Neocortex anterior temporal lobectomy with amygdalo - hippocampectomy (original spencer technique) in the treatment of mesial temporal lobe epilepsy

Lobectomia temporal anterior en el tratamiento de epilepsia temporal mesial: detalles técnicos y perspectivas en el control de las convulsiones

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Abstract

The anterior temporal lobectomy is a valuable procedure in the management of seizure disorders caused by mesial temporal lobe epilepsy. It has been described modifications in the techniques of treatment of mesial temporal lobe epilepsy whose the purpose is reduce the incidence of these complications while still achieving seizure control. **Objectives:** To discuss the technical details, modalities, risks, complications and results of anterior temporal lobectomy in patients affected by mesial temporal lobe epilepsy. **Methods:** It was performed bibliographical consultation, using the databases MEDLINE, LILACS, SciELO, PubMed, utilizing language as selection criteria, choosing preferably recent articles in Portuguese, Spanish or English. **Results:** The anterior temporal lobectomy improves the quality of life of patients affected by mesial temporal lobe epilepsy. Furthermore, it has been described associated to a lower technical difficulty, shorter surgical time and better control of seizures when compared to selective amygdalohippocampectomy. However, the selective approaches has been described a lower rates of visual complications when compared to ATL. **Conclusions:** In spite of the results described in the literature, there is no important study comparing ATL *versus* all selectives amygdalohippocampectomy techniques, what would be for future necessary for an important source of data about this topic.

Key words: Temporal Lobe Epilepsy, Epilepsy/surgery, Anterior Temporal Lobectomy, Seizures.

Resumen

La lobectomía temporal anterior es un valioso procedimiento en el manejo de convulsiones cuya etiología es la epilepsia mesial del lóbulo temporal. Se está describiendo modificaciones en las técnicas quirúrgicas de la epilepsia mesial del lóbulo temporal cuya finalidad es reducir las complicaciones derivadas del procedimiento mientras preserva el control de las convulsiones. **Objetivos**: Discutir las técnicas, modalidades quirúrgicas, riesgos, complicaciones y resultados de la lobectomía temporal anterior en pacientes afectados por epilepsia mesial del lobo temporal. **Métodos**: Consulta bibliográfica se realizó utilizando la base de datos MEDLINE, LILACS, SciELO, PubMed, utilizando el lenguaje como criterio de selección eligiendo preferentemente artículos recientes en portugués, español o Inglés. **Resultados**: Este procedimiento mejora la calidad de vida de los pacientes afectados por la epilepsia del lóbulo temporal mesial. Además, este abordaje quirúrgico ha sido descrito asociada a una menor dificultad técnica, menor tiempo quirúrgico y mejor control de convulsiones cuando comparado a la amygdalohippocampectomy selectiva. Sin embargo, los enfoques selectivos se han descrito con menores tasas de complicaciones visuales en comparación con la lobectomía anterior. **Conclusiones**: No hay un estudio importante comparando lobectomía temporal anterior frente a todas las técnicas de amigdalohippocampectomía selectiva, lo que sería para el futuro necesario para una importante fuente de datos sobre este tema.

Palabras clave: Epilepsia del lobo temporal, Epilepsia/cirugía, Lobectomía temporal Anterior, Convulsiones.

Introduction

Epilepsy is a chronic neurologic disorder that affects 0.5 to 1% of the world's population and it has being considered the fourth leading cause of neurological conditions[1,2]. In order that, the temporal lobe epilepsy has been described in the literature like a specific syndrome associated to a high incidence and severity, whose main etiology is the mesial temporal lobe epilepsy (MTLE)[2,3,4,5,6]. Stressing that, the MTLE is the most prevalent medically refractory epilepsy in adolescents and adults, whose pathologic hallmark classic is hippocampal sclerosis[3,7].

Anterior temporal lobectomy (ATL), also named as "anteromesial temporal lobectomy"[8] or "anteromedial temporal resection"[9], is a procedure surgical that aims mainly to resection of hippocampus and amigdaloid body how mean to control potentially harmful seizures, preventing the genesis of epileptic electrical activity[5,8,10].

The ATL was widely performed after the Spencer's modification published in 1984[11], whose essay described the use of this technique to preserve the function of lateral temporal cortex and to access the mesial temporal structures through the temporal pole corridor in 36 patients and it showed none mortality rates associated to control of seizures considered excellent by the standards of the time. However, even though there are benefits in this procedure, the ATL was showed significant rates of late complications like visual field disorders in the most of patients independently of hemisphere underwent to the surgery, while language and memory disorders are found in patients operated in the dominant hemisphere[8-22].

Tradicionally, the ideal candidates to be submitted the ATL must have failed to attain adequate seizure control while receiving adequate doses of anticonvulsant drugs and have a reasonable chance of benefiting from surgery. In order that, the syndrome of unilateral MTLE due to mesial temporal sclerosis has the strongest level of evidence (Level A) to indicate surgical treatment by ATL, once over 90% of such patients are either seizure-free or benefit from significantly reduced seizures after this procedure[3,4,6,9,12].

This article aims to clarify the pitfalls of ATL, risks and complications related to treatment of mesial temporal lobe epilepsy described in the literature at moment, emphasizing the benefits of ATL regarding to the better control of seizures when compared to the selective amygdalohippocampectomy, as well as allow the better knowledge about the late complications of this procedure.

Casuistic and Methods

It was performed bibliographical consultation from 1954 (first description of this procedure[23]) to 2016, using the databases MEDLINE, LILACS, SciELO, PubMed, utilizing language and date of publication as selection criteria, choosing preferably recent articles, higher 2000, in portuguese, spanish or english and only articles based on human studies. Stressing that, the references were reviewed aiming the selection of relevant papers to be included in this paper.

Technical details of anterior temporal lobectomy

The anteromedial temporal resection technique aims to preserve the function of lateral temporal cortex and to access the mesial temporal structures through the temporal pole corridor[2,9,11,24]. Such that, this resection is a iconic anyways revolves around to 3 to 3.5 cm neocortical and whole involving just middle in the inferior temporal gyrus as access to the temple and as access to the resection of the important structures that provide the triad of epileptogenisis in the internal mesial cortex[2,11].

The success of this technique is based upon intracranial study in this patients, either for electrodes or neuroimaging exams (Figure 1), and must be accomplished by surgeons familiarized with the microsurgical anatomy of amygdala and hippocampus as well as the temporal horn ventricle aiming performed the resection of the amygdala interval cortex and the hippocampus and, consequently, allowing the preservation of the neocortex.

The procedure is performed with the patient in the supine position, elevating the ipsilateral shoulder with a roll and rotating the head to the contralateral side (Figure 2 and 3). The head is tilted slightly laterally to place the zygomatic process at an approximately 50-degree angle from the horizontal plane of the surgical floor (Figure 3)[11]. In order that, this position of patient's head is important because the hippocampus

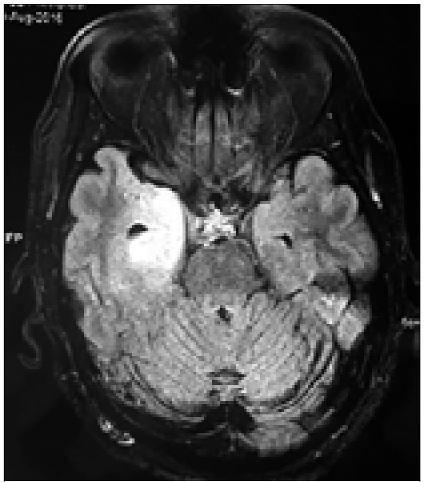

Figure 1. Case 1- Magnetic resonance image showing the mesial sclerosis in a 72 year Old Patient with partial complex epilepsies.


Figure 2. Case 1- Positioning of head.


Figure 3. Case 1- Positioning of the head.

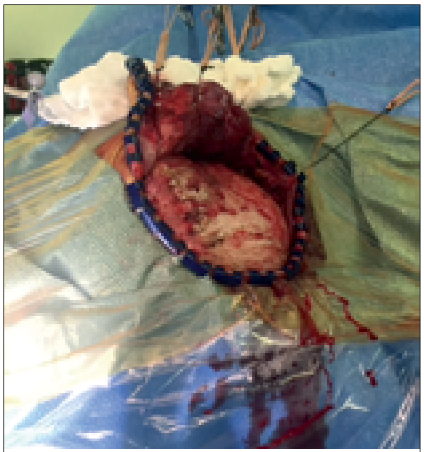
Figure 4. Case 1- Flap reflected by surgical hooks.

is positioned in perfectly aligned and consequently making possible the surgeon stay longer in microscopic exposure; Hence, if the surgeon have the "head military position", he going to be moving the microscope too far interior and tipping backing and, consequently, is cannot see that example tail of hippocampus[11].

The skin incision is begin at the zygoma just anterior to the tragus and is carried over the carried to a line drawn from mastoid tip to vertex, stressing that it is then curved gently anteriorly to the hairline at midpupil (Figure 2)[11]. Care must be taken to dissect the skin flap such that zygoma and the frontozygomatic suture may be easily palpated (Figure 4). The anterior two-thirds of the temporalis fascia and muscle is incised with the cautery[11]. An osteoplastic bone flap is the fashioned to expose the frontal opercular dura mater, pterion and temporal lobe dura mater (Figure 5). This is hinged on the posterior one-third of the temporalis muscle[11]. The pterion is the rongeured and burred flat with a high speed air frill, as has been described for pterional approaches to brain base[11]. Additional temporal squamous bone is roungeured as close as possible to the middle fossa floor[11,25].

The dura mater is opened in a U shape with the base directed medially[11]. In addition, it is incised toward the temporal tip and then elevated with tenting stitches. The surface of the temporal lobe is inspected for lateral cortical lesions. On the nondominant temporal lobe, 4.5 cm are measured from the anterior temporal tip and marked on the cortical surface of the superior, middle and inferior temporal gyri (Figure 6)[11,24,25]. Three centimeters of superior temporal gyrus is outlined for resection on the dominant temporal lobe[11,24,25]. However, in spite of the existence of these standard measures, Spencer et al[11], showed that is necessary to study the patient's anatomy once the measures can be range from 3 cm to 3.5 cm and sometimes over 3.5 cm.

The cut continues inferiorly along the floor of the middle fossa to the tentorial incisura (Figure 7)[2,11]. Any bridging anterior temporal veins are coagulated and divide[11]. In order that, using the bipolar coagulation and gentle suction, the posterior incision is carried down to the ependyma of the temporal horn

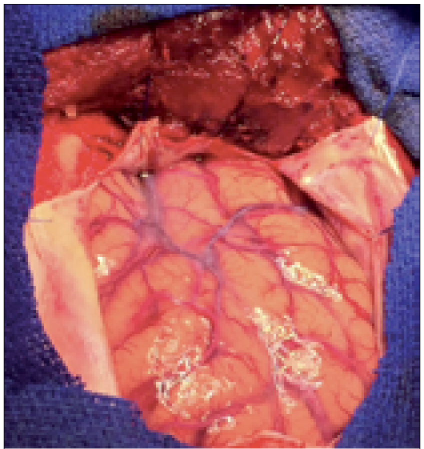
Figure 5. Case 1- Craniotomy exposure of temporal lobe.

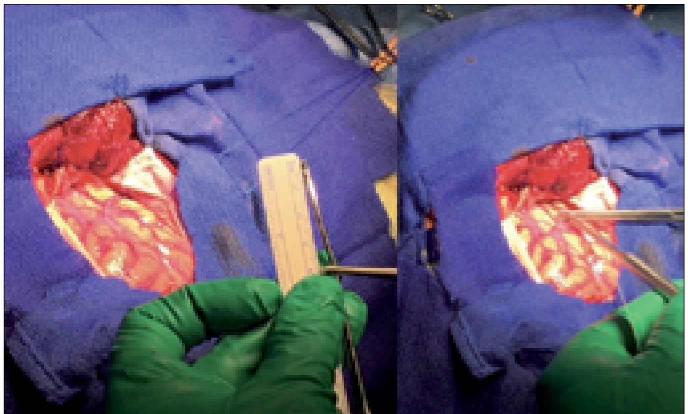
Figure 6. Case 1- Measurement from the tip of temporal lobe 3.5 to 4 cm.

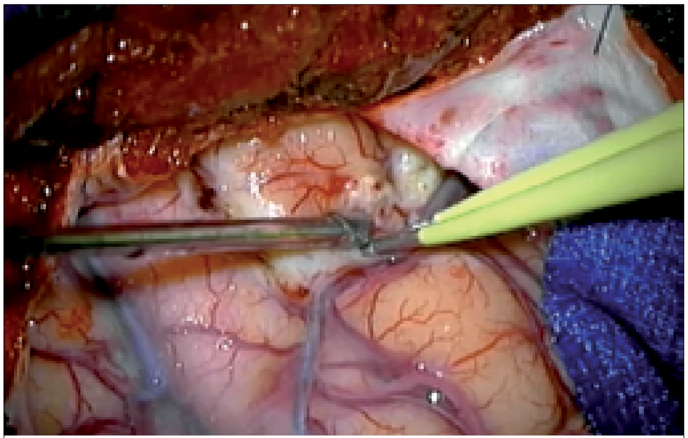

Figure 7. Case 1- Resection of temporal lobe surface, preserving the superior temporal gyrus.

Figure 8. Case 1- After the resection the temporal tip.

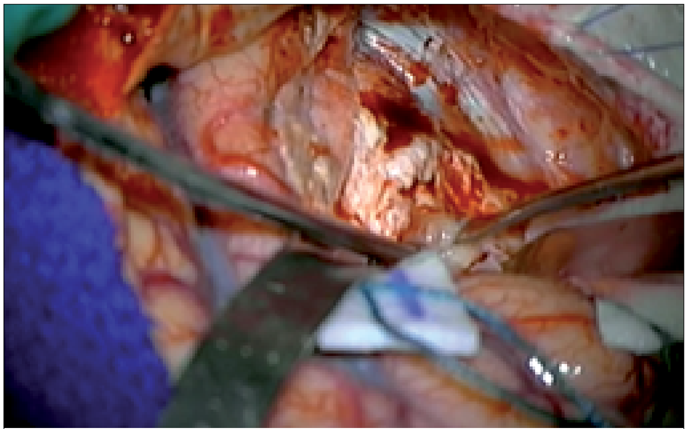

Figure 9. Case 1- Identifying the ventricle using an dissector.

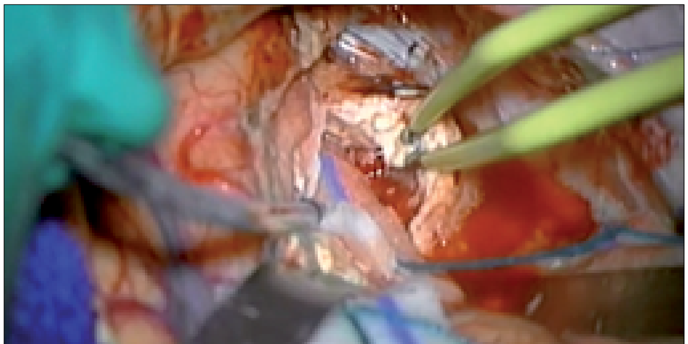

Figure 10. Case 1- Resection of hipoccampus.

of the lateral ventricle. Stressing that, it is necessary to expose the important landmarks to security of access: the Sylvian fissure, the middle cerebral artery and the velum terminate, once the incision is carried inferiorly to the sylvian fissure and then subpially along the frontal operculum and the insula until to expose the middle cerebral artery[2,11,24,25]. This meticulous subpial dissection technique is used to avoid injury to the middle cerebral artery branches in the sylvian fissure and to protect the vascular supply of the unresected part superior temporal gyrus by leaving both pial layers of the superior temporal sulcus undisrupted on the lower part of the superior temporal gyrus, as well as to protect the underlying third nerve, and cerebral peduncle[25]. The cut is extended anteriorly and medially around the amygdala, joining the other incisions, and the anterolateral 4.5 cm of the temporal lobe is removed en bloc preserving the superior gyrus (Figure 8), sectioned and submitted to pathological examination[2,1124].

Moreover, this incision is extended posteriorly by splitting the projection fibers of the occipitotemporal fasciculus[11,25]. With the use of a curved self-retaining retractor (number three Penfield), the lateral temporal cortex is gently elevated and aim to expose the insula, and dissection extending to the lateral uncus is performed[11,24,25]. After uncus resection, the temporal lobe is reflected laterally aim to expose the medial temporal structures from the amygdala to the ventricular atrium (Figure 9)[11,24]. With the choroidal fissure and the pia arachnoid (Figure 12) over the brain stem as the superior and medial boundaries, respectively, and the hippocampal projections at the atrium as the posterior boundary[2,25]. Subsequently, in spite of the opening of the ventricle anteriorly exposes the hippocampal head, Spencer[11] advocates about the better results of the opening the lateral ventricle wall aiming to expose the hippocampus without injuries. Injuries in inferior and medial ventricle wall are correlated to motors disorders[23], so the use of Penfield retractor inserted along the anterior ventricle as a mean to protect the ependymal vessels during the resection by ultrasonic aspiration. After this step, a second en bloc resection of the hippocampus (Figure 10), amyg-

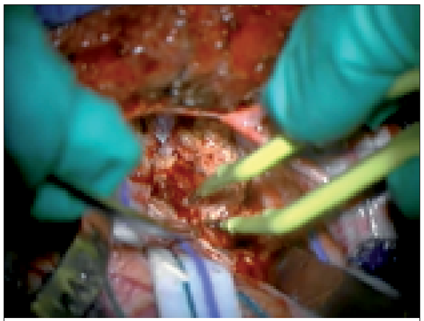

Figure 11. Case 1- Resection of amygdaloid body.

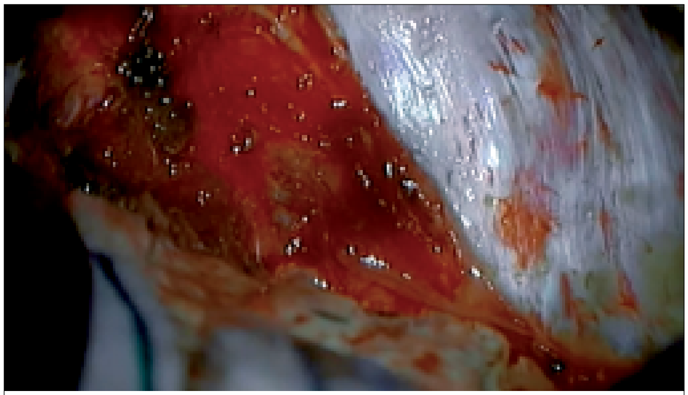

Figure 12. Case 1- Arteries visible through the arachnoid mesial temporal.

dala (Figure 11), parahippocampus (Figure 14) and fusiform gyrus is performed[11,24]. In order that, the surgeon need be careful and consider the half distance between the inferior choroid point and middle cerebral artery is the limit for resection superiorly to avoiding damage of adjacent structures, as well as it is necessary be careful regarding to avoid the manipulation of the edge of the tentorium and third cranial nerve[25]. (Figure 13). After mesial temporal resection (Figure 15), hemostasis is achieved (Figure 16), and the wound is closed in a standard manner. The post operative comparison between pre operative and post operative image exams are necessary and all steps of surgery are stereotyped (Figures 17 to 28).

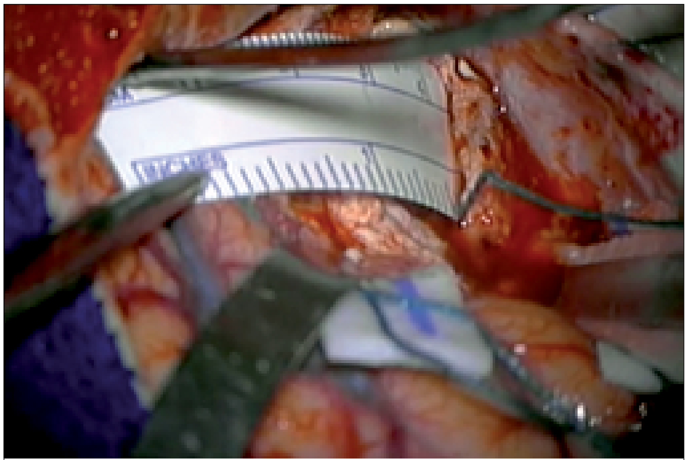

Figure 13. Case 1- Measurement between the inferior choroid point and middle cerebral artery. The half distance is the limit for resection superiorly avoiding damage.

Other techniques

The postoperative complications of ATL are related to damage of neocortex structures and the resection of mesial structures mainly in dominant hemisphere, as well as the inappropriate execution of the technique in act surgical[2,8,11]. By this perspective of significant rates of ATL complications, it has been described many techniques of selective amygdalohippocampectomy, whose it is based in the preservation of functional cortex and its deeper connections associated to resection of the epileptogenic mesial structure through route transmiddle temporal gyrus without resection of neocortex[26], transsylvian route by the inferior limiting groove of insula[27,28], subtemporal by collateral groove[29] and the hippocampal transection as a mean to minimize memory dysfunction following hippocampectomy[30,31].

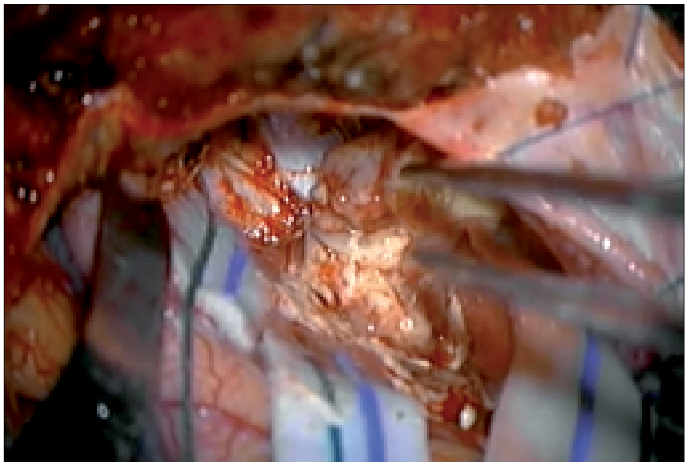

Figure 14. Case 1- Resection of parahipoccampus.

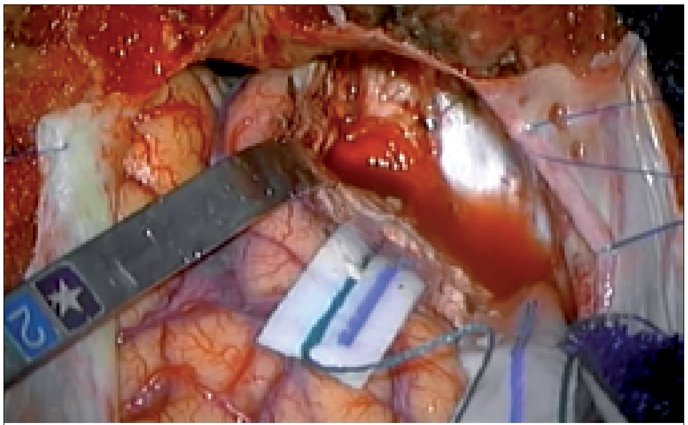

Figure 15. Overview identifying the mesial resection.

Figure 16. Case 1- Hemostasia with floseal.

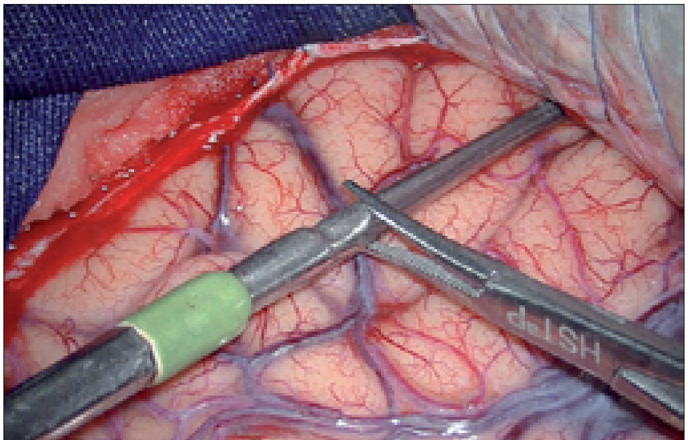

Figure 19. Case 2- Measurement of 4.5 cm till the the temporal tip.

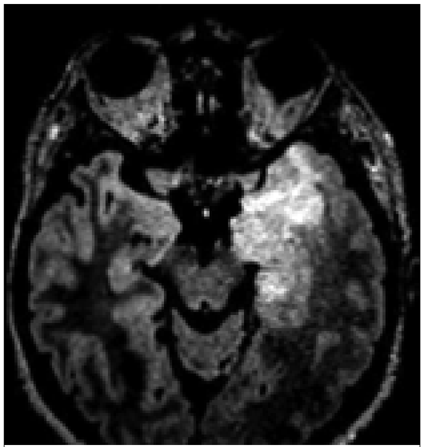

Figure 17. Case 2- 53 year old, complex partial epilepsy.

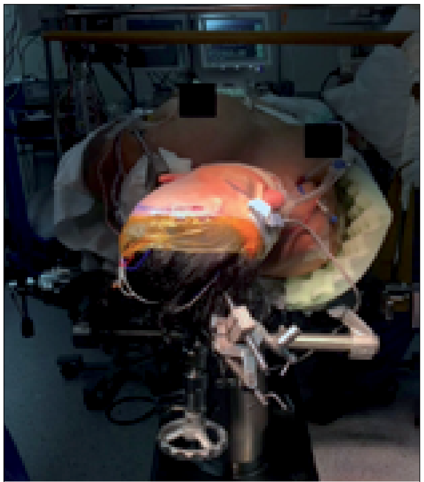

Figure 18. Case 2- Patient in head fix with extension of head and 30 degrees regarding horizontal plan.

Considerations about the use of the 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 surgery are more difficult to find. Such 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 the engraving point mark of the incision and plan the extension of pterional craniotomy looking for the ideal position to reach the amygdala and hippocampus, as well as it helps in guiding the surgical pathway to the temporal horn and the posterior extent of mesial temporal resection.

However, van Roost et al.[32], found that neuronavigation can overestimate the extent of posterior hippocampal resection, which is related mainly to brain shift during the ssurgery. Such that, while neuronavigation is a useful adjunct, a thorough understanding of the anatomy is essential. On the other

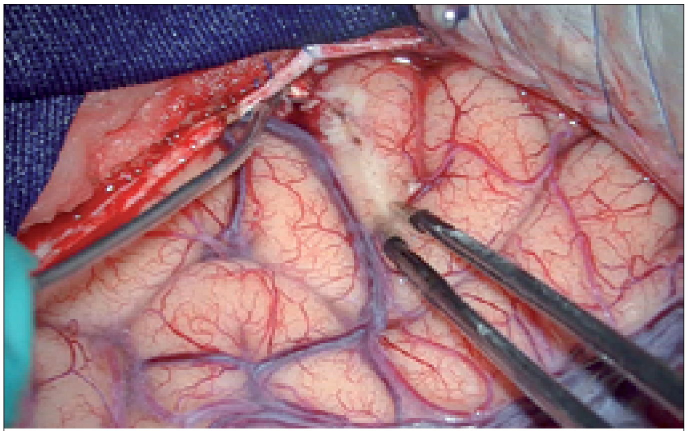

Figure 20. Case 2- Initial Corticectomy.

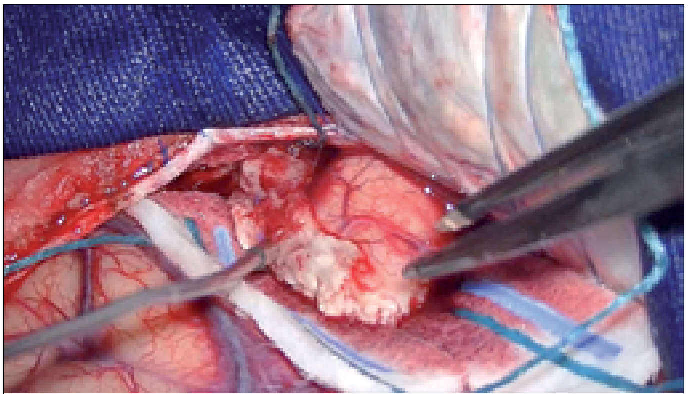

Figure 21. Case 2- Complete neocorticectomy.

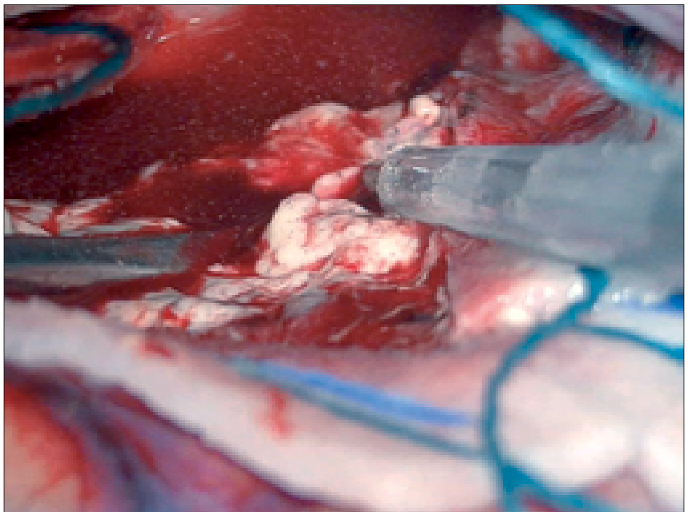

Figure 23. Case 2- With a dissector Penfield 4 we introduce it in temporal horn of ventricle and with other hand we resect the wall of temporal horn with ulstrossonic aspirator.

Figure 22. Case 2- Piece of neocortex resected as a door for the amygdalohipoccampectomy.

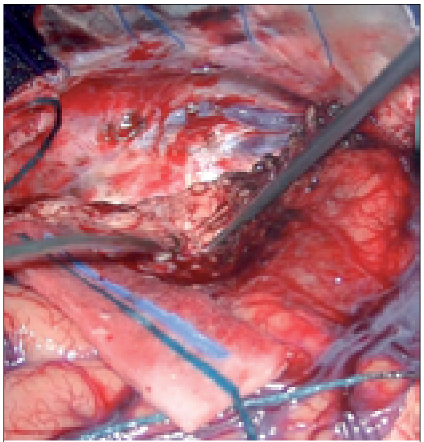

Figure 24. Case 2- We can indentify the hippocampus and we try to resect it en block.

hand, intraoperative MRI was found to be helpful to ensure the completeness of hippocampal resection[33].

Epileptogenic evaluation for surgery

Evaluation for surgery should involve interictal electroencephalogram (iEEG), video-EEG, interictal SPECT, magnetic resonance imaging analysis, and age-appropriate neuropsychological/developmental assessment. The intracranial EEG may be imperative in localization of the correct focus of seizure, indicating a complementar surgery after a ATL or selective amygdalohippocampectomy[2,3,6,9,10,12,34]. Functional MRI and EEG may be useful and should be included actually in the protocols of seizure foci investigation[3,6,12,16].

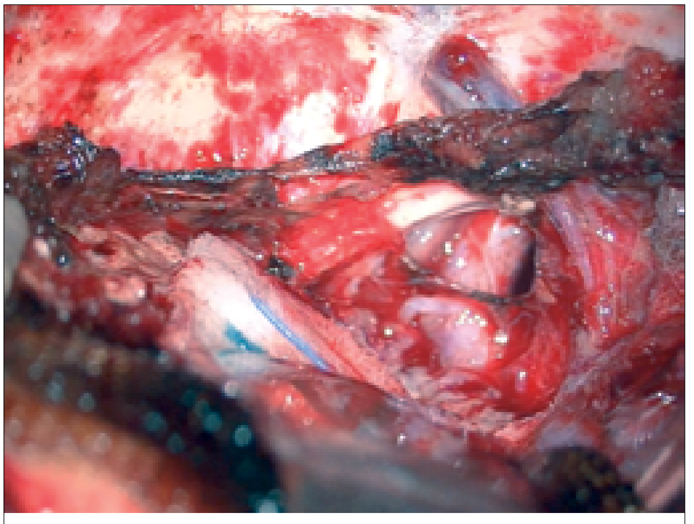

Figure 25. Case 2- Complete resection of amygdala and hipoccampus, and it is possible to identify the III nerve, carotid artery.

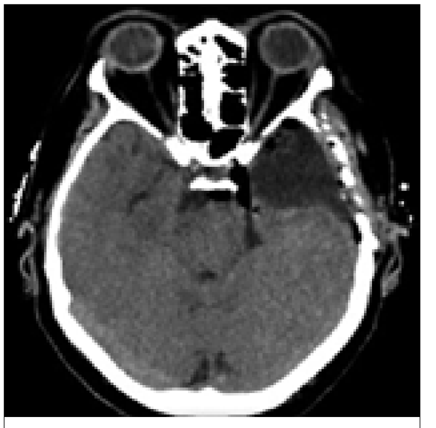

Figure 26. Case 2- Resection of Hipoccampus and Amygdala and neocortex.

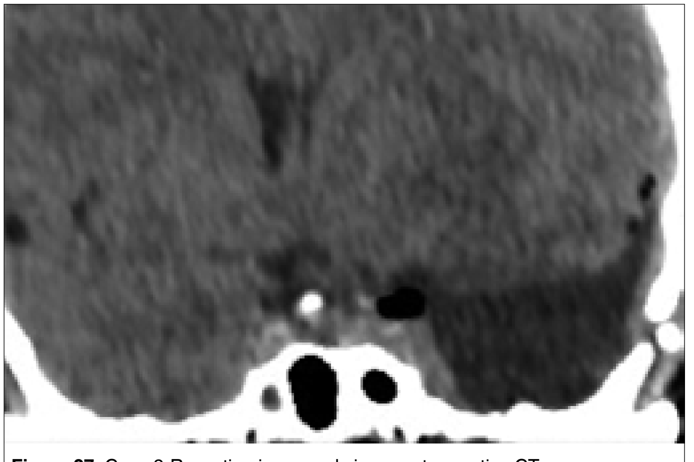

Figure 27. Case 2-Resection in coronal view, post operative CT scan.

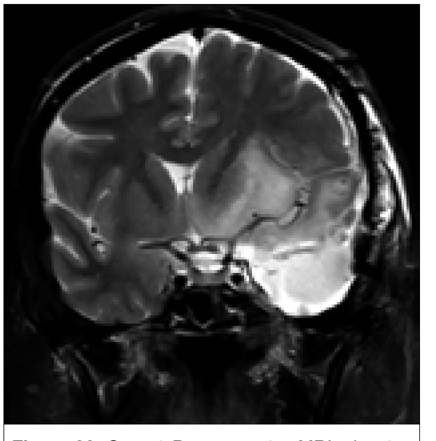

Figure 28. Case 2-Post operative MRI showing the resection of hippocampus and amygdala.

Results and Discussion

Although lasting complications rates are very variable on this type of epilepsy surgery, the presence of hemiparesis, variable visual field defect, hemorrhage, infarction (commonly of deep penetrating vessels leading to lacunar stroke), hydrocephalus, memory impairment, transient dysnomia, transient dysphasia, brain swelling, frontalis nerve plasy, aphasia, amusia, oculomotor nerve plasy and mood changes are risks to be considered during the surgical act of both techniques[2,4,8-23].

Regarding to the reason for ATL failure, it should be highlighted that it is not always apparent for an individual case. Such that, among the reasons persistence of the seizures in outpatients follow-up of ATL and selective amygdalohippocampectomy surgery include: 1) technical error implying in the failure to adequately resection the entire mesial structures; 2) misdiagnosis implying in the unrecognized seizures emanating from the other epileptogenic area; or 3) the progression of disease implying in the development of a new seizure focus in the contralateral mesial temporal structures[8,12].

McClelland and colleagues[14], in 2011, described the surgical risk of anterior temporal lobectomy (ATL) in patients (n = 677) affected by intractable temporal lobe epilepsy. This essay showed the incidence of postoperative neurological complications (deficits, including those secondary to infarction or hemorrhage) in 2.7% (n = 19) of patients, hydrocephalus in 0.4% (n = 4), homonymous/heteronymous hemianopsia in 1.1%, (n = 8), postoperative infection in 0.8% (n = 6) and ventriculostomy placement in 0.1% (n = 1). Furthermore, it revealed 3.5% of patients were discharged to long-term rehabilitation, and postoperative neurological complications (deficits, including those secondary to infarction or hemorrhage) affected 2.7%, suggests that the number of persistent disabling deficits may have exceeded 2%. Moreover, it is believed that permanent hemiparesis varies between 0 and 2%, whose etiology has been ascribed to postoperative hemorrhage, or to spasm or thrombosis of the middle cerebral, posterior cerebral, anterior or posterior choroidal arteries.

About the visual field defect in ATL

approach, it is a contralateral superior homonymous quadrantanopia attributed to disruption of Meyer's loop, the anterior bundle of the optic radiations that travels through the temporal lobe[13,15-17]. In a case series described by Mengesha et al.[17], in 2009, was studied 18 and 33 patients underwent to transcortical selective amygdalohippocampectomy approach and ATL, respectively. It showed that although the visual field deficit is often not noticeable to the patient underwent to ATL, it may, depending on its density and extent, have implications for driving. In order that, in studies performed in the United Kingdom, 25%-50% of patients failed to meet driving requirements because of a postsurgical visual field deficit[18,19]. While, all the patients who underwent selective amygdalohippocampectomy approach had a visual field defect that affected at least one coordinate, and this defect was homonymous in all but one patient who had a small superior quadrant defect that reached significance only in the eye ipsilateral to the surgery[17].

Many studies reported superiority of selective approach compared with ATL in some aspects of postoperative cognitive performance[2,20,26-29], but some showed substantially mixed findings or lack of superiority of more limited resection[2,21]. Such that, although there are exceptions, most of these studies still recognize the potential for meaningful cognitive declines following the more selective procedure[20]. However, in spite of the potential to avoid meaningful cognitive declines through selective technique, it is necessary to emphasize that the most of cognitive declines related to ATL are transitory and the ATL has been described in the literature associated to a higher or similar rates of control of seizures[2,10,12,21].

Renowden et al.[35], in 1995, described the results of transcortical (n = 7) and transsylvian (n = 10) selective amygdalohippocampectomy, stressing that the clinical and neuropsychological outcomes after these approaches were compared with those of ATL. This paper showed no significant difference in seizure control between transcortical or transsylvian approach and ATL in 1 years of follow-up. However, in spite of the verbal memory and cognition were not significantly different in the two selective groups, patients with left selective amygdalohippocampectomy fared significantly better in terms of verbal and nonverbal memory when compared with those with left ATL. Furthermore, this essay revealed that all the patients (n = 17) presented incomplete contralateral quadrantanopia and 53% of the patients (4 transcortical and 5 transsylvian approach) demonstrated wallerian degeneration in the optic radiations after surgery.

Nascimento et al.[12], in 2015, described the results of ATL and transcortical selective amygdalohippocampectomy approach in a case series (n = 67), whose 34 and 33 patients underwent to amygdalohippocampectomy selective and ATL, respectively. It showed presence of hand dominance dexterous in 89.6% (n = 60) of patients, equal proportion between nondominant (n = 33) and dominant hemisphere (n = 34), average of patient's age of 35 years, average of follow-up of 5 years and average of duration of disease of 26 years. It showed presence of paresis of III cranial nerve, hemiparesia permanent, systemic infection and death related to the surgery in the similar rates between the techniques, 4% (n = 3), 1% (n = 1), 0% (n = 0) and 0% (n = 0). So that, regarding to the presence of disorders in the patients underwent to selective approach and ATL (p = 0,37), it showed presence of complications without association to neurological deficits in 82.4% (n = 28) and 72.7 (n = 24), respectively, and complications associated to permanent neurological deficits in 1.47% (n = 1) and 3% (n = 2), respectively. Furthermore, in spite of it showed no significant difference in neuropsychological performance, neither immediately or late, between the techniques; it showed a better control of the seizures after 4 years in the patients underwent to ATL (Engel I = 51.5%) when compared to selective approach (Engel I = 44%).

Drane et al and coauthors, in 2015[36], described the results of stereotactic laser amygdalohippocampectomy and ATL in a case series (n = 58 - 19 selective approach and 39 ATL) of patients with medically intractable MTLE, whose surgical procedures were performed in 10 dominant and 9 nondominant hemisphere in the laser ablation group and a prospective casuistic, nonrandomized, nonblinded of patients underwent to ATL. It showed higher rates of seizures control (Engel I) in patients underwent to ATL when compared to laser approach group (p < 0.0001), in spite of the better object recognition and naming outcome was demonstrated in laser ablation when compared to ATL group (p < 0.001). In order that, Gross et al.[37], had showed similar results in 49 cases (including 6 reoperations) of laser ablation, it showed 61,5% improvement in the seizure-free rate at 12 months, as well as 67% (n = 6/9) with MTLE and 50% (n = 2/4) of patients without MTLE were seizure free. However, they demonstrated presence of hemorrhage, total visual field deficit and transient cranial nerve deficit (oculomotor and trochlear nerve) in 4.1% (n = 2), 8.2%(n = 4) and 2% (n = 2), respectively.

Bujarski and coauthors, in 2013[22], described the results of a retrospective analysis of seizure, cognitive, and psychiatric outcomes in a noncontemporaneous cohort of 69 patients with unilateral refractory temporal lobe epilepsy and magnetic resonance image evidence of mesial temporal sclerosis after either an ATL or a selective approach. Regarding to the duration of follow-up, the mean duration of follow-up for ATL was 9.7 years (ranging from 1 to 18 years), and for transcortical selective amygdalohippocampectomy it was 6.85 years (ranging from 1 to 15 years). This essay showed better seizure outcome (Engel class IA) in patients underwent to ATL (p = 0.034), while a higher occurrence of seizures solely during attempted medication withdrawal in the selective approach than in the STL group (p = 0.016). Moreover, it revealed no significant (p < 0.05) difference in the effect of surgery type on any cognitive and most psychiatric variables. Stressing that, similar results was found in systematic review and meta-analysis, by Attiah et al.[38], and Josephson et al.[39], that directly compared seizure outcomes in 25,144 and 1,294 patients (4,675 papers), respectively, undergoing selective approach or ATL for MTLE.

Conclusions

Based on literature and authors experience, ATL is a safe procedure when indicated to selected cases and it is an effective treatment for drug-resistant MTLE (seizure freedom rates higher of 80%)[2,4,11,34], however this procedure must be accomplished by very surgeons familiarized with the microsurgical anatomy of amygdala and hippocampus as well as the temporal horn ventricle.

In spite of the literature reveal a similar or higher incidence of visual field disorders in ATL and selective approach, it is often not noticeable for the patient and it has not been associated to lower quality of life in the literature[11,15]. Moreover, although the control of epileptic crisis is similar in the first 3 years after the surgery, it is higher after the fourth year postoperative when compared to the selective resections[12,22,35,36]. Furthermore, we concluded that in spite of those undergoing of ATL approach showed a slight inferiority in question tansient verbal memory disturb, the most crucial worst performance data was not related to surgical technique, but it related to the dominant side operated.

There is no important study comparing ATL versus all selective approaches in the same time, what would be for future necessary for an important source of data about this topic.

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