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Presurgical and postsurgical neuropsychological assessment in epilepsy

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Abstract

Background: Epilepsy surgery represents a valuable treatment for people with drug-resistant epilepsy, which often leads to a substantial improvement in the cognitive-behavioral domains and to a better quality of life, especially in children. A neuropsychological assessment is considered mandatory and should form an integral component of the presurgical evaluation and assessment of postoperative outcome for all epilepsy surgery patients. In this context, the presurgical neuropsychological assessment in combination, as well as other relevant neurological investigations are important for assessing the risk of potential postsurgical cognitive deficits, to determine the dominant hemisphere responsible for language function and to predict the risk of memory decline and of visual and motor deficits. A postsurgical neuropsychological assessment is necessary in assessing the outcomes because cognitive decline is one of the most significant sequelae of epilepsy surgery.

Conclusions: The neuropsychological assessment remains an obligatory and valuable part of the presurgical and postsurgical assessment. This article provides a comprehensive overview of the role of neuropsychological assessment in the pre- and postsurgical evaluation of epilepsy surgery patients. The neuropsychological profile may have a predictive role for the identification of the cognitive risk, prognosis, and treatment. New researches about neuropsychological assessment may provide many relevant answers about the outcome of the epilepsy surgery as well as to influence the quality of life.
Key words: epilepsy, presurgical, postsurgical psychological assessment.

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Introduction

According to International League Against Epilepsy (ILAE) definition, "epilepsy is a disorder of the brain characterized by an enduring predisposition to generate epileptic seizures, and by the neurobiologic, cognitive, psychological, and social consequences of this condition" [1]. Cognitive impairments, as well as mood and behavioral issues, represent common comorbidities of epilepsy [2, 3]. Despite the availability of antiseizure drugs for symptomatic treatment of epileptic seizures, about one-third of patients have drug-resistant epilepsy [4, 5]. Epilepsy surgery represents an elective treatment and cognitive decline is the most frequent comorbidity associated with this procedure [6-10].

The main aim of the surgery procedure is to improve the person's health-related quality of life and to obtain the seizure freedom [11]. Moreover, early epilepsy surgery improves the quality of life, cognitive and developmental outcomes and allows the person to regain a normal life [12]. Furthermore, a successful epilepsy surgery focuses to preserve or even to improve the patient's functional capabilities, emotional state, and behavior, including social cognitive function [13]. However, 30% to 50% of surgery patients have a risk of additional postoperative memory impairment [14]. The major determinant of surgical cognitive outcome is the "functionality" of brain areas affected by epilepsy which needs to be resected and the second determinant is the "functionality" of brain areas and functions that are not affected by epilepsy or surgery, also called patient's mental reserve capacity.

In the context of epilepsy surgery, a neuropsychological assessment is considered mandatory and should form an integral component of the presurgical evaluation and assessment of postoperative outcome for all epilepsy surgery patients [6, 15, 16]. In addition, the determination of language lateralization is very important in planning surgical resections and predicting cognitive outcomes [6, 17, 18].

According to the special report of the ILAE Neuropsychology Task Force, Diagnostic Methods Commission: 2017-2021, Neuropsychological assessment in epilepsy surgery [6], a neuropsychological assessment plays a vital role during the two main phases of the neurosurgical management: the first phase is the preoperative assessment, which implies the diagnosis of the impact of a lesion on cognitive functions and the second phase includes the postoperative or post-traumatic one, which will evaluate the cognitive result of the injury or the surgical treatment.

A neuropsychological assessment is a comprehensive and exhaustive assessment of skills and abilities linked to brain function, which provide an overview of a person's functioning, drawing on the person's history, the clinician's observations, and test scores in various cognitive domains [7, 19, 20]. The evaluation quantifies such domains as memory, IQ, language, attention, executive functioning, visuospatial skills, cognitive abilities, emotional functioning, and behavior [14, 20, 21]. The aim of a neuropsychological evaluation is to assess and identify attentively and comprehensively the behavioral strengths and weaknesses beyond the multiple cognitive areas [22, 23].

The neuropsychological assessment contributes to a number of important decisions in medical aspects, such as identification of candidates for surgery, potential risk, benefits and efficacy of treatments and rehabilitation, as well as, identification of epilepsy-related cognitive impairments and their etiologic attribution to lesions [24, 25]. The assessment also determines whether developmental problems are present, establishes a diagnosis, guides treatment and educational planning, measures progress and demonstrates eligibility for special education services [21]. According to K.B. Casaletto and R.K. Heaton [26], the primordial purposes of neuropsychological assessment remain constant, viz: (1) detect cognitive dysfunction and guide differential diagnosis, (2) characterize changes in cognitive strengths and weaknesses over time, and (3) guide recommendations regarding everyday life and treatment planning.

Presurgical neuropsychological assessment

The primary role of neuropsychological assessment is to assess all cognitive, emotional and behavioral domains and to use the results from the presurgical assessment to establish a baseline assessment against which cognitive change can be measured after the surgery [6, 24]. The presurgical assessment also provides the teamwork with seizure description, lateralization, and localization, as well as with evidence-based predictions of cognitive results associated with the proposed surgery, including risk of amnesia, psychologic and psychiatric issues [27-29]. The assessment should include formal measures of psychosocial function and health-related quality of life, and it is important to include the parental/caregiver or teacher evaluations of behavior, mainly in children [6].

After the assessment, it is vital to provide feedback and preoperative counseling including investigations of patient and family expectations of surgical treatment [6]. Communication of the results of the neuropsychological assessment to the patient is an integral part of the presurgical evaluation. This will help the surgical candidate and their family understand the etiology of any cognitive or behavioral difficulties identified. The results of neuropsychological assessment contribute to the prediction of the postsurgical deficit risk. The most considerable predictors of neuropsychological outcomes include the performance of presurgical tests, which reflect the functional integrity of the resected tissues and cognitive reserve capacities [7].

A preoperative neuropsychological assessment should include standardized tests of cognitive function and behavioral, emotional, and psychosocial functions [6, 21]. In general, a neuropsychological assessment will typically include assessment of intellectual functioning (IQ), verbal and visual memory, language, attention, executive function, visual-spatial and visual-perceptual skills, visual-motor and fine motor coordination as well as emotional and behavioral functioning [8, 20, 21, 24, 25, 30].

Postsurgical neuropsychological assessment

A postsurgical neuropsychological assessment is necessary in evaluating the outcome because cognitive decline is one of the most significant sequelae of the epilepsy surgery. A postsurgical neuropsychological assessment should be an integral part of the epilepsy surgery [6]. The same principles that inform the comprehensive nature of the preoperative neuropsychological assessment should guide the assessment of postoperative outcome. The postoperative assessment should address all aspects of cognitive and behavioral function, as assessed prior to the surgery [6, 7]. In addition, a detailed picture of postoperative changes in seizure control should form an important part of the postoperative neuropsychological assessment since the relationship between postoperative seizure control and cognitive change is a complex one [31]. There is some evidence that cognition and memory improves with seizure control following successful epilepsy surgery, at least in some patients, while other studies have found no association or report greater cognitive declines in those with ongoing seizures following surgery [10, 31-35]. After surgery, children demonstrate faster rehabilitation from surgically caused impairments than adults; there is evidence of a greater plasticity and compensational capacity in childhood [36, 37].

Additionally, the psychiatric comorbidities can occur independently or arise from the same organic substrate as the seizures and cognitive impairment [14]. Risk factors for psychiatric illness include a previous patient or family history, a structural brain abnormality, seizure frequency, medication effects, cognitive impairment, personality traits, and social and family functioning [22, 25, 38, 39]. In some cases, psychotherapeutic support is welcome to help surgical candidates maximize their postoperative potential [6, 32].

Clinical case study

Neuropsychological assessment is recognized as a core investigation in presurgical planning for children with epilepsy. The present case study evaluated an 11-year-old child, left-handed. The study was carried out at the Institute of Emergency Medicine and National Center for Epileptology during 2019-2020. The patient was referred by his epileptologist for a neuropsychological assessment because of his epileptic seizures and the diagnosis of a tumor in the temporal-parietal left hemisphere. As a result, the patient underwent an epilepsy/tumor neurosurgery. To assess the risk of cognitive decline and emotional and behavioral risk, the patient's cognitive function was evaluated before and 6 months after the neurosurgery. The neuropsychological assessment in this case, comprised 6 presurgical and post-

Table 1

Neuropsychological assessment. Presurgical and postsurgical results organized by domain of function

Presurgical assessment		Postsurgical assessment	
Domain of function	Scores	Domain of function	Scores
Intellectual functioning		Intellectual functioning	
Matrices Progressive Raven	IQ=118	Matrices Progressive Raven	IQ=121
Memory function		Memory function	
Rey auditory verbal memory test (RAVLT)	8/15; 8/15; 12/15; 11/15; 12/15 List B – 8/15 List A – 11/15 after 30 min 15 words from 15	Rey auditory verbal memory test (RAVLT)	9/15; 11/15; 11/15; 13/15; 15/15 list B 5/15 List A – 13/15 after 30 min 12 words from 15
Visual memory. Rey Complex Figure Test		Visual memory. Rey Complex Figure Test	
Copy - 90 percentiles Immediate recall - 90 percentiles Time – 3 min 18 sec		Copy - 80 percentiles Immediate recall - 80 percentiles Time – 4 min 8 sec	
Language. Verbal Fluency		Language. Verbal Fluency	
Phonemic: COWAT test – F-5; A-12; S – 9 Semantic: Animals – 15		Phonemic: COWAT test – F-5; A-11; S -8 Semantic: Animals - 13	
Visual spatial skills		Visual spatial skills	
Clock drawing test	Copied from the 3-rd trial. Minutes – incorrect	Clock drawing test	Drawing from the 1st trial. Minutes – incorrect
Cube copy test	Copied from the 3-rd trial	Cube copy test	Copied from the 2-nd trial.

surgical standardized tests. To assess the cognitive function, we used the following psychological instruments: Clinical interview; The Raven's Progressive Matrices Test [40]; Rey auditory verbal memory test (RAVLT) [41, 42]; Rey Complex Figure for visual memory test [43]; COWAT test for verbal fluency [44], the Cube coping and the Clock drawing test [45, 46].

Results

The neuropsychological test results are presented in table1 2 and 3.

Table 2

Visual spatial skills, constructive disabilities

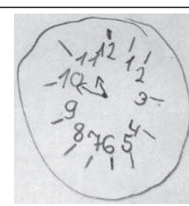
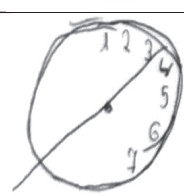
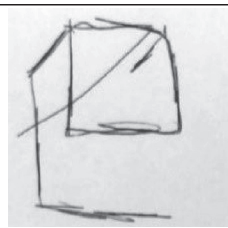
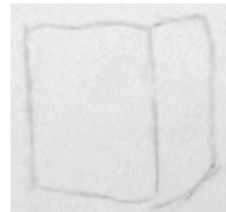
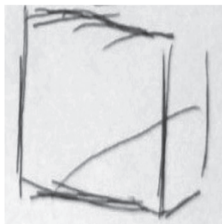
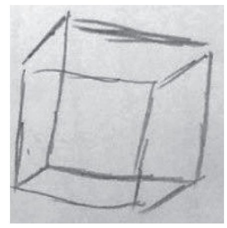
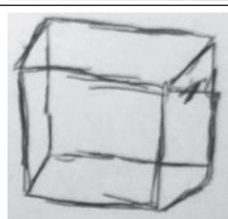
Image 1. Presurgical Clock Drawing Test		Image 2. Postsurgical Clock Drawing Test	
1st trial		1st trial	
2nd trial			
3rd trial			

Table 3

Visual spatial skills, constructive disabilities

Image 1. Presurgical Cube Coping Test		**Image 2. Postsurgical Cube Coping Test**	
1st trial		1st trial	
2nd trial		2nd trial	
3rd trial			

Discussion

According to data shown in tab.1, a significant postsurgical improvement in the intellectual performance can be observed. Before surgery the IQ of the patient was 118 which corresponds to high average level, subsequently after the surgery the patient reached superior higher level with IQ=121.

According to the results of the Rey auditory verbal learning test (RAVLT), it can be concluded that the patient proved improvement in the first five recalling trials after the surgery; however, a decrease was noticed at the interference trial and after 30 min. It can be presumed that the concentration and the short verbal memory improved, however the long-term verbal memory slightly decreased.

On the Rey complex figure test, the presurgical results were better than the postsurgical outcomes. Before surgery, the patient obtained 90 percentiles at reproducing and immediate recall test and after the surgery the score was 80 percentiles at the same test trials. Another important observation regarding this test is the time for performing the Rey figure. Prior to the surgery, the patient copied the Rey figure in 3 min. 18 sec. and after the surgery; he copied and recalled the same figure in 4 min. 8 sec. It can be hypothesized that the processing and reaction speed became slower after the surgery. Additionally, this test revealed a high level of anxiety before surgery, this was emphasized by the manner of drawing, whereas the lines of the figure were repeatedly aggressively accentuated. Later, the patient's mother confirmed that the patient did not know about his health condition and his future surgery. After the surgery, the patient manifested irritability, which disappeared over a few months.

Nevertheless, the patient faced difficulties at the language test (COWAT); his performance on confrontation naming, phonemic and semantic fluency was impaired equally before and after the surgery. However, it is difficult to assume if his verbal fluency was affected by epileptic seizures, tumor or both.

While performing the Clock test, the patient was confused, thus, before surgery (tab. 2, image 1) he had 3 attempts to draw the clock and he accomplished it from the third trial with mild error at ticking the minutes. Postsurgically (tab. 2, image 2), he drew the clock from the first trial and repeated the same mistake prior the surgery, and he reproduced more exactly the third presurgical trial. Almost the same difficulties were encountered when coping the cube test. Before surgery (tab. 3, image 1) the patient reproduced the cube from the third trial and after the surgery (tab. 3, Image 2) from the second trial.

Thus, the neuropsychological assessment before the surgery, revealed impairment in visual spatial skills, namely in the clock drawing and cube coping test. His performance was a borderline, with soft decline on measures of psychomotor processing speed, confrontation naming and semantic fluency. Otherwise, the verbal, visual memory and intelligence level were in the normal limits. Postsurgically, we noted an improvement in intelligence level and visual spatial skills, however a slight decline but in normal limits were registered in verbal and visual memory.

In conclusion, we can affirm that epilepsy surgery provided seizure freedom, improvement of intellectual level, positive changes in behavioral and emotional domains and a better quality of life of the patient and his family.

This result confirms the findings of previous study conducted by C. Cunningham et al. [47], who described an 8-year-old boy with a history of intractable epilepsy who underwent a left frontal temporal-parietal resection. He passed a neuropsychological testing prior to and following surgery. Presurgical results indicated that his IQ was within the low-average range, whereas visual-perceptual abilities, the motor tasks and attention domains indicated some difficulties. Postsurgical neuropsychological evaluation revealed a positive outcome. IQ remained in the low average range and there was a mild improvement in visual-perceptual/visual-constructional areas.

Regarding intelligence, E. Wyllie et al. [48] studied seizure outcome in 136 pediatric patients who underwent surgery for intractable epilepsy and showed that IQ level tended to be higher in adolescents (85) than in children (76), whereas the full scale IQ tended to be highest for patients who underwent temporal resection. Another study [49] concluded that intelligence level remained stable two years after epilepsy surgery in 94 children and adolescents. A seizure-free outcome was the most important factor for the prognosis of cognitive development, regardless of the intellectual level of the child before surgery. On the other hand, U. Gleissner et al. [50] revealed in their study that the postoperative cognitive result was not dependent on seizure outcome, while IQ alone is not a good predictor of postoperative outcome in pediatric patients with epilepsy.

A long-term follow-up study of 42 children, who underwent temporal lobe surgery after an average postoperative period of 9 years, reported that the surgery performed in childhood results in excellent long-term seizure control and favorable cognitive outcome along with positive effects on brain development [51]. A study from Khajavi et al. [52], which included 34 pediatric patients with medically refractory epilepsy and primary brain tumors who underwent the neurosurgery, reported that completeness of tumor resection is the most important factor in determining seizure outcome.

A retrospective study comparing preoperative evaluation and postoperative outcomes demonstrated that the resection surgery is an effective and safe intervention in early stages and in strictly selected pediatric patients with refractory epilepsy [53].

A. Miserocchi et al. [54] evaluated the relevance of the presurgical workup and the postoperative outcome in 68 children who underwent temporal lobe epilepsy surgery (TLE), and concluded postoperatively that the percentage of patients with a pathological score invariably decreased compared with the results from the preoperative evaluation in all cognitive domains. Results of the neuropsychological evaluation indicated a long-term improvement in cognitive performance in all the explored domains after TLE surgery.

Conclusions

This article shows the importance of the neuropsychological assessment in epilepsy surgery as an obligatory and valuable part of the presurgical and postsurgical assessment. The article provides a comprehensive overview of the role of neuropsychological assessment in the presurgical and postsurgical evaluation of epilepsy patients undergoing epilepsy surgery. The neuropsychological profile may have a predictive role for the identification of the cognitive risks, outcomes, and treatment. The neuropsychologist, along with other specialists from the multidisciplinary team, plays an important role in both the presurgical process and postsurgical rehabilitation and is a support to the patient and his family.

Therefore, new researches about neuropsychological assessment may provide many relevant answers regarding the outcome of the epilepsy surgery as well as to influence the quality of life of the patient and his family.

References

1. Fisher RS, Acevedo C, Arzimanoglou A, Bogacz A, Cross JH, Elger CE, W, et al. ILAE official report: a practical clinical definition of epilepsy. Epilepsia. 2014;55(4):475-482. doi: 10.1111/epi.12550.
2. Witt JA, Helmstaedter C. Cognition in epilepsy. Curr Opin Neurol. 2017;30(2):174-179. doi: 10.1097/wco.0000000000000430.
3. Helmstaedter C, Witt JA. Clinical neuropsychology in epilepsy. Epilepsy. 2012;437-459. doi: 10.1016/b978-0-444-52898-8.00036-7.
4. Löscher W, Potschka H, Sisodiya SM, Vezzani A. Drug resistance in epilepsy: clinical impact, potential mechanisms, and new innovative treatment options. Pharmacol Rev. 2020;72(3):606-638. doi: 10.1124/pr.120.019539.
5. Tang F, Hartz AMS, Bauer B. Drug-resistant epilepsy: multiple hypotheses, few answers. Front Neurol. 2017;8:301. doi: 10.3389/fneur.2017.00301.
6. Baxendale S, Wilson SJ, Baker GA, Barr W, Helmstaedter C, Hermann BP, Langfitt J, Reuner G, Rzezak P, Samson S, Smith ML. Indications and expectations for neuropsychological assessment in epilepsy surgery in children and adults. Report of the ILAE Neuropsychology Task Force Diagnostic Methods Commission: 2017-2021 Neuropsychological assessment in epilepsy surgery. Epileptic Disord. 2019;21(3):221. doi: 10.1684/epd.2019.1065.
7. Vogt VL, Äikiä M, del Barrio A, Boon P, Borbély C, Bran E, et al. Current standards of neuropsychological assessment in epilepsy surgery centers across Europe. Epilepsia. 2017;58(3):343-355. doi: 10.1111/epi.13646.
8. Ryvlin P, Rheims S. Epilepsy surgery: eligibility criteria and presurgical evaluation. Dialogues Clin Neurosci. 2008;10(1):91-103.
9. Sherman EMS, Wiebe S, Fay-McClymont TB, Tellez-Zenteno J, Metcalfe A, Hernandez-Ronquillo L, et al. Neuropsychological outcomes after epilepsy surgery: systematic review and pooled estimates. Epilepsia. 2011;52(5):857-869. doi: 10.1111/j.1528-1167.2011.03022.x.
10. Helmstaedter C, Kurthen M, Lux S, Reuber M, Elger CE. Chronic epilepsy and cognition: a longitudinal study in temporal lobe epilepsy. Ann Neurol. 2003;54(4):425-432. doi: 10.1002/ana.10692.
11. Baud MO, Perneger T, Rácz A, Pensel MC, Elger C, Rydenhag B, et al. European trends in epilepsy surgery. Neurology. 2018;91(2):e96-e106. doi: 10.1212/wnl.0000000000005776.
12. Helmstaedter C. Cognitive outcomes of different surgical approaches in temporal lobe epilepsy. Epileptic Disord. 2013 Sep;15(3):221-39. doi: 10.1684/epd.2013.0587.
13. Kirsch HE. Social cognition and epilepsy surgery. Epilepsy Behav. 2006;8(1):71-80. doi: 10.1016/j.yebeh.2005.09.002.
14. Helmstaedter C, Witt JA. Clinical neuropsychology in epilepsy: theoretical and practical issues. Handb Clin Neurol. 2012;107:437-459. doi: 10.1016/B978-0-444-52898-8.00036-7.
15. Stranjalis G, Liouta E. Neurosurgical Neuropsychology: an emerging sub-specialty. Dialogues Clin Neurosci Ment Health. 2018;1(2):74-78. doi: 10.26386/obrela.v1i2.50.

16. Valton L, Mascott CR. What is the role of neuropsychological testing in the investigation and management of pharmacologically intractable partial epilepsy? Rev Neurol (Paris). 2004;160 Spec No 1:5S154-63.
17. Rosazza C, Ghielmetti F, Minati L, Vitali P, Giovagnoli AR, Deleo F, et al. Preoperative language lateralization in temporal lobe epilepsy (TLE) predicts peri-ictal, pre- and post-operative language performance: An fMRI study. Neuroimage Clin. 2013;3:73-83. doi: 10.1016/j.nicl.2013.07.001.
18. Chou N, Serafini S, Muh CR. Cortical language areas and plasticity in pediatric patients with epilepsy: a review. Pediatr Neurol. 2018;78:3-12. doi: 10.1016/j.pediatrneurol.2017.10.001.
19. Costa DI, Azambuja LS, Portuguez MS, Costa JC. Neuropsychological assessment in children. J Pediatr. 2004;80(2 Suppl):S111-6. doi: 10.2223/1175.
20. Benton AL. Neuropsychological assessment. Ann Rev Psychol. 1994;45(1):1-23. doi: 10.1146/annurev.ps.45.020194.000245.
21. Lezak MD, Howieson DB, Bigler ED, Tranel D. Neuropsychological assessment. 5th ed. Oxford: Oxford University Press; 2012. 1200 p.
22. Helmstaedter C, Witt JA. How neuropsychology can improve the care of individual patients with epilepsy. Looking back and into the future. Seizure. 2017;44:113-120. doi: 10.1016/j.seizure.2016.09.010.
23. Helmstaedter C, Witt JA. Epilepsy and cognition – a bidirectional relationship? Seizure. 2017;49:83-89. doi: 10.1016/j.seizure.2017.02.017.
24. Jones-Gotman M, Smith ML, Risse GL, Westerveld M, Swanson SJ, Giovagnoli AR, et al. The contribution of neuropsychology to diagnostic assessment in epilepsy. Epilepsy Behav. 2010;18(1-2):3-12. doi: 10.1016/j.yebeh.2010.02.019.
25. Gonzalez LM, Wrennall JA. A neuropsychological model for the presurgical evaluation of children with focal-onset epilepsy: an integrated approach. Seizure. 2020;77:29-39. doi: 10.1016/j.seizure.2018.12.013
26. Casaletto KB, Heaton RK. Neuropsychological assessment: past and future. J Int Neuropsychol Soc. 2017;23(9-10):778-790. doi: 10.1017/s1355617717001060.
27. Riccio CA, Sullivan JR, Cohen MJ. Neuropsychological assessment and intervention for childhood and adolescent disorders. Hoboken: John Wiley & Sons; 2010. 720 p. doi: 10.1002/9781118269954.
28. Yeates KO, Taylor HG. Neuropsychological assessment of older children. In: Goldstein G, Nussbaum PD, Beers SR, editors. Neuropsychology. Boston: Springer; 1998. p. 35-61. (Human brain function). doi: 10.1007/978-1-4899-1950-2_3.
29. Duchowny M. Pediatric epilepsy surgery: past, present, and future. Epilepsia. 2020;61(2):228-229. doi: 10.1111/epi.16436.
30. Siegel AM. Presurgical evaluation and surgical treatment of medically refractory epilepsy. Neurosurg Rev. 2004;27(1):1-18. doi: 10.1007/s10143-003-0305-6.
31. Baxendale S, Thompson P. Defining meaningful postoperative change in epilepsy surgery patients: Measuring the unmeasurable? Epilepsy Beh. 2005;6(2):207-211. doi: 10.1016/j.yebeh.2004.12.009.
32. Malmgren K, Edelvik A. Long-term outcomes of surgical treatment for epilepsy in adults with regard to seizures, antiepileptic drug treatment and employment. Seizure. 2017;44:217-224. doi: 10.1016/j.seizure.2016.10.015.
33. Bauman K, Devinsky O, Liu AA. Temporal lobe surgery and memory: lessons, risks, and opportunities. Epilepsy Behav. 2019;101(Pt A):106596. doi: 10.1016/j.yebeh.2019.106596.
34. Drane DL, Ojemann JG, Kim MS, Gross RE, Miller JW, Faught RE, Loring DW. Interictal epileptiform discharge effects on neuropsychological assessment and epilepsy surgical planning. Epilepsy Behav. 2016;56:131-138. doi: 10.1016/j.yebeh.2016.01.001.
35. Helmstaedter C, Reuber M, Elger CE. Interaction of cognitive aging and memory deficits related to epilepsy surgery. Ann Neurol. 2002;52(1):89-94. doi: 10.1002/ana.10260.
36. Gleissner U, Sassen R, Schramm J, Elger CE, Helmstaedter C. Greater functional recovery after temporal lobe epilepsy surgery in children. Brain. 2005;128(12):2822-2829. doi: 10.1093/brain/awh597.
37. Reuner G, Ramantani G. Cognitive development in pediatric epilepsy surgery. Neuropediatrics. 2017;49(02):93-103. doi: 10.1055/s-0037-1609034.
38. Ramos-Perdigués S, Baillés E, Mané A, Carreño M, Donaire A, Rumià J, et al. Psychiatric symptoms in refractory epilepsy during the first year after surgery. Neurotherapeutics. 2018;15(4):1082-1092. doi: 10.1007/s13311-018-0652-1.
39. Koch-Stoecker S, Schmitz B, Kanner AM. Treatment of postsurgical psychiatric complications. Epilepsia. 2013;54:46-52. doi: 10.1111/epi.12105.
40. Raven J. The Raven's progressive matrices: change and stability over culture and time. Cogn Psychol. 2000;41(1):1-48. doi: 10.1006/cogp.1999.0735.
41. Schoenberg M, Dawson K, Duff K, Patton D, Scott J, Adams R. Test performance and classification statistics for the Rey Auditory Verbal Learning Test in selected clinical samples. Arch Clin Neuropsychol. 2006;21(7):693-703. doi: 10.1016/j.acn.2006.06.010.
42. Bean J. (2011). Rey Auditory Verbal Learning Test, Rey AVLT. In: Kreutzer J, et al., editors. Encyclopedia of clinical neuropsychology. London: Springer; 2011. p. 2174–2175. doi: 10.1007/978-0-387-79948-3_1153
43. Anderson P, Anderson V, Garth J. Assessment and Development of organizational ability: the Rey Complex Figure Organizational Strategy Score (RCF-OSS). Clin Neuropsychol. 2001;15(1):81-94. doi: 10.1076/clin.15.1.81.1905
44. Sumerall SW, Timmons PL, James AL, Ewing MJ, Oehlert ME. Expanded norms for the controlled oral word association test. J Clin Psychol. 1997;53(5):517-521. doi: 10.1002/(sici)1097-4679(199708)53:5<517::aid-jclp14>3.0.co;2-h
45. Villa G, Gainotti G, De Bonis C. Constructive disabilities in focal brain-damaged patients. Influence of hemispheric side, locus of lesion and coexistent mental deterioration. Neuropsychologia. 1986;24(4):497-510. doi: 10.1016/0028-3932(86)90094-1.
46. Mori S, Osawa A, Maeshima S, Ozaki K, Sakurai T, Kondo I, Saito E. Clinical examination of reliability/validity of scoring methods for Cube-Copying Test (CCT). Jpn J Compr Rehabil Sci. 2014;5:102-108.
47. Cunningham C, Tuxhorn I, Kotagal P, Bingaman W, Anaya S, Stein MT. Epilepsy surgery in an 8-year-old boy with intractable seizures. J Dev Behav Pediatr. 2007;28(4):330-333. doi: 10.1097/dbp.0b013e318132505b.
48. Wyllie E, Comair YG, Kotagal P, Bulacio J, Bingaman W, Ruggieri P. Seizure outcome after epilepsy surgery in children and adolescents. Ann Neurol. 1998;44(5):740-748. doi: 10.1002/ana.410440507.
49. Viggedal G, Olsson I, Carlsson G, Rydenhag B, Uvebrant P. Intelligence two years after epilepsy surgery in children. Epilepsy Behav. 2013;29(3):565-570. doi: 10.1016/j.yebeh.2013.10.012.
50. Gleissner U, Clusmann H, Sassen R, Elger CE, Helmstaedter C. Postsurgical outcome in pediatric patients with epilepsy: a comparison of patients with intellectual disabilities, subaverage intelligence, and average-range intelligence. Epilepsia. 2006;47(2):406-414. doi: 10.1111/j.1528-1167.2006.00436.x.
51. Skirrow C, Cross JH, Cormack F, Harkness W, Vargha-Khadem F, Baldeweg T. Long-term intellectual outcome after temporal lobe surgery in childhood. Neurology. 2011;76(15):1330-1337. doi: 10.1212/wnl.0b013e31821527f0.
52. Khajavi K, Comair YG, Wyllie E, Palmer J, Morris HH, Hahn JF. Surgical management of pediatric tumor-associated epilepsy. J Child Neurol. 1999;14(1):15-25. doi: 10.1177/088307389901400102.
53. Yu T, Zhang G, Kohrman MH, Wang Y, Cai L, Shu W, et al. A retrospective study comparing preoperative evaluations and postoperative outcomes in paediatric and adult patients undergoing surgical resection for refractory epilepsy. Seizure. 2012;21(6):444-449. doi: 10.1016/j.seizure.2012.04.010.
54. Miserocchi A, Cascardo B, Piroddi C, Fuschillo D, Cardinale F, Nobili L, et al. Surgery for temporal lobe epilepsy in children: relevance of presurgical evaluation and analysis of outcome. J Neurosurg Pediatr. 2013;11(3):256-267. doi: 10.3171/2012.12.peds12334.

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