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Life Outcomes of Anterior Temporal Lobectomy: Serial Long-term Follow-up Evaluations

Jana E. Jones, PhD¹, Jacquelyn B. Blocher, BA², and Daren C. Jackson, PhD¹

¹University of Wisconsin School of Medicine & Public Health, Department of Neurology, Madison, WI

²Long Island University, Department of Psychology, Brookville, New York

Abstract

Background—At three time points, this study examined long-term psychosocial life outcomes of individuals who underwent anterior temporal lobectomy (ATL) compared to individuals with temporal lobe epilepsy that were medically managed.

Objective—Participants were on average 17 years post-surgery. Seizure frequency, employment, driving, independent living, financial independence, mental health, and quality of life were examined at each follow-up assessment, and predictors of outcomes were examined.

Methods—All participants were diagnosed with medically intractable complex partial seizures of temporal lobe origin with or without secondary generalization. A structured clinical interview was utilized at all three time points. Information was obtained regarding seizure frequency, anti-epilepsy medications, employment, driving status, financial assistance, and independent living. Additionally, questions regarding quality of life, satisfaction with surgery, and presence of depression or anxiety were included.

Results—Surgery resulted in significantly improved and sustained seizure outcomes. At the first, second, and third follow-ups 67%, 72%, and 67% of participants in the surgery group remained seizure free in the year prior to follow-up interview. At each follow-up, 97%, 84%, and 84% reported that they would undergo surgery again. Seizure freedom predicted driving outcomes at all three time points, but was not a significant predictor for employment, independent living or financial independence. Psychosocial life outcomes in the surgical group were improved and maintained over time when compared to the medically managed group.

Conclusion—This systematic long-term investigation provides strong support for the positive impact of ATL on psychosocial life outcomes including driving, employment, independent living, and financial independence.

Corresponding Author: Jana E. Jones, PhD, University of Wisconsin School of Medicine & Public Health, Department of Neurology, 1685 Highland Ave, Medical Foundation Centennial Building, Room 7229, Madison, WI 53705, 608-262-5481 (voice), 608-265-0172 (fax), jejjones@neurology.wisc.edu.

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Keywords

anterior temporal lobectomy; epilepsy; psychosocial outcomes; surgical outcomes

INTRODUCTION

In a systematic review of the literature Dodrill et al.¹ reported only one anterior temporal lobectomy (ATL) study measuring psychosocial functioning that incorporated a control group. Almost twenty years after this review, 15 follow-up studies exist which include a medically-managed control group. Téllez-Zenteno et al.² under-scored the need for systematic, long-term controlled studies, as many of the current studies have an absence of control participants. The ability to compare individuals who underwent ATL with controls over a longer follow-up period is essential to observe the trajectory of psychosocial life outcomes in both groups. Hamiwka et al.³ suggested that improvement in social outcomes after surgery might occur slowly over time and may not be observed early on (i.e., 1 year follow-up). The trajectory of life outcomes over time is unclear.³

Table 1 shows the variable methodology of existing studies with control groups, including inconsistent follow-up intervals and differences in psychosocial outcomes of interest. Many included quality of life measures such as the Epilepsy Surgery Inventory (ESI-55) and Quality of Life in Epilepsy Inventory (QOLIE-89). More practical life changes such as employment and education were measured in only six of these studies. Additionally, many of the more recent studies failed to identify epilepsy specific predictors of good and poor psychosocial life outcomes. Several studies from the past 10 years did not include data on seizure-freedom.

The present study examined the long-term psychosocial life outcomes of individuals who underwent ATL compared with medically-managed individuals. Participants initially were interviewed as part of a 5-year follow-up.⁴ Since the initial follow-up, individuals were followed at two additional time points, on average 12 and 17 years post-surgery. This longer-term serial follow-up study focused on the trajectory of psychosocial life outcomes such as employment, driving, independent living, financial independence, as well as mental health and quality of life. Predictors of good versus poor psychosocial life outcomes were also examined.

METHODS

Participants

Participants were candidates for ATL between 1990 and 1997. This study is an observational controlled study. Individuals in this study were not randomly assigned to treatment or control groups. Individuals were diagnosed with medically intractable complex partial seizures of temporal lobe origin. All participants were at least 18 years old and had at least borderline intelligence (WAIS-R Verbal or Performance IQ > 69). Ninety-one individuals met criteria for this study and 84 (92%) participated in the first follow-up interview with an average follow-up of 5 years post-surgery or surgical evaluation.⁴ Of the

original cohort, 61 underwent ATL, and 23 were evaluated and served as a medically managed (control) group. Selection for ATL was determined by an established surgical protocol including (a) prolonged electroencephalography (EEG) monitoring of spontaneous seizures with scalp, epidural, or subdural electrodes; (b) magnetic resonance imaging (MRI); (c) positron emission tomography (PET); (d) Wada test; and (e) neuropsychological assessment and independent speech and language evaluation.⁴ Participants in the medical management group either failed to meet criteria for surgery or declined surgery and continued to receive antiepileptic drug (AED) treatment. At baseline (Table 2), the surgery and medical management groups did not differ in chronologic age, age at seizure onset, IQ, Memory Quotient, MMPI clinical scale elevations, education, or number of medications.

The present study focuses on the second and third follow-up results. Approximately 12 years post-surgery or surgical evaluation and 7 years after the initial follow-up, 75 individuals (89% of the original cohort), 57 ATL and 18 controls, participated in the second follow-up. A third follow-up was conducted an average of 17 years post-surgery or surgical evaluation and 5 years after the second evaluation; 61% (42 ATL and 9 controls) individuals from the original cohort participated in the third follow-up. Surgery group participants were not included in the second and third follow-up interviews due to the following reasons: unable to locate (3 at second follow-up, 9 at third follow-up), declined participation (0 and 3), or were deceased (1 and 3). Within the medical management group, reasons for non-participation included: unable to locate (3 at second follow-up, 6 at third follow-up), declined participation (1 and 3), or were deceased (0 and 2). Attrition was greatest at the third follow-up. There were no significant differences in age, gender or seizure frequency among individuals who participated and did not participate in the third follow-up.

Additionally, there were no differences in time between assessments for the two groups. The average time between pre-surgical assessment and second follow-up was 11.92 years ($SD = 2.09$) for the surgery group and 11.66 years ($SD = 2.07$) for the medical management group. Average time to third follow-up was 17.44 years ($SD = 2.14$) for the surgery group and 18.23 years ($SD = 1.55$) for the medical management group.

Procedures

All participants underwent a 20–60 minute semi-structured telephone interview at each follow-up. Medical records were reviewed to obtain baseline information regarding seizure frequency and psychosocial life outcome status⁴, but were not used at subsequent follow-ups as the majority of individuals were no longer followed at the surgical center. Additionally, whenever difficulty recalling information was demonstrated corroboration by a family member or significant other was utilized. Assessment of psychosocial outcomes focused on employment, education, driving status, financial assistance, and independent living. Information was obtained for the month prior to the initial surgical evaluation, and long-term outcome information was garnered for the previous year before each follow-up interview. Two questions regarding quality of life were included. Three questions regarding depression and anxiety were included in the second and third follow-up interviews (See Questionnaire, Supplement Content 1: Psychosocial Outcomes Questionnaire to review items included in each interview). All participants gave informed consent via telephone. A

waiver of HIPAA authorization was obtained. The Health Sciences Institutional Review Board at the University of Wisconsin School of Medicine and Public Health approved this study.

Employment, independent living, financial independence, and driving—Full-time employment was defined as earning at least minimum wage and working >35 h/week.⁵ Independent living was defined as not requiring assistance in any of three activities of daily living (e.g., organizing and taking medications, keeping appointments, and showering) and as living alone, with a roommate(s), or with significant other(s) (not if living with parents or in an assisted-living arrangement)⁶. Financial independence was defined as receiving no financial assistance from any of three types of governmental assistance: Supplemental Security Income (SSI), Social Security Disability (SSDI), and W-2 (Wisconsin's AFDC replacement program). Driving was defined as holding an active (non-suspended) driver's license.

Quality of life and Mental health—Two one-item scales measuring quality of life were included.⁴ The first solicited a rating of overall quality of life on a 10-point scale.^{7, 8} The second solicited ratings on a 5-point scale; an adaptation of the Dartmouth COOP quality of life chart was used, and the reliability and validity of this measure has been demonstrated in a number of patient populations.^{7, 9} Individuals in the surgery group were also asked to rate their overall satisfaction with the surgery and if they would have the surgery again. Additionally, participants were asked three questions regarding mental health: 1) Are you currently seeing a therapist, counselor, psychologist, or psychiatrist? 2) Have you seen anyone regularly for mood, anxiety, etc. in the past year? 3) Have you been diagnosed with depression, anxiety, etc. in the past year? In the surgery group, baseline and post-surgery Minnesota Multiphasic Personality Inventory (MMPI) clinical scale elevations (i.e., T-scores > 70) were used to indicate psychopathology.

Seizure frequency—Due to concerns about the reliability of self-reported seizure frequency,^{10,11} report of seizure frequency was limited to the year prior to each evaluation. Seizure frequency was categorized as none, daily, weekly, monthly, or yearly.¹² In addition, seizure frequency at follow-up was classified as follows: (a) seizure free, (b) auras with or without one seizure, (c) two to 12 seizures, and (d) more than 12 seizures. This system was recommended for assessing surgery outcomes as related to quality-of-life outcomes.¹³ This system was utilized in the first follow-up interview, and as a result, the classification system recommended by Engel et al.¹⁴ was not used. An additional question regarding seizure freedom since surgery was added.

Data analyses

A modest sample size precluded the use of regression techniques; therefore, t-tests and chi-square tests were used to compare groups on demographic and psychosocial outcome variables, and non-parametric Mann-Whitney U tests were used to compare Likert scale data (quality of life and satisfaction with surgery).

RESULTS

Seizure status

Seizure frequency is presented in Table 3. At the first follow-up, surgery group participants were less likely than medical management group participants ($p < 0.001$) to have experienced seizures in the past year, with 67% vs. 6% being seizure-free. Similar results were seen at the second (72% vs. 28%, $p < 0.001$) and third follow-ups (67% vs. 11%, $p < 0.001$). In the surgery group, 51% remained completely seizure free since surgery. At the first follow-up, 63% of surgery group vs. 100% of medical management group were taking at least one AED ($p < 0.001$); these numbers were similar at the second (66% vs. 88%, $p = 0.112$) and third follow-ups (62% vs. 89%, $p < 0.001$), although this difference was not significant at the second follow-up. At the second follow-up, only one surgery group participant had undergone another ATL within the past five years, and no surgery group participants had received a Vagus Nerve Stimulator (VNS). At the third follow-up, no surgery group participants had undergone another ATL or VNS.

Psychosocial outcomes: Status of surgery and medical management groups

Table 4 contains psychosocial outcome data by group (surgery vs. medical management) at each time point. Both groups showed comparably poor psychosocial status at baseline. There were no significant differences between groups in full-time employment, independent living, financial independence, and driving status at baseline, as reported previously.⁴

As shown in Table 4, there were significant group differences for every psychosocial outcome measure at the initial, 5-year follow-up. Participants in the surgery group were more likely than those in the medical management group to be employed full-time (68% vs. 39%, $p = 0.025$) and living independently (84% vs. 39%, $p < 0.001$). Likewise, surgery group participants were more likely to be financially independent (81% vs. 56%, $p = 0.032$) and have a valid driver's license (67% vs. 28%, $p = 0.004$).

At the second follow-up, these favorable outcomes were maintained. ATL participants continued to show better psychosocial outcomes than their medically managed counterparts in all four categories: full-time employment (61% vs. 33%, $p = 0.037$), independent living (74% vs. 44%, $p = 0.022$), financial independence (81% vs. 44%, $p = 0.003$), and driving status (72% vs. 33%, $p = 0.003$).

At the third follow-up, a similar pattern was seen for independent living (76% vs. 33%, $p = 0.012$) and driving status (74% vs. 33%, $p = 0.019$), with the surgery group indicating better outcomes than the medical management group. Although surgery participants also showed better outcomes for full-time employment (43% vs. 22%) and financial independence (76% vs. 44%), there was no longer a significant difference between the groups (p 's = 0.250 and 0.058, respectively). Notably, when individuals over the age of 60 were excluded from the analyses at the third follow-up (surgery group = 8; medical management group = 1), the employment rate rose from 43% to 50% in the surgery group and declined from 22% to 13% in the medical management group, suggesting that retirement age may play a role in the decrease in employment rates in the surgery group.

Epilepsy factors as predictors

At the first, second, and third follow-up assessments, freedom from seizures was associated with holding an active driver's license in surgery group participants (first follow-up: $r = 0.368$, $p = 0.005$; second follow-up: $r = 0.290$, $p = 0.029$; third follow-up: $r = 0.318$, $p = 0.046$). No other psychosocial outcome variables were predicted by seizure freedom. Additionally, there were no statistically significant associations between number of seizure medications and any psychosocial outcome variables (all r 's < 0.25).

Psychopathology

A history of anxiety, depression and treatment of these problems was investigated at the second and third follow-up interviews. There was no difference between groups in diagnosis (second follow-up: surgery group = 16%; medical management group = 18%) or treatment (both groups = 18% at the second follow-up) of anxiety or depressive disorders in the previous 12 months (p 's > 0.850). These numbers changed only slightly at the third follow-up (surgery group: 17% received both diagnosis and treatment; medical management group: 11%; p 's > 0.65). The number of elevated MMPI clinical scales at baseline was not associated with presence of seizures following surgery. However, surgery group participants with elevated MMPI clinical scales post-surgery were significantly more likely to experience seizures at each follow-up assessment (first follow-up: $r = 0.321$, $p = 0.044$; second follow-up: $r = .443$, $p = 0.004$; third follow-up: $r = 0.515$, $p = 0.004$).

Quality of life and satisfaction with surgery

At the initial follow-up assessment, the surgery group endorsed better quality of life ($M = 8.00$, $SD = 1.88$) than the medical management group ($M = 6.65$, $SD = 2.12$; $p = 0.015$). The groups did not differ significantly in their assessment of quality of life at subsequent follow-up assessments, although surgery group participants continued to report better quality of life (second follow-up: $M = 8.18$, $SD = 1.90$; third follow-up: $M = 8.24$, $SD = 1.75$) relative to their medically-managed counterparts (second follow-up: $M = 7.71$, $SD = 1.90$; third follow-up: $M = 7.33$, $SD = 2.06$). Notably, in the surgery group at first follow-up, those individuals who were free from seizures reported significantly higher quality of life ($M = 8.37$, $SD = 1.79$) than did individuals still experiencing seizures ($M = 7.26$, $SD = 1.88$; $t(55) = 2.159$, $p = 0.035$). At subsequent follow-ups, quality of life ratings did not differ between seizure-free and non-seizure-free participants in the surgery group.

The surgical group participants reported satisfaction with the results of surgery at the first ($M = 9.40$, $SD = 1.36$), second ($M = 9.02$, $SD = 1.93$) and third ($M = 8.98$, $SD = 2.09$) follow-up assessments. Additionally, 97% of participants at the first follow-up, 84% at second follow-up, and 84% at third follow-up, reported that they "would have the surgery again." At all three follow-up assessments, these percentages are significantly higher than would be expected to occur by chance (all p 's < 0.05).

DISCUSSION

As reported previously,⁴ the surgery and medical management groups had similar psychosocial characteristics at baseline. At all three evaluations psychosocial life outcome

differences between the surgery group and the medical management group were reported (Table 4). In the surgery group across the three evaluations, more individuals were working fulltime compared to the medical management group. Similar employment outcomes have been reported in a study that followed individuals 4-years post-surgery.¹⁵

Seizure related outcomes

Surgery clearly resulted in significantly improved and sustained seizure outcomes (Table 4). These rates are similar to those reported by Téllez-Zenteno et al.¹⁶ Driving status was the only psychosocial outcome found to correlate with seizure freedom. This finding is in contrast to Kellett et al.¹⁷ and Wheelock et al.¹⁸ who reported improved psychosocial outcomes with seizure freedom.

Psychopathology

There are a number of studies reporting a significant relationship between psychiatric history and seizure outcomes following surgery.^{19–22} Baseline MMPI clinical scale elevations were not associated with poorer seizure outcomes. This finding is similar to a recent study by Adams et al.²³ that reported no relationship between psychiatric history and seizure outcome among individuals with mesial temporal sclerosis at post-surgical follow-up. However, we found that individuals with elevated MMPI clinical scales post-surgery were significantly more likely to continue experiencing seizures at each follow-up assessment. Devinsky et al.²⁴ reported a similar finding in which there was a significant relationship between post-surgical depressive symptoms and ongoing seizures at a 24-month follow-up. In terms of psychiatric comorbidity at follow-up, there were no differences in rates of depression, anxiety or treatment related to these conditions between the surgery group and medical management group at the second and third follow-up. Devinsky et al.²⁴ also reported similar rates of depressive symptoms in their sample 24 months post-surgery.

Quality of life and satisfaction with surgery

At the initial follow-up, the surgery group endorsed higher quality of life than the medical management group. A similar finding was reported by Markand et al.²⁵ This significant difference disappeared at the second and third follow-up interviews. As reported by Wilson et al.,^{26, 27} this finding may reflect the difficulties discarding the sick role and the “burden of normality” particularly among individuals who are seizure free. Interestingly, seizure freedom did not correlate with better quality of life ratings at the second and third follow-up.

Additionally, individuals in the surgery group were very satisfied with the results of their surgery at all follow-up interviews.

Limitations

The sample size is modest, limiting the data analyses, and individuals were not randomized to the surgical or medical management groups.⁴ Controls were individuals with TLE who were considered for surgery but did not have surgical intervention. Both groups were comparable in baseline cognitive and psychosocial characteristics. Due to the difficulty of scheduling follow-up in-person interviews, data were gathered by telephone using structured interviews via self-report with confirmation from significant others when appropriate. It was

not possible to use longer standardized measures of QOL in the current study design. When possible, information was cross-checked with medical records at the initial follow-up (5-year) but at the subsequent follow-up interviews most participants were no longer receiving medical treatment at the surgical center. At the third follow-up, the surgical and medical management group demonstrated attrition. The majority of individuals were not located or lost at follow-up. Finally, we neglected to take into account the fact that our sample was aging and may be of retirement age, and these individuals were excluded from analyses when appropriate.

Conclusion

This systematic long-term investigation provides support for the positive impact of ATL on long-term psychosocial real life outcomes. Seizure freedom was achieved in two-thirds of the sample at all time points, reflecting previous shorter term follow-up studies and providing support for the long term seizure freedom of this surgical procedure. Driving was predicted by seizure freedom at all three evaluations; however, seizure freedom did not predict additional psychosocial outcomes. The vast majority of surgical participants had significantly reduced seizure frequency across all follow-up evaluations. Seizure reduction, not only seizure freedom, may play a significant role in improved psychosocial outcomes over time, reflecting the complex nature of the relationship between seizures, seizure freedom and psychosocial outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1**Controlled Investigations of Psychosocial Outcomes in Temporal Lobectomy**

Author	Surgical procedure	Number of subjects	Outcomes measures	Seizure free (SF)/not seizure free	Follow-up interval
Rausch & Crandall (1982)	Temporal lobectomy	31 surgery 9 no surgery	<ul style="list-style-type: none"> Dependency Work and school Family relationships Nonfamily relationships 	<ul style="list-style-type: none"> Improvement limited to SF SF increase in IQ 	1–24 mo
Guldvog et al. (1991)	Anterior temporal lobectomy	147 surgery 94 no surgery	<ul style="list-style-type: none"> Employment/school Social pensions Social status Degree of social support Dependency AEDs 	Not reported	<ul style="list-style-type: none"> 2–29 yr after surgery (mdn, 9 yr) 2–13 yr for no surgery (mdn, 9 yr)
Vickrey et al. (1995)	Anterior temporal lobectomy	202 surgery 46 no surgery	<ul style="list-style-type: none"> ESI-55 Employment KAS 	Not reported	<ul style="list-style-type: none"> 5.8 yr for surgery 5.7 yr for no surgery
Baxendale & Thompson (1996)	Temporal lobe surgery	32 surgery 70 no surgery	<ul style="list-style-type: none"> Self-concept Preoperative expectations 	SF/Not SF did not differ significantly in item ratings	1 yr
Kellet et al. (1997)	48% Anterior temporal lobectomy 25% Amygdalohippocampectomy 18% Temporal lesionectomy 9% Extra temporal resection	94 surgery 36 no surgery	<ul style="list-style-type: none"> HRQOL Employment Driving 	SF group HRQOL scores better than those with more than 10 seizures per year	1986–1994 (years included in follow-up) <ul style="list-style-type: none"> No interval given
McLachlan et al. (1997)	Temporal lobectomy	56 surgery 25 no surgery	<ul style="list-style-type: none"> ESI-55 	SF group better QOL at follow-up	6, 12, 24 mo
Gilliam et al. (1999)	Anterior temporal lobectomy	125 surgery 71 wait list control	<ul style="list-style-type: none"> ESI-55 POMS Driving Employment/school AEDs 	SF status not associated with better HRQOL	12 & 24 mo

Author	Surgical procedure	Number of subjects	Outcomes measures	Seizure free (SF)/not seizure free	Follow-up interval
			<ul style="list-style-type: none"> Seizure frequency Adverse events profile 		
Markand et al. (2000)	Anterior temporal lobectomy	53 surgery 37 no surgery	<ul style="list-style-type: none"> QOLIE-89 	HRQOL better in seizure free patients from baseline to 2 year follow up	1 & 2 yr
Wiebe et al. (2001)	Anterior temporal lobectomy	40 surgery 40 wait list control	<ul style="list-style-type: none"> LSSS QOLIE-89 GHC CES-D 	Not reported	3, 6, 9, 12 mo
Helmslaetter et al. (2003)	Temporal lobectomy	147 surgery 120 no surgery	<ul style="list-style-type: none"> VLMT DCS-R Employment/school BDI QOLIE-10 	Seizure free improvement of non-memory functions in T1-T2 and improvement of memory in T2-T3; seizure free less impaired QOLIE-10 scores and less depression	1 yr & 2-10 yr
Slavem & Guldvog (2005)	Resective surgery for focal epilepsy	139 surgery 139 no surgery	<ul style="list-style-type: none"> Survival rates 	Not reported	Average 25 yr
Bien et al. (2006)	Temporal lobectomy	131 surgery 105 wait-list control 194 pre-surgical candidates no surgery 49 no surgery	<ul style="list-style-type: none"> Seizure questionnaire ESI-55 AEDs 	QOL scores of SF patients higher than those of patients who were not SF	Minimum 1 yr
Mikati et al. (2006)	75% Temporal lobectomy 25% Extra temporal resections	20 surgery 17 no surgery	<ul style="list-style-type: none"> ESI-55 	85% of surgery group seizure-free	3 years
McGlone et al. (2008)	Anterior temporal lobectomy (n=8) Amygdalohippocampectomy (n = 1) Hemispherectomy (n = 1)	16 VNS, 10 surgery 9 no surgery	<ul style="list-style-type: none"> QOLIE-89 GDS WMS, MOQ 	Not reported	1 yr
Slavem et al. (2008)	Resective surgery for focal epilepsy	70 surgery 70 matched controls	<ul style="list-style-type: none"> QOLIE-89 	Not reported	Average 15 yr

Abbreviations: AEDs: Anti-epilepsy drugs; BDI: Beck Depression Inventory; CES-D: Center for Epidemiological Studies Depression Scale; DCS-R: Diagnostikum für Zerebralschädigung revised (visual memory test); ESI-55: Epilepsy Surgery Inventory-55; GDS: Geriatric Depression Scale; GHQ: General Health Questionnaire; HRQOL: Health Related Quality of Life; KAS: Katz Adjustment Scale; LSSS: Liverpool Seizure Severity Scale; MOQ: Memory Observation Questionnaire; POMs: Profile of Mood State; QOL: Quality of Life; QOLIE-89, QOLIE-10: Quality of Life in Epilepsy; VMLT: Verbaler Lern und Merkfähigkeitstest (verbal learning test); WMS: Wechsler Memory Scale.

Table 2

Baseline Characteristics: Surgery and Medical Management Groups

Characteristic	Surgery group (n = 57)	Medical management group (n = 18)
Age at baseline (yr) [M(SD)]	37.9 (9.3)	37.9 (10.0)
Age at onset (yr) [M(SD)]	11.4 (10.3)	15.7 (12.9)
Gender [no (%)]		
Female	28 (49.1%)	13 (72.2%)
Male	29 (50.9%)	5 (27.8%)
Full Scale IQ [M(SD)]	86.05 (20.23)	79.19 (22.78)
Memory Quotient (MQ) [M(SD)]	95.95 (14.19)	90.47 (14.30)
MMPI	1.95 (1.90)	2.55 (2.02)
Education [no (%)]		
-Special Ed./less than high school	9 (15.8%)	2 (11.1%)
-GED/high school diploma	30 (52.7%)	9 (50.0%)
-Some college/trade certification	10 (17.6%)	6 (33.4%)
-College graduate	5 (8.8%)	0 (0.0%)
-Graduate degree	3 (5.3%)	1 (5.6%)
Medications [no (%)]		
-Monotherapy	29 (50.9%)	8 (44.4%)
-Polytherapy	28 (49.1%)	10 (55.6%)

Table 3**Seizure Frequency at Each Follow-up**

Seizure Frequency (past year)	First follow-up *		Second follow-up *		Third follow-up *	
	Surgery (n = 57)	MM (n = 18)	Surgery (n = 57)	MM (n = 18)	Surgery (n = 42)	MM (n = 9)
Seizure free	38 (66.7%)	1 (5.6%)	41 (71.9%)	5 (27.8%)	28 (66.7%)	1 (11.1%)
Auras with/without one seizure	7 (12.3%)	0 (0%)	10 (17.5%)	1 (5.6%)	9 (21.4%)	2 (22.2%)
Two to 12 seizures	6 (10.5%)	6 (33.3%)	4 (7.0%)	4 (22.2%)	2 (4.8%)	1 (11.1%)
More than 12 seizures	6 (10.5%)	11 (61.1%)	2 (3.5%)	8 (44.4%)	3 (7.1%)	4 (55.6%)

Surgery = Surgical group

MM = Medical management group

* Surgery group participants experienced fewer seizures at all follow-up time points compared to medical management group participants; $p = 0.05$.

Table 4
Surgery and Medical Management Groups Psychosocial Outcomes at Each Follow-up

Psychosocial Outcomes	Baseline			First follow-up			Second follow-up			Third follow-up		
	Surgery (n=57)	MM (n=18)	p-value	Surgery (n=57)	MM (n=18)	p-value	Surgery (n=57)	MM (n=18)	p-value	Surgery (n=42)	MM (n=9)	p-value
Full-time Employment	56%	44%	ns	68%	39%	0.025	61%	33%	0.037	43%	22%	ns
Independent Living	56%	33%	ns	84%	39%	<0.001	74%	44%	0.022	76%	33%	0.012
Financial Independence	72%	61%	ns	81%	56%	0.032	81%	44%	0.003	76%	44%	ns
Driving Status	12%	28%	ns	67%	28%	0.004	72%	33%	0.003	74%	33%	0.019

Surgery = Surgical group

MM = Medical management group

ns: p>0.05