Hemispherectomy in Treatment of seizures: current perspectives of the indications, techniques and complications - Literature Review

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Resumen

Introducción: A hemisferectomía es un procedimiento valioso en el tratamiento de trastornos convulsivos causados por desordenes hemisféricos unilaterales. El hemisferectomía anatómica se ha utilizado para este fin desde 1938, sin embargo, se abandonó este procedimiento después de informes de complicaciones postoperatorias causadas por hemosiderosis superficial, ependimitis e hidrocefalia obstructiva. Así que, se ha mostrado en la literatura modificaciones en las indicaciones y técnicas de hemisferectomía anatómica cuya finalidad es la de reducir la incidencia de esta complicación sin dejar de lograr control de las convulsiones. Sobre la base de la literatura, la hemisferectomía mejora la calidad de vida de los pacientes que tiene la indicación para realizar este procedimiento, ya que permite reducir la frecuencia de las convulsiones, si tónica o átona, tónico-clónicas **Objetivo:** El objetivo de esta revisión de la literatura es discutir los detalles técnicos, modalidades, riesgos, complicaciones, resultados y de pronóstico de hemisferectomía basado en la revisión crítica de la literatura. **Casuística y Métodos:** Se realizó la consulta bibliográfica, utilizando la base de datos MEDLINE, LILACS, SciELO, que utiliza el lenguaje como criterios de selección, la elección de los artículos recientes preferiblemente en portugués, español o inglés. **Conclusión:** Según las referencias, hemisferectomía es un procedimiento con buen resultado para las personas con convulsiones derivadas cuando está indicado para casos seleccionados y la tasa de éxito no es proporcional a la extensión de la resección del tejido neuronal. A mayor resección puede o no reducir la frecuencia de las crisis, sin embargo, la incidencia de la morbilidad puede ser mayor.

Palabras clave: Cirugía Epilepsia, Convulsiones, Hemisferectomia.

Abstract

Background: The hemispherectomy is a valuable procedure in the management of seizure disorders caused by unilateral hemispheric disease. The anatomical hemispherectomy has been used for this purpose since 1938, however, it was abandoned after reports of postoperative complications caused by superficial hemosiderosis, ependymitis and obstructive hydrocephalus. So that, it has been showed modifications in the techniques of hemispherectomy whose the purpose is reduce the incidence of this complications while still achieving seizure control. Based on literature, the hemispherectomy improves the quality of life of patients that has the indication to perform this procedure because it allows reducing the frequency of seizures, whether tonic or atonic, tonic-clonic. **Aim:** The aim of this literature review is discuss the indications, technical details, modalities, risks, complications, results as well de prognosis of callosotomy based on critical literature review and the authors experience. **Casuistry and Methods:** It was performed bibliographical consultation, using the databases MEDLINE, LILACS, SciELO, utilizing language as selection criteria, choosing preferably recent articles in Portuguese, Spanish or English. **Conclusion:** According to references, the functional hemispherectomy has a good outocome for those with seizures arisin when indi-

cated to selected cases and the success rate is not proportional to the extent of neuronal tissue resection. So that, a greater resection cannot necessarily reduce the seizure frequency, however the morbidity may also be larger.

Key words: Epilepsy/surgery, Seizures, Hemispherectomy.

Introduction

Hemispherectomy is a palliative surgical approach that aims to control potentially harmful seizures, for instance, atonic or drop seizures, preventing the spread of epileptic electrical activity[1,2,3,18,27].

This technique was presented to epilepsy surgery in 1938 by Mckenzie[44], however the first consistent description about this procedure it happened in 1950 by Krynauw[36], whose essay described the use of this technique to remove the brain hemisphere with hemiplegic infantile in 12 children and it showed control of seizures associated to a recovery of cognitive function considered excellent by the standards of the time. Even though there are benefits in this procedure, the anatomical hemispherectomy was showed high rates of late complications that culminated in its disuse of this technique, due to its important morbidity and mortality[1,2,3,4,49].

In spite of this perspective of disuse of hemispherectomy around 1960s, it has been growing the number of papers about this surgical procedure, culminating in the adaptation of techniques and indications of hemispherectomy and, consequently, reduction of risks and complications resulting from this surgery. So that, the first description of the technique hemispherectomy based in removal of epileptogenic hemisphere (anatomical hemispherectomy) evolved to many techniques of functional hemispherectomy, whose it is based in the disconnection between the epileptogenic hemisphere and contralateral hemisphere and deep brain structures without creating a cavit[1,2,3,24,21,23,48,54,55,57,58,61].

The functional hemispherectomy was initiated with the introduction of the hemispherotomy[24], and 3 different approaches were described by Delalande[24], Schramm[54] and Villemure and coauthors[58,59,60]. However, although the hemispherectomy has been showed a reduction in the complications rates and a improve in the efficient of treatment in children affected by epileptic syndromes hemispherical intractable, until thirty per cent of the patients will develop recurrence of the seizures[4,31].

Tradicionally, the ideal candidates to be submitted the hemispherectomy have severe unilateral cortical disease associated to ipsilateral findings in the neuroimaging exams and electrophysiological studies[33,35,46,47,57]. So that, the use of hemispherectomy in unilateral focal process, like Rasmussen syndrome, Sturge-Weber sydrome, hemimegalencephaly, extensive vascular insults hemispherical and trauma cranioencephalics are likely to better control of the seizure when compared to diffuse or bilateral processes such as malformations of cortical development.

This article aims to clarify the indications, techniques, riisks and complications related to hemispherectomy described in the literature at moment, allowing the better knowledge of the techniques existing until the moment and considerations about the late complications of this procedure. The late complications are related to residual cavity surgery which was in contact to the wall of lateral ventricle through the foramen of Monro causing recurrent bleeding that results in hemosiderosis, epididymitis of wall ventricle and consequently cerebrospinal fluid flow obstruct associated to cranial nerves[1,2,3].

Casuistry and Methods

It was performed bibliographical consultation, using the databases MEDLINE, LILACS, SciELO, utilizing language as selection criteria, choosing preferably recent articles in portuguese, spanish or english.

Hemispherectomy techniques

Anatomical Hemispherectomy

The first step is open the Sylvian fissure with care to avoid any catastrophic injures to the contralateral vessels[8,28]. After openning the acess through the Sylvian fissure, it is necessary to identify, dissect, clip and divide from lateral to the lenticulostriate branches of the basal ganglia of ipsilateral middle cerebral artery[8,20,28,36]. Similarly, it is necessary to divide from proximal to the origin of the calloso-marginal artery of the ipsilateral anterior cerebral artery[2,8,28,36]

In the second step, a cottonoid is placed in the foramen of Monroe to protect the underlying choroid plexus and prevent the blood and debris entering the ventricular system for what the callosotomy by interhemispheric aprroach is performed. So that, for the implementation of the callosotomy can be used the microdissection, coagulation, and aspiration techniques from the genu anteriorly to the splenium posteriorly[2,8,28,36].

Lastly, the fronto-basal white matter is divided through the anterior part of the lateral ventricle[8]. So that, the temporal stem is dissected, while the posterior communicating arteries are clipped and divided at its P3 segment[8]. Stressing that the amygdala and the hippocampus are removed employing sub-pial dissection with special care on the preservation of the occulomotor nerve[2,8,28,36]. About the exposed choroid plexus, it may be coagulated or left untouched, according to the surgeon's preference, while the ipsilateral basal nuclei and thalamus may be left in situ for better motor outcome[(2,8,28,52)].

Rasmussen's Modification (Functional Hemispherectomy)

The temporal lobe is removed with two cortical incisions, one on the superior temporal gyrus, running in parallel to the Sylvian fissure, and a second one placed on the dorsal temporal lobe, down to the temporal base, perpendicular to the first one and localized 8cm from the temporal lobe pole[8] (Figure 1 a, 1b, 1c, 1d). The hippocampus, the parahippocampal gyrus, the medial part of the uncus, and the lateral part of amygdala are removed with the ultrasonic aspirator after opening the tem-

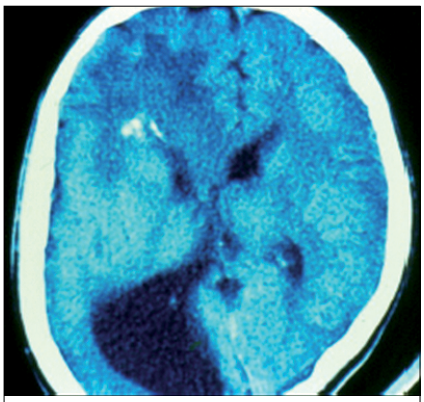

Figure 1a. Brain CT shows of child with hemimegaencphalia and multimodal epileptic crisis.

Figure 1b. The craniotomy for hemispherectomy should be hudge and enough to access all lobes.

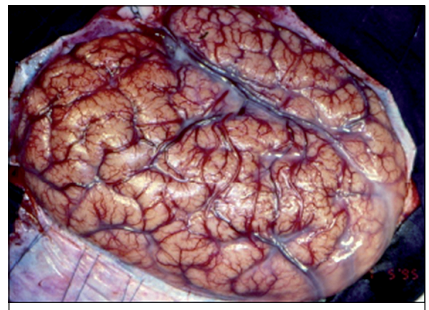

Figure 1c. After removal of boné flap we can identify the typical surfasse of megaencephalia.

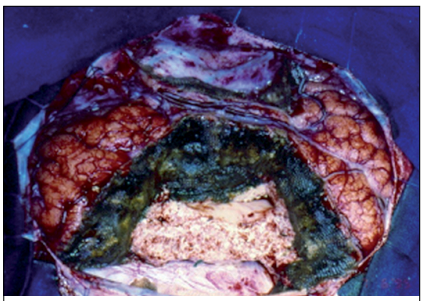

Figure 1d. After functional hemispherectomy showing removal of central bloc and temporal lobe, callosotomy preserving the frontal and occipital pole.

poral pole, stressing that the ipsilateral third cranial nerve should be protected. After this, the next step involves to provide the access into the ipsilateral lateral ventricle through the resection of the suprasylvian cortex by two parallel incisions perpendicular to the sylvian fissure[8,28,50,57,61]. So that, this step ends with transection of the corona radiata[8].
After to removal this cortical block, (Figure 2 a, 2 b) the next step is the completion of the transventricular parasagittal callosotomy[8]. The pericallosal artery constitutes the medial border of the resection, while working at the knee of the corpus callosum. The remaining anterior and posterior callosal fiber tracts are disconnected from the ependymal surface toward the cingulate gyrus[8,28,50,57].
Finaly, it is necesary to resect the anterior and posterior concections of the frontal lobe and parieto-occiptal lobes[8,57]. So that, the anterior cerebral artery, the superior circular sulcus and the M1 segment of the middle cerebral artery are the borders for the transsection of the corona radiata. The posterior disconnection takes place after fully opening the Sylvian fissure and promptly elevating the parietal opercula[28,50]. (Figure 3a, 3b).
As a result the end of this technique, the disconnection line extends from the posterior part of the lateral ventricle opening, to the trigone of the temporal pole cavity[8,28,50].

Delalande's Modification (Vertical Parasagittal hemispherotomy)

This thechnique innitiate with in a linear transverse incision, whose opennig allow a small parasagittal frontoparietal craniotomy with 3×5 cm localized 1-2 cm from midline and 1/3 anterior and 2/3 posterior to the coronal suture[8,21,22]. After the incision, it is necessary reach the ependyma of the lateral ventricle through a limited cortical resection in the frontal cortex, whose dimensions are 3x2 cm[8,21,22]. Upon entering the lateral ventricle, the surgeon identifies the foramen of Monro and the posterior aspect of the thalamus, while the corpus callosum is found by following the roof of the lateral ventricle mesially[8,21,22]. So that, the body and splenium are resected to the roof of the third ventricle and the arachnoid cisterns are exposed[21]. Posterior disconnection of the hippocampus is achieved by cutting the posterior column of the fornix at the level of the ventricular trigone[21,22]. The vertical incision is performed lateral to the thalamus, guided by the choroid plexus of the temporal horn, then following the temporal horn from the trigone to most anterior part of ventricle, keeping the incision in the white matter[8,21,22].
The callosotomy is then completed by resecting the genu and the rostrum of the corpus callosum to the anterior commissure[8,22]. The next step is the resection of the posterior part of the gyrus rectus, which will allow the visualization of the anterior cerebral artery and optic nerve and provide enough space for the last disconnection step - a straight incision anterolaterally through the caudate nucleus from the rectus gyrus to the anterior temporal horn[8,21].

Villemure's Modification (Lateral Perinsular Hemispherotomy)

The lateral perisular hemispherectomy is a lateral disconnection procedure of the fronto-parieto-temporal opercular cortices[8,21,43,58]. A barn-door skin incision is made, centered on the insula,

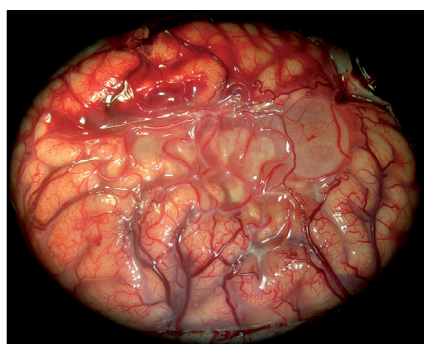

Figure 2a. Cortical surface, in a surgical view of a child harboring on Rasmussen encephalitis.

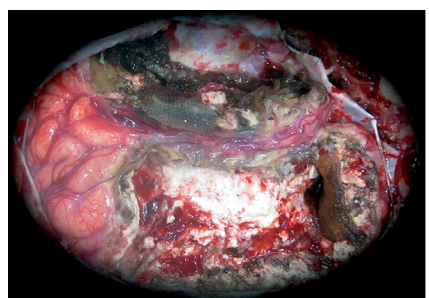

Figure 2b. Surgical view after functional hemispherectomy: callosotomy, temporal lobectomy and removal of central block.

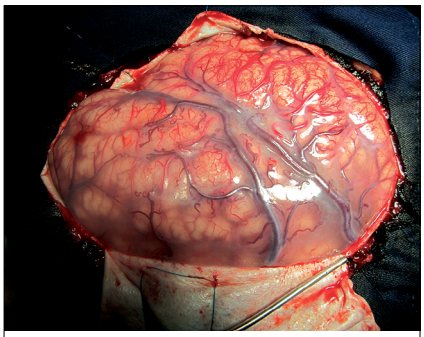

Figure 3a. Surgical view of a case of micropoligyria in child with polimodal epileptic crisis.

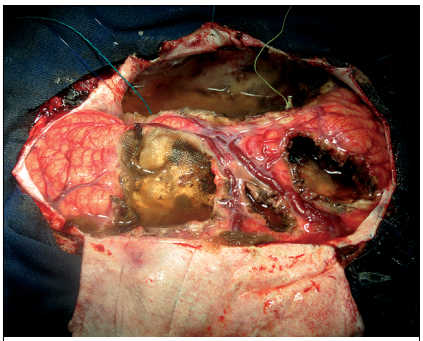

Figure 3b. Surgical view after functional hemisperectomy.

with a bone window from the coronal suture, to 3-4 cm posterior to the external auditory canal[21,58]. The inferior part should be just above the middle fossa, and ideally should go high enough, to the mid-convexity, to provide access to the suprasylvian circular sulcus. Adequate exposure would provide access to the brain 2-2,5 cm below and above the sylvian fissure. The dura mater is reflected either caudally or rostrally[8,21,43,58].

This technique is divided into three phases: the supra-insular, the infra-insular, and the insular phase. The subpial resection technique is employed during all the phases of this procedure[8,21,58].

In the supra-insular phase, the resection of the frontal and parietal opercula is carried out, leaving the underlying insular cortex completely exposed[8,21,43,59]. Transection of the corona radiata is performed while opening the lateral ventricle from the frontal horn to the trigone. All tissue entering the callosum from the medial wall is transected, in order to perform a transventricular parasagittal callosotomy[21,59]. The orientation and localization is confirmed with the falx, the pericallosal vessels and the cingulum[8,21,59]. At the level of the splenium, the extension of the medial incision anteriorly to reach the choroidal fissure will interrupt the fimbria-fornix and disconnect the hippocampus[8,43,59]. The last step of this stage consists of disconnecting the frontal lobe just anterior to the basal ganglia, going from the rostrum in the direction of the sphenoid wing, while staying in the frontal horn[21,58]. During the infra-insular phase a temporal lobotomy is performed (resection of the temporal operculum, transection of the temporal stem, uncus, and removal of the amygdala and the anterior hippocampus)[8,59]. At this stage, if the resection is maximal, the optic tract is visible[43,59]. Finally, during the insular phase the insula can be resected by subpial aspiration or undermined with an incision at the level of the claustrum/external capsule[21,58,59].

Schramm's Modification (Transsylvian Functional Hemispherotomy)

The skin incision is curved from anterior to the tragus up to the superior frontal area incision and the temporalis fascia is opened in the same way[2,8,21]. The bone flap, whose dimensions is 4x5 cm, is placed just above the Sylvian fissure with the usage of neuronavigation. The inferior and anterior borders are formed by the temporal operculum and the limen insulae, respectively. The anterior border is 5 cm anteriorly, and the pulvinar's projection represents the posterior border[6,8,21].

The Sylvian fissure is widely opened to expose the circular sulcus and insula, as well as all branches of the middle cerabral artery are identified and pro-perly exposed and skeletonized[6]. In order to perform an unco-amygdalo-hippocampectomy, the temporal horn is opened from the inferior circular sulcus[6,21].

The next step involves the transection of the long fibers of the corona radiata, as a consequence of the opening of the ipsilateral lateral ventricle in its entire length. So that, the insular cortex is visible and may be resected with segurancy[8].

Lastly, it is necessary perfom the mesial disconnection, whose procedure involves disconnection of the fronto-basal white matter fibers followed by disconnection of the corpus callosum, and concerns disconnection of the occipital and parietal white matter fibers[6,8,21].

Other techniques

Regarnding to anothers variations of hemispherectomy, it has been described the cerebral hemicorticectomy[64], the hemispheric deafferentation, transcortical subinsular hemispherotomy[54,62], or the transopercular hemispherotomy[21].

Considerations about the use of neuronavigation

In spite of the anatomy is similar in different people, it is necessary to consider anatomic variation in some patients, and hence, the landmarks of hemis pherotomy more difficult to find. So that, some centers use neuronavigation as a solution for this situation once the use of neuronavigation implies in the reduction in size of the craniotomy. An example is the advantageous usage of a neuronavigator in hemimegalencephaly cases, where the anatomical distortion could be easily misleading[28].

Selection of patients

The selection of the patients directly implies in the success of the hemispherectomy, once different factors have to be considered, such as the intractability of the patient's epilepsy, the etiology of the seizures, the type and localization of seizures, the age of the patient, the age at the surgery, the radiological and neurological findings[21,33,35,41,46].

Even though, traditionally, the ideal candidates to be submitted the hemispherectomy have severe unilateral cortical disease associated to ipsilateral findings in the neuroimaging exams and electrophysiological studies[33,35,41,46,47], it is still a discussion question if the presence of bilateral abnormalities in the preoperative in magnetic resonance, positron emission tomography or electroencephalogram of scalp is really associated to worse result postoperative in the hemispherectomy[16,30,51,56,64]. So that, It should be also noted papers that suggest the hemispherectomy surgery may be offered in cases where there is bilateral disease with the hope that antiepileptiform medication can control the contralateral hemisphere seizures. Furthermore, it is also offered at times as a purely palliative procedure for severe cases with bilateral seizure onset

when one side predominates[16,38,39,40,42].
At the moment, the patients being indicated for hemispherectomy needs to comply with theses criterias:

- Patients with medical intractability of seizures[3,18,19,21,27].
- Patients with contralateral hemiplegic is a relative criteria, once if hemispherectomy is done prior to maximal hemiplegia, the digital dexterity and foot tapping may be lost, but the patient will be able to walk and use proximal muscles of the upper limb. So that, although this loss of function may have to be accepted as the cost of control of debilitating seizures and cognitive decline, in other cases the hemispherectomy may be done when the distal power of upper and lower limbs become completely lost[3,19,21].
- Neurodevelopment retardation is usually present due to the interference of frequent seizures on the developing normal hemisphere. So that, this would therefore be a relative prerequisite for hemispherectomy[3,19,38,39,40].
- Patient with the hemisphere contralateral to the hemiplegic should be demonstrated by radiological (MRI/CT) and functional (scalp EEG, EEG video telemetry, PET, SPECT) imaging to have a diffuse abnormality[3,9,19,39,46,47].
- Patient with the remaining hemisphere should be normal to have a good result following seizures. Spread of epileptiform discharges to the normal hemisphere on EEG or even rare independent discharges on the normal side however does not imply a poor response to surgery[3,19,39].

Regarding to the indications of hemispherectomy in childhood, it is necessary to evaluate a few considerations:

- Pediatric age group (preferably below 9 years of age) except for post infarct sequel[11,12,13,14,15].
- That is important to remember that hemispherotomy is a procedure that is usually performed in the pediatric age group where a significant recovery due to neuronal plasticity may be expected. Adults may also often have the same degree of recovery[11,14,15].
- That is necessary to be considered the noxious effects of frequent uncontrolled seizures, the plasticity of the brain and the high doses of antiepileptic medications on the developing brain[11,12,21].
- That is necessary to be considered the social implications of a debilitating disease and the lost time at schooling due to the disease[15].
- That is necessary to be considered the morbidity of a major surgery at a young age and the possibility of increased neurological deficits in some cases needs to be well appreciated and weighed against the substantial gains offered by surgery towards seizure relief and long-term functional outcome[11,12,15,21].

Epileptogenic evaluation for surgery

Evaluation for surgery should involve interictal electroencephalogram (iEEG), interictal SPECT, magnetic resonance imaging (MRI) analysis, and age-appropriate neuropsychological/developmental assessment. The intracranial EEG may be imperative in loca-lization of the correct focus of seizure, indicating a complementar surgery after a hemispherectomy[1,2,3,15,45,46,59]. Functional MRI and EEG may be useful and should be included actually in the protocols of seizure foci investigation[45].

Combined approaches

Regarding to choose of the surgical combined hemispherectomy approaches, it is depending on the kind of technique the neurosurgeon prefer, pre-operative electrographic, neuropsychological, image evaluation the functional hemispherectomy may associated with procedures like anatomical hemispherectomy[25], callosotomy, hippocampectomy, anterior and posterior comissurotomy and others[1,2,3,5,10,11,12].

Risks of hemispherectomy surgery

Although lasting complications rates of hemispherectomy are very variable on this type of epilepsy surgery, the presence of contralateral homonymous hemianopsia, hemiparesis, postoperative akinetic state, hemiparesis, apathy and sometimes aggression, buccal apraxia manifesting as drooling of saliva, memory deficits and persistence of seizures are risks to be considered during the surgical act[11,12,13,14,15,38,40,46].
Regarding to the reason for hemispherectomy failure, it should be highlighted that it is not always apparent for an individual case[38]. So that, among the reasons persistence of the seizures in outpatients follow-up of hemispherectomy surgery include: technical error implying in the failure to adequately disconnect or resection the entire hemisphere; misdiagnosis implying in the unrecognized seizures emanating from the contralateral hemisphere; or the progression of disease implying in the development of a new seizure focus in the contralateral hemisphere[16,38,39,42].
About the hemiparesis, it should be highlighted that it is generally more important in the upper than in the lower extremities. In a case series described by Ribaupierre et al.[21], in 2004, was studied the quality of life after hemispherotomy and it showed that 84% of the children were able to walk either alone or with help, and all children who were able to walk before surgery retained the ability to walk. However, the etiology shoul be considered, so that Bode et al[7]. showed bigger distal extremity motor loss in patients with perinatal strokes compared to other epilepsy etiologies, irrespective of time of epilepsy onset or surgery.
Regarding to the intraoperative risk of bleeding, Jonas et al.[33] and Devlin[25] compare in their papers the bleeding among the different diseases. So that, their results showed a significant bigger in blood loss intraoperative in patients affected by hemimegalencephaly when compared to another diseases. Furthermore, the acumulus of clots in the third ventricule and in lateral ventricule may be observed in many cases of anatomical hemispherectomy[1]. Stressing that the cronic bledding close the wall ventricle implies in high rates of hemosiderosis and others lasting complications[1].
Regarding to the risk of meningitis, Almeida et al.[1], Ribaupierre & Delalande[21], Kossoff et al.[35] and others authors suggesting the presence of low-grade fever can be seen as well as other symptoms of “aseptic meningitis” such as lethargy, decrease in appetite, and irritability after the procedure. However, Hillier et al., Drool et al. and others authors defend the idea that in these cases of aseptic meningitis there are only a lack of isolated pathogen once there is no definitive test that demonstrates the absence of infecciciosos agents.

Results

Guénot[32], in 2004, after reviewed many types of procedures for epilepsy conclude that temporal resection is an efficient and scientifically validated treatment of drug-resistant temporal lobe epilepsy. So that, the extra-temporal resections, hemispherotomy, and palliative surgery often allow cure of epilepsy, or a decrease of seizure frequency. Regarding to control of the seizures, it showed that In spite of the anatomical hemispherectomy is a proceddure that presents a high rates of seizure control, it is associated to a increased mortality and morbidity by late complications.

Schramm et al.[52], in 2001, described the results of the keyhole transsylvian hemispherectomy aproach in a case series (n = 20), whose the mean follow-up period was 46 months. In spite of it showed a mortality, temporal cyst and infection rates of 5% (n = 1) each, it showed that 88% of patients were in Engel Outcome Class I, 6% in Class III, and 6% in Class IV. Regarding to the technique approach, the operation time was significantly shorter (avarage of 3,6 h) than with the Rasmussen technique (avarage of 6,3 h) and 25% shorter than with the transcortical perisylvian technique (avarage of 4,9 h). Furthermore, the proportion of patients requiring blood replacements was lower (15 *versus* 58%), as was the mean amount of transfused blood.

Villemure & Daniel[58], in 2006, described the results of the periinsular hemispherectomy aproach in a case series (n = 43), whose the mean follow-up period was 9 years. It showed a mortality, hydrocephalus and hemorrage rates of 2% (n = 1), 2% (n = 1) and 5% (n = 3), respectively. Regarding to control of seizures, it showed that 90% of patients were in Engel Outcome Class I, but when compared the etiology this essay described that patients affected by Rasmussen syndrome, vascular diseases and hemimegalencephaly presented 90%, 93% and 80% of patients with Engel Class I, respectively. However, The authors did not differentiate between cortical dysplasia and hemimegalencepaly in their analyses in these series.

Kestle et al.[34], in 2000, described the results of the periinsular hemispherectomy aproach in a case series (n = 11), whose the mean follow-up period, age at surgery and seizure onset to surgery was 3 years, 4,8 years and 4,3 years, respectvely. It showed 0% (n = 0) of incidence rates of complications like hemosiderosis, deaths, hidrocephalus and epiditimits related to the surgery. So that, it showed useful hand function preserved in 91% (n = 10) associated to behavior difficult in 27% (n = 3) and developmental delay in 63,7% (n = 7). About the diagnosis, this essay was constituted by Rasmussen syndrome (n = 1; 9%), Sturge-Weber syndrome (n = 1; 9%); cortical dysplasia (n = 5; 45%), hemimegalencephaly (n = 2; 18%), porencephaly (n = 1; 9%) and pachygyria (n = 1; 9%).

Devlin et al.[25], in 2003, described the results of the functional associated to anatomical hemispherevtomy aproach in a case series (n = 33), whose the mean follow-up period and age at surgery was 3,4 years and 4,25 years, respectvely. It showed 9% (n = 3) of incidence rates of hidrocephalus associated to difficulty with expressive language in 18,2% (n = 6), improved the hemiparesis in (n = 5), improved the behavior disturbs in (n = 17) and deteriorate the visual field in (n = 13) related to the surgery. Regarding to control of seizures, 52% (n = 18) were seizure free, 9% (n = 2) experienced rare seizures, 30% (n = 10) showed > 75% reduction in seizures and 9% (n = 2) showed < 75% seizure reduction or no improvement. However, when compared the etiology this essay described that patients affected by Rasmussen syndrome, vascular diseases and hemimegalencephaly presented 40%, 100% and 27% of patients with Engel Class I, respectively. It should ben noted that the authors did not differentiate between cortical dysplasia and HME in their analyses in these series, and they did not differentiate between Rasmussen syndrome and Sturge-Weber syndrome in their analysis.

Complications of hemisferectomy surgery

About the consequences of hemispherectomy surgery, many complications may be listed like a hemosiderosis, hidrocephalus, cerebralspinal fluid leaks, intracranial postoperative hematomas, osteomielitis, epiditimitis, trivial head traumas, infection, Hypothermia, "aseptic meningitis", neurological deficits, hemiparesis[1,2,3,27,35,38,40].

Cook et al.[17], in 2004, showed in a case series of comparation of anatomical hemispherectomy, functional hemispherectomy, and hemispherotomy. So that, it showed no significant differences between the 3 groups once 71% of patients overall being seizure free at 2 years after surgery. However, there was a slightly better outcome in the hemispherotomy group (83%) compared with the functional (73%) and anatomical (59%) hemispherectomy groups.

In the literature has been observed a low rate of mortality associated a anatomical and functional hemispherectomy surgery, ranging from 2% to 7%[1,4,6,8,10,18,27,33,35,38,40] and ranging from 0% to 4%[1,2,3,7,10,34,46,52,5357,58,59,60,61], respectively. Furthermore, a seizure free rate of 81% was described in 2004; this is being related to an intraoperative technology of the modern era. So that, the most frequent of all the complications in the anatomical hemispherectomy surgery is the hydrocephalus, was observed in a rate from 9% to 81%[17,21,26,29,37,38,39,40] aginst the incidence rate of functional hemispherectomy complications that raging from 0% to 16%[10,25,34,55].

Future on hemisferectomy

In spite of there are studies in the literature emphasizing the role of endoscopic procedures for epilepsy surgery, the diferent disconnection approaches are initial and controversial[3], once in our opinion it not possible to infer that a specific technique of hemispherectomy has less morbidity or better outcome if results are not adjusted for different causative pathologies. The literature review showed that there are none or low rates of patients that developed superficial cerebral hemosiderosis related to functional hemispherectomy often seen following the classical anatomical hemispherectomy[1,2,3,57,58,59,60,61]. Furthermore, 82% of patients have been presented seizure-free since hospital discharge while another 11,5% have had at least 80% reduction in their seizure frequency, as well as the majority of patients have shown an improvement in their intellectual capacity and sociability[1,17,61].

Conclusions

Based in the literature, we concluded that hemispherectomy is a efficient

procedure regarding to the control of the seizures when indicated to selected cases. However, although the success rate has been presented as not proportional to the extent of neural tissue resection[1,2,3,18,21,61], the morbidity and complication rates has been presented as proportional to the extent of neural tissue resection. So that, the evolution of the hemispherectomy techniques culminate in the disconnection procedures and consequently it results in a decrease in short- and long-term complications.

Regarding to the treatment of refractory epilepsy, the comparison between the anatomical and functional hemispherectomy showed comparable result in control of the seizures for anatomical hemispherectomy (85% control of hemispheric seizures rate for resection procedure against 82% for disconnection procedures)[1,3,21,61], however with higher rate of permanent complications that functional hemispherectomy (raging from 2% and 33% against 0-16%)[1,3,21,38,39,40]. There is no important study comparing the functional hemispherectomy approaches with results adjusted for different causative pathologies, what would be for future necessary for an important source of data about this topic.

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