition and a functional self-lubricating property. The results stimulate the pursuit of creating new magnesium-containing compositions and open up prospects for developing technologies to obtain scientifically substantiated antifriction self-lubricating coatings. It should be noted that the proposed powder mixture based on magnesium reagents for forming antifriction self-lubricating magnesium-containing coatings can be applied by various technological methods that utilize powder materials.

The development and testing of magnesium coatings, despite the economic difficulties experienced by the country, is a necessary component of the technical and social development of both science and society as a whole.

Findings

On the MRI scan, the brain parenchyma, coposed of neurons, glial cells and blood vessels appears noraml.

The cerebral corte xis highly complex, consisting of specific histological neuronal layers with a thickness of approximately 3 to 5 millimeters (Image 1).

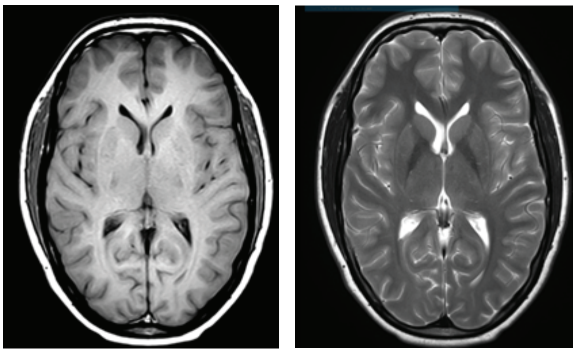
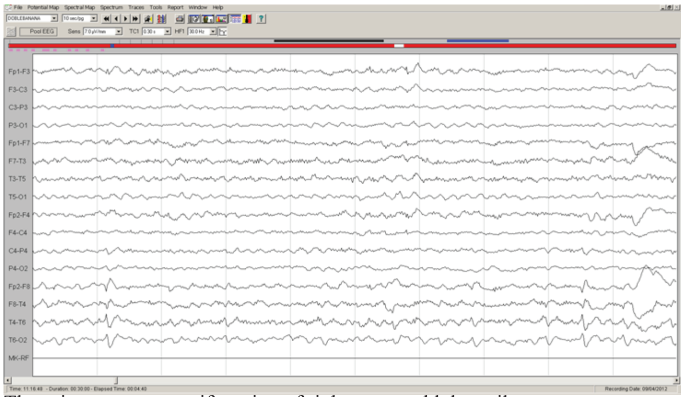


***Image 1**. a y b axial en T1 y T2 images of a mormal brain, showing ventricular asymmetry as a variant, with greater width of the right lateral ventricle*



The seizures are a manifestation of right temporal lobe epilepsy
Courtesy of Noel Plascencia MD head of neurophysiology, Laboratorio medico CHOPO

***Image 2.** Electroencephalogram of a 24 year old patient showing a spike with pase reversal at F8,T4, and T6 in the temporal region of the right cerebral hemisfphere*

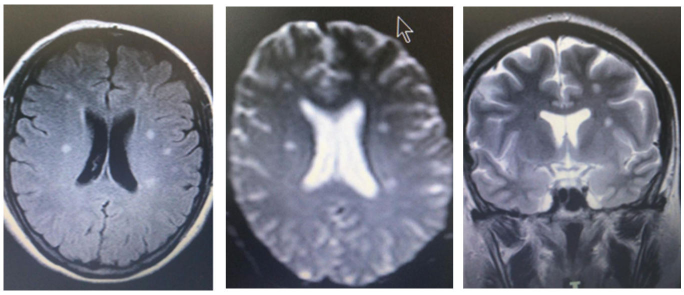


***Image 3.** Electroencephalogram of a 24 year old patient showing a spike with pase reversal at F8,T4, and T6 in the temporal region of the right cerebral hemisfphere*

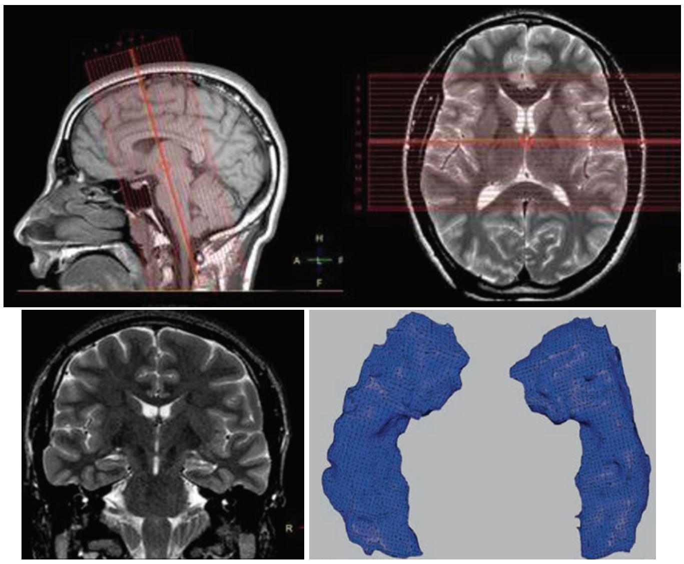


***Image 4.** a, b, c and d acquisitions using thin slice imaging of de hippocampus; 3D structure of the hippocampi*

EEG is very useful initial diagnostic method; the example shows a 24 year old patient expreiencing epileptic seizures at the beginning and end of the tracing (Image 2).

Lesions affecting the brain or cerebral cortex are visulized using the protocols we employ (Image 3).

Hippocampal volumetry is preforme don coronal slices angled parallel to the plane of the clivus (Image 4).

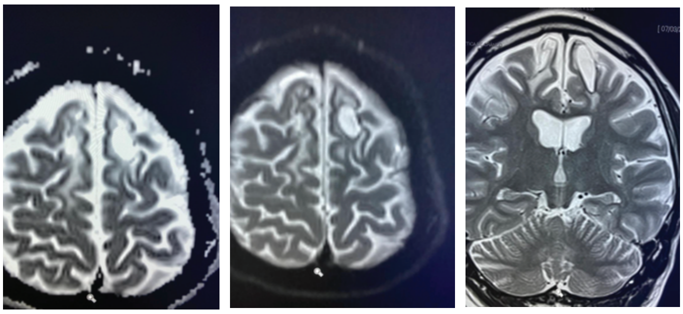


***Image 5**. Aaxial and coronal T2 weighted images of a 34 years old patient with a history of a motro vehicle accident, seizues, and a bilateral frontal extra temporal focus*

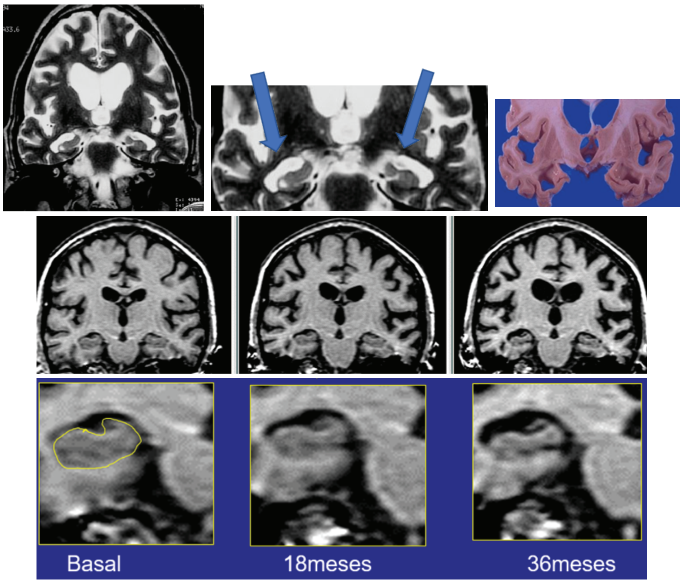


***Image 6**. a,b & c pathological specimen showing reduced hippocampal volume; 76 year old patient with a history of dementia .*
36 month follow up of hippocampal volume d,e,f,g ,h i (courtesy of Bernardo Boleaga MD)

Patient with an extra temporal epileptogenic focus and a frontal lobe lesions secondary to motor vehicle accident (Image 5).

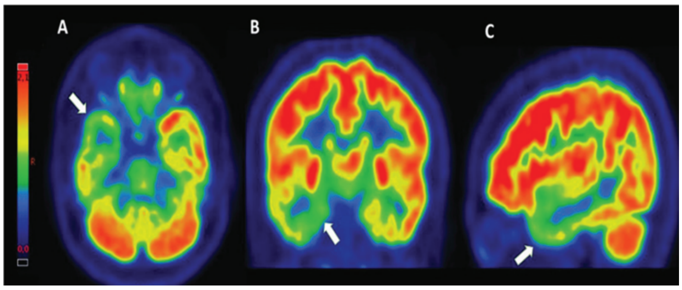
Hippocampal atrophy (Image 6)

PET-CT is also an important tool during the interictal period; example taken from the literature (Image 7).

Conclusion

It is important to understand the mechanisms of epileptic seizure generation through clinical evaluation, neurophysiological studies, and imaging.

It is important to evaluate the brain morphologically and functionally in order to identify foci in the temporal and/or extratemporal lobes.



***Images 7**. a,b & c 18FDG PET-CT showing an area of hypotetabolism in the right temoral lobe , right temporal epilepsy.*

It is important to consider the epileptogenic focus in order to provide the treating physician with possible definitive medical and/or surgical treatment.

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