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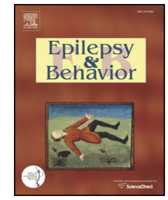

Long-term seizure and psychosocial outcomes after resective surgery for intractable epilepsy

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A B S T R A C T

Resective surgery is considered an effective treatment for refractory localization-related epilepsy. Most studies have reported seizure and psychosocial outcomes of 2–5 years postsurgery and a few up to 10 years. Our study aimed to assess long-term (up to 15 years) postsurgical seizure and psychosocial outcomes at our epilepsy center. The Henry Ford Health System Corporate Data Store was accessed to identify patients who had undergone surgical resection for localization-related epilepsy from 1993 to 2011. Demographics including age at epilepsy onset and surgery, seizure frequency before surgery, and pathology were gathered from electronic medical records. Phone surveys were conducted from May 2012 to January 2013 to determine patients' current seizure frequency and psychosocial metrics including driving and employment status and use of antidepressants. Surgical outcomes were based on Engel's classification (classes I and II = favorable outcomes). McNemar's tests, chi-square tests, two sample t-tests, and Wilcoxon two sample tests were used to analyze the relationships of psychosocial and surgical outcomes with demographic and surgical characteristics. A total of 470 patients had resective epilepsy surgery, and of those, 50 (11%) had died since surgery. Of the remaining, 253 (60%) were contacted with mean follow-up of 10.6 ± 5.0 years (27% of patients had follow-up of 15 years or longer). Of the patients surveyed, 32% were seizure-free and 75% had a favorable outcome (classes I and II). Favorable outcomes had significant associations with temporal resection (78% temporal vs 58% extratemporal, $p = 0.01$) and when surgery was performed after scalp EEG only (85% vs 65%, $p < 0.001$). Most importantly, favorable and seizure-free outcome rates remained stable after surgery over long-term follow-up [i.e., <5 years (77%, 41%), 5–10 years (67%, 29%), 10–15 years (78%, 38%), and >15 years (78%, 26%)]. Compared to before surgery, patients at the time of the survey were more likely to be driving (51% vs 35%, $p < 0.001$) and using antidepressants (30% vs 22%, $p = 0.013$) but less likely to be working full-time (23% vs 42%, $p < 0.001$). A large majority of patients (92%) considered epilepsy surgery worthwhile regardless of the resection site, and this was associated with favorable outcomes (favorable = 98% vs unfavorable = 74%, $p < 0.001$). The findings suggest that resective epilepsy surgery yields favorable long-term postoperative seizure and psychosocial outcomes.

1. Introduction

Resective brain surgery is an effective treatment option for intractable partial epilepsy [1–3], and short-term efficacy has been established through a well-known, randomized controlled trial [4]. A multicenter study group showed initial seizure and quality-of-life (QOL) outcomes for up to 2 years [5] and defined long-term follow-up as >2 years [6]. Relatively few studies have reported a long-term outcome of over 10 years [7–10] and some up to 18 years (mean = 11 years, 9 months) [11] or up to 24 years (mean = 7 years) [12]. Some studies have also shown that postsurgery seizure control remains sustained over the years [9,13,14]. In addition, the psychosocial outcomes are noted to indicate long-term benefits [15] as well.

The aim of our surgical cohort study was to assess long-term postsurgical seizure and psychosocial outcomes in all patients evaluated and operated on at our tertiary epilepsy center by conducting follow-up phone surveys.

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Table 1
Engel's classification.
Source: Engel J Jr, Van Ness PC, Rasmussen TB, Ojemann LM. Outcome with respect to epileptic seizures. In: Engel J Jr (Ed). Surgical treatment of the epilepsies. 2nd ed. Raven Press, New York, NY. 1993, pp. 609–621.

I. Free of disabling seizures
A — Completely seizure-free since surgery
B — Nondisabling simple partial seizures only since surgery
C — Some disabling seizures after surgery but free of disabling seizures for at least 2 years
D — Generalized convulsions with antiepileptic drug withdrawal only

II. Rare disabling seizures ("almost seizure-free")
A — Initially free of disabling seizures but has rare seizures now
B — Rare disabling seizures since surgery
C — More than rare disabling seizures after surgery but rare seizures for at least 2 years
D — Nocturnal seizures only

III. Worthwhile improvement
A — Worthwhile seizure reduction
B — Prolonged seizure-free intervals amounting to greater than half the follow-up period but not less than 2 years

IV. No worthwhile improvement
A — Significant seizure reduction
B — No appreciable change
C — Seizures are worse

2. Materials and methods

2.1. Study description, approvals, and consents

This was a retrospective study to gather preoperative and surgical information and a cross-sectional study to assess postsurgical seizure and psychosocial outcomes. Patients were retrospectively identified using the Henry Ford Health System Corporate Data Store as having had a surgical resection for intractable localization-related epilepsy between July 1993 and September 2011. Data were collected using medical record chart review along with phone surveys. This study was approved by the Henry Ford Health System Institutional Review Board (IRB # 7531). Written consents were waived because of the low-risk, retrospective methodologies of the chart review. Verbal consents were obtained prior to starting every phone survey.

2.2. Data collection

Retrospective chart reviews using the electronic medical record (EMR) were performed to collect demographic information on gender and race, age at epilepsy onset and surgery, seizure frequency before surgery, presurgical evaluation by scalp EEG (sEEG) or the necessity for extraoperative electrocorticography (eECoG), side and site of resection, and pathology. Information on more recent seizure frequency status was obtained from clinic notes at the last office visit found in the EMR. Subject contact information was obtained from the EMR or through the public search database of the Department of Public Health Sciences. Follow-up phone surveys were attempted for all the patients by the research assistant (RT) between May 2012 and January 2013. Phone surveys were chosen over mailed or in-person surveys because of the potential for a better response rate, especially given that a number of the patients may have moved out of the area and/or were not receiving their care at our institution. This data collection method may have been more time- and cost-efficient. The research assistant was given a script which included confidentiality statements along with questions about the patients' current seizure frequency and the current number of antiepilepsy drugs being taken and to assess psychosocial metrics.

Table 2
Data from electronic medical records of patients who had epilepsy surgery and comparisons between patients who did and did not complete surveys.

Variable	Response	Survey completed ($n = 253$)	No survey ($n = 167$)	p-Value
Age at the time of the study for those alive ($n = 420$)	Mean ± S.D.	46.2 ± 13.3	44.1 ± 12.1	0.096
	Median (range)	47 (15 to 80)	45 (16 to 78)	
Gender	F	137 (54%)	84 (50%)	0.439
	M	116 (46%)	83 (50%)	
Race	Caucasian	202 (88%)	132 (90%)	0.835
	African-American	20 (9%)	11 (7%)	
	Others	8 (3%)	4 (3%)	
Presurgical evaluation	Scalp EEG	120 (47%)	89 (53%)	0.240
	Scalp EEG and eECoG	133 (53%)	78 (47%)	
Age at epilepsy onset, years	Mean ± S.D.	15.7 ± 13.9	14.4 ± 11.9	0.318
	Median (range)	12 (0 to 63)	12 (0.25 to 55)	
Age at epilepsy surgery, years	Mean ± S.D.	35.7 ± 13.3	33.0 ± 11.6	0.032
	Median (range)	35 (5 months to 67)	32 (3 to 67)	
Epilepsy duration until surgery, years	Mean ± S.D.	20.5 ± 13.2	18.7 ± 13.0	0.183
	Median (range)	20 (0 to 59.5)	17 (0 to 52)	
Location of epilepsy surgery	Temporal resection	215 (85%)	140 (84%)	0.750
	Extratemporal resection	38 (15%)	27 (16%)	
Side of epilepsy surgery	Right	132 (52%)	79 (47%)	0.428
	Left	120 (47%)	88 (53%)	
	Bilateral	1 (0%)	0 (0%)	
Number of AEDs before surgery	Mean ± S.D.	2.1 ± 0.8	2.0 ± 0.9	0.375
	Median (range)	2 (0 to 5)	2 (0 to 6)	
Number of AEDs after surgery	Mean ± S.D.	2.0 ± 0.8	2.0 ± 0.9	0.690
	Median (range)	2 (0 to 6)	2 (1 to 6)	
Seizure frequency at the last clinic visit[a]	None	101 (66%)	88 (81%)	0.036
	Daily	16 (10%)	6 (6%)	
	Weekly	8 (5%)	6 (6%)	
	Monthly	24 (16%)	8 (7%)	
	Yearly	4 (3%)	0 (0%)	
AEDs tapered or discontinued	Yes	122 (50%)	87 (56%)	0.243
Discontinuation leads to seizures[b]	Yes	47 (39%)	31 (36%)	0.695

[a] $n = 288$ for all patients, $n = 153$ for patients with survey and $n = 108$ for patients without survey.
[b] Any therapy with an AED tapered or discontinued.

Table 3
Surgical pathology findings for patients with epilepsy surgery by survey completion, location of resection, and outcomes.

Pathology	No survey ($n = 167$)	Survey completed (N = 253)	Temporal resection (N = 215)[a]	Extratemporal resection (N = 38)[a]	Favorable seizure outcomes (N = 189)[a]	Not favorable seizure outcomes (N = 64)[a]
Hippocampal sclerosis	38 (23%)	61 (24%)	61 (28%)	0 (0%)	44 (23%)	17 (27%)
Gliosis	28 (17%)	37 (15%)	30 (14%)	7 (18%)	28 (15%)	9 (14%)
Focal cortical dysplasia	14 (8%)	22 (9%)	17 (8%)	5 (13%)	18 (10%)	4 (6%)
Tumor (benign + malignant)	19 (12%)	12 (5%)	8 (4%)	4 (11%)	9 (5%)	3 (5%)
Neuronal mixed glial tumors	8 (5%)	10 (4%)	8 (4%)	2 (5%)	9 (5%)	1 (2%)
Vascular malformation	11 (7%)	6 (2%)	4 (2%)	2 (5%)	4 (2%)	2 (3%)
Others	47 (28%)	105 (42%)	87 (40%)	18 (47%)	77 (41%)	28 (44%)
p-Value	0.02		0.007		0.882	

[a] Only surveyed patients.

The psychosocial metrics to assess driving status, employment status, and antidepressant use were chosen based on our clinical experience with patients with epilepsy as well as the outcomes selected by Dupont et al. [15]. Patients who were deceased at the time of the survey and those who could not be contacted despite at least three phone attempts were not included in the final outcome assessment.

2.3. Outcome assessment

Postsurgical seizure outcomes were based on Engel's classification [16], and classes I and II were considered as favorable outcomes (Table 1). This classification was done by a single epileptologist (VSW) and was based on the patients' responses to seizure frequency. Psychosocial outcomes included on the phone survey assessed before and after surgery included driving status, employment status (full-time, part-time, or unemployed), and the use of antidepressant medications. Patients' satisfaction was assessed by asking them if it was worthwhile having the epilepsy surgery.

2.4. Statistical analysis

To assess the associations of survey response, surgery location, and favorable outcomes with demographic, surgical treatment, and psychosocial measures, chi-square tests were performed for the categorical measures, two sample t-tests were done for age and time, and Wilcoxon two sample tests were performed for the ordinal information, such as the number of antiepilepsy drugs (AEDs). Multivariable analysis for favorable outcomes was done using logistic regression with information from the EMR as the potential independent variables. McNemar's tests were done to compare preoperative to postoperative responses for driving status, employment status, and use of antidepressants. All testing was done at the 0.05 level. Statistical analyses were performed using SAS version 9.2.

3. Results

3.1. Description of identified patients

A total of 470 patients with epilepsy were identified as having surgery between 1993 and 2011 and were included in the initial analyses. Of these patients, 237 (51%) were female and 374 (88%) were Caucasian. The mean age at surgery was 35.4 years with a range from 5 months to 71 years. More than 95% of the resective surgeries for epilepsy were performed by a single neurosurgeon (KE). Based on the time period of the phone survey, the duration of time since surgery was up to 19.3 years (mean $= 10.6 \pm 5$). During the follow-up period between May 2012 and January 2013, deaths were confirmed in 50 patients (11%). Of the remaining 420 patients eligible for survey completion, 253 (60%) were contacted, completed the phone survey, and included in the final analysis. Only 8 patients refused to answer the phone survey after being contacted. The remaining 159 patients could not be contacted (no answer or answering machine) after at least three attempts on different days and different times.

3.2. Medical record and survey response

To assess any potential responder bias, comparisons of demographic, medical, and surgical information between patients who did and did not complete the surveys were done (Table 2). Patients who completed the surveys on average were almost three years older at the time of surgery than those patients who did not ($p = 0.032$). Regarding information about seizure frequency at the last visit ($n = 288$), patients who were not surveyed were more likely not to have seizures at their last clinic visit. No differences were detected for current age, gender, race, age at epilepsy onset, location, side, number of AEDs before and after surgery, and AED tapering in these two groups. Differences were observed in the pathology distribution between patients with and without surveys ($p = 0.02$). Patients with surveys had higher percentages of other pathologies (including reactive changes, glial proliferation, hemorrhage, cortical necrosis, fibrosis, encephalomalacia, or nonspecific changes) and lower percentages of tumors and vascular malformations (Table 3). The rate of response was similar for the different groups based on time since surgery ($p = 0.293$, Table 4).

3.3. Favorable seizure outcomes

Among those who were surveyed, favorable outcomes (Engel classes I and II) were noted in 189 (75%) patients, with 82 (32%) reporting seizure freedom (Engel class IA) (Fig. 1). Engel classes III and IV were observed in 11% and 14%, respectively, of the patients surveyed. Patients

Table 4
Postsurgical seizure outcomes in surveyed patients by follow-up time since surgery.

Follow-up time, years	All eligible patients, *n* (%)	All surveys, N (%)[a]	Favorable seizure outcomes (Engel classes I and II) at the time of the survey, N (%)[b]	Seizure freedom (Engel class IA) at the time of the survey, N (%)[b]
0 to <5	63 (15%)	44 (70%)	34 (77%)	18 (41%)
5 to <10	120 (29%)	73 (61%)	49 (67%)	21 (29%)
10 to <15	123 (29%)	68 (55%)	53 (78%)	25 (37%)
15+	114 (27%)	68 (60%)	53 (78%)	18 (26%)
p-Value	NA	0.293	0.372	0.311

[a] Percentage of all eligible patients excluding deaths.
[b] Percentage of surveyed patients.

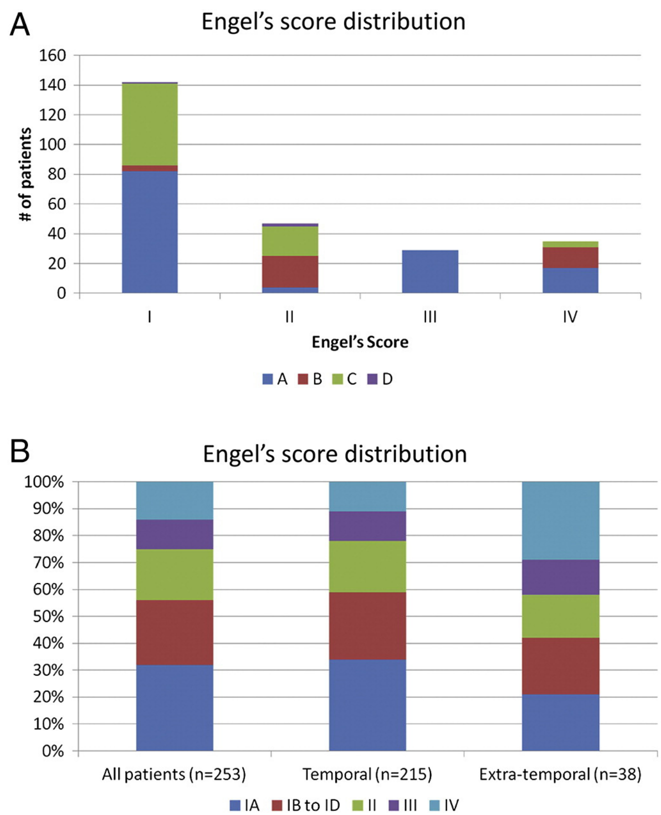

Fig. 1. A. Seizure outcomes after epilepsy surgery were assessed based on Engel's classification with A, B, C, and D reflecting the subcategories described in Table 1. Note the number of patients (y-axis) with the graded Engel's classification (x-axis) [1]. B. Seizure outcomes graded with Engel's classification after temporal and extratemporal resections.

with favorable outcomes were on average 5 years older at the time of the survey compared to patients with unfavorable outcomes (47.5 ± 13.2 vs 42.6 ± 13.1, $p = 0.011$). They were also older at the time of surgery (36.9 ± 13.3 vs 32.3 ± 12.6, $p = 0.014$). Higher rates of favorable outcomes were noted in patients who underwent resective surgery after scalp EEG monitoring (without eECoG) (85% vs 65%, $p < 0.001$) and those who underwent temporal resection (temporal = 78% vs extratemporal = 58%, $p = 0.01$). Favorable outcomes were not significantly different based on age at onset, side, pathology, and number of AEDs before and after surgery. Multivariable analysis for favorable outcomes showed that only surgery after scalp EEG monitoring without eECoG (OR = 2.6, 95% CI = 1.38 to 4.9, $p = 0.002$) remained significant, while age at survey ($p = 0.56$), location ($p = 0.34$), and age at surgery ($p = 0.94$) were no longer significant after adjusting for presurgical evaluation. Higher rates of seizure freedom were also noted in those who had surgery after scalp EEG monitoring (without eECoG) (43% vs 23%, $p = 0.001$).

Of the 253 patients with surveys, 54% were not having seizures at the time of the survey (Table 5). The differences in the location of surgery were significant for the frequency of current seizures ($p = 0.014$, Table 5), with patients with temporal resection having less frequent or no seizures compared to patients with extratemporal resection. As stated previously, those with temporal resective surgeries had a higher rate of favorable outcomes when compared to patients with extratemporal resection (Table 5). In addition, 20% were currently not taking any AEDs and 92% said that the epilepsy surgery was worthwhile (Table 6).

3.4. Psychosocial outcomes

When comparing the surveyed psychosocial metrics, patients were more likely to be driving (before surgery = 35% vs at survey = 51%, $p < 0.001$) and taking antidepressants (before surgery = 22% vs at survey = 30%, $p = 0.013$) at the time of the survey than before surgery. They were less likely to be currently employed full-time (before surgery = 42% vs at survey = 23%, $p < 0.001$).

Additional analyses were done to assess the differences in the psychosocial outcomes and location. The patients with temporal resection were currently on a lesser number of AEDs ($p = 0.027$, Table 6) and had a higher rate of full-time employment before surgery compared to patients with extratemporal resection ($p = 0.006$, Table 6). However, there was no significant difference in full-time employment in both these groups at the time of the survey.

3.5. Psychosocial metrics and favorable seizure outcomes

Patients with a favorable seizure outcome were currently on a lesser number of AEDs (median = 1 vs 3, $p < 0.001$), more likely to currently be driving (65% vs 11%, $p < 0.001$), more likely to be currently employed full-time (28% vs 8%, $p < 0.001$), less likely to be on antidepressants (24% vs 47%, $p < 0.001$), and more likely to say that the epilepsy surgery was worthwhile (98% vs 74%, $p < 0.001$) (Table 6). Seizure-free patients had similar results to those with favorable outcomes. They were on a lesser number of AEDs (median = 0.5 vs 2, $p < 0.001$), more likely to be driving (83% vs 36%, $p < 0.001$), more likely to be employed full-time (34% vs 18%, $p < 0.001$), and more likely to say that the epilepsy surgery was worthwhile (99% vs 89%, $p = 0.006$).

4. Discussion

In this study, we assessed seizure outcomes for up to two decades after resective surgery for epilepsy as well as its impact on psychosocial outcomes in a heterogeneous group of patients.

Our data show that favorable seizure outcomes of up to 78% were attained after surgery for epilepsy, with significantly better results from temporal resection than extratemporal resection in agreement with other studies [17–19], irrespective of pathology or side of resection. The assessment of long-term outcomes helps in defining the enduring effect of epilepsy surgery. In the surveyed patients, rates for favorable seizure outcomes appear to have been sustained over time for up to two decades, indicating stable maintenance of long-term seizure outcomes [9,13,14].

In our study, almost a quarter of the surveyed patients had hippocampal sclerosis, and the favorable seizure outcome was as noted in previous reports [9,18,20]. Unlike other studies [12,18], the type of pathology had

Table 5
Postsurgical seizure outcomes for all surveyed patients by location of resection.

Variable	Response	All surveys ($n = 253$)	Temporal resection (N = 215)	Extratemporal resection (N = 38)	p-Value
Frequency at the time of the survey	Daily	19 (8%)	11 (5%)	8 (22%)	0.014
	Weekly	28 (11%)	24 (11%)	4 (11%)	
	Monthly	42 (17%)	36 (17%)	6 (16%)	
	Yearly	24 (10%)	22 (10%)	2 (5%)	
	None	135 (54%)	118 (56%)	17 (46%)	
Favorable outcomes (Engel classes I and II)		189 (75%)	167 (78%)	22 (58%)	0.010
Seizure freedom (Engel class IA)		82 (32%)	74 (34%)	8 (21%)	0.105

Table 6
Comparison of postsurgical psychosocial outcomes by favorable seizure outcomes (Engel classes I and II) and location of resection.

Variable	Response	All surveys ($n = 253$)	Temporal resection ($n = 215$)	Extratemporal resection ($n = 38$)	p-Value	Favorable seizure outcomes ($n = 189$)	Not favorable seizure outcomes ($n = 64$)	p-Value
Number of AEDs at the time of the survey	Mean ± S.D.	1.7 ± 1.6	1.6 ± 1.3	2.1 ± 1.3	0.027	1.3 ± 1.1	2.7 ± 1.3	<.001
	Median (range)	2 (0 to 6)	2 (0 to 6)	2 (0 to 5)		1 (0 to 5)	3 (0 to 6)	
Driving status before surgery	Yes	88 (35%)	78 (36%)	10 (26%)	0.235	71 (38%)	17 (27%)	0.110
Driving status at the time of the survey	Yes	129 (51%)	114 (53%)	15 (39%)	0.302	122 (65%)	7 (11%)	<.001
	No, due to seizures	77 (30%)	63 (29%)	14 (37%)		29 (15%)	48 (75%)	
	No, due to other reasons	47 (19%)	38 (18%)	9 (24%)		38 (20%)	9 (14%)	
Employment before surgery	Full-time	106 (42%)	96 (45%)	10 (26%)	0.006	83 (44%)	23 (36%)	0.255
	Part-time	42 (17%)	31 (14%)	11 (29%)		30 (16%)	12 (19%)	
	Not employed	104 (41%)	88 (41%)	16 (42%)		76 (40%)	28 (44%)	
	With disability	1 (0%)	0 (0%)	1 (3%)		0 (0%)	1 (2%)	
Employment status at the time of the survey	Full-time	58 (23%)	49 (23%)	9 (24%)	0.426	53 (28%)	5 (8%)	<.001
	Part-time	6 (2%)	5 (2%)	1 (3%)		3 (2%)	3 (5%)	
	Part-time due to other issues	24 (9%)	20 (9%)	4 (11%)		20 (11%)	4 (6%)	
	Not employed due to seizures	45 (18%)	35 (16%)	10 (26%)		11 (6%)	34 (53%)	
	Not employed due to other issues	88 (35%)	77 (36%)	11 (29%)		76 (40%)	12 (19%)	
	Retired	18 (7%)	18 (8%)	0 (0%)		15 (8%)	3 (5%)	
	With disability	14 (6%)	11 (5%)	3 (8%)		11 (6%)	3 (5%)	
Antidepressants before surgery	Yes	56 (22%)	52 (24%)	4 (11%)	0.062	39 (21%)	17 (27%)	0.324
Antidepressants at the time of the survey	Yes	75 (30%)	68 (32%)	7 (18%)	0.097	45 (24%)	30 (47%)	<.001
Was it worthwhile to have epilepsy surgery?	Yes	230 (92%)	196 (92%)	34 (92%)	0.979	184 (98%)	46 (74%)	<.001

no significant effect on the favorable outcome. The numbers in our study are small and may have contributed to this different finding.

There was no significant difference in the favorable outcome whether the surgery was done on the right or the left side (76% vs 74%, $p = 0.771$) in the surveyed patients. This is in agreement with the study by Tanriverdi et al. that reports that the side of surgery has no effect on seizure outcomes [21]. As we reported previously, extraoperative electrocorticography (eECoG) was performed in patients with discordant findings on noninvasive presurgical evaluation implying complex cases [22]. Indeed, we noted a decreased seizure frequency as well as complete seizure freedom in those who had resection after scalp EEG monitoring when compared to those who proceeded to eECoG to further localize the ictal focus, as was also observed by Noe et al. [23].

In our study, AEDs were tapered or discontinued in half of the surveyed patients, with 39% of these having seizure recurrence. One study reported that discontinuation of AEDs after surgery led to seizure freedom in a third of the patients and seizure recurrence in another third, while the remaining third of the patients on AEDs continued having seizures [24]. By comparison, in the study by Schiller et al. [25], high seizure recurrence was noted after withdrawing AEDs in patients who were rendered seizure-free after surgery. Overall, the proportion of seizure freedom after discontinuation of AEDs postsurgery varied across studies [17,24–26]. In addition, we noted a significant reduction in the number of AEDs in those with favorable outcomes when compared to those with unfavorable outcomes as reported in other studies [11,27].

We found that 35% of patients drove before surgery for epilepsy and 51% drove postsurgery which was a statistically significant increase. Resective epilepsy surgery led to regaining driving privileges in those with favorable seizure outcomes and seizure freedom, and driving status improved after surgery as also noted in other studies [28].

Our findings show that there was a decrease in full-time employment status from before to after epilepsy surgery at the time of the survey [15]. This could be due to relative aging of the surveyed patients who were comparatively older and undergoing surgery at a later age. About 7% were retired, and 35% were not employed for reasons other than seizures such as limited education and job training due to longstanding epilepsy or limited employment opportunities due to difficult economic times at the time of the survey. In agreement with other studies, a significantly better full-time employment rate was noted in those with favorable outcomes than those without [29,30].

Numerous studies have reported a relationship between depression as a psychiatric comorbidity and seizure outcomes after epilepsy surgery [31–35]. We have studied the presence of possible underlying depression and its treatment by assessing the use of antidepressants. We found that more patients were being treated with antidepressants at the time of the survey, possibly indicating continuing postsurgical depressive symptoms, other ongoing comorbidities, or depression as a side effect of AEDs, and improved clinical recognition of depression in epilepsy when compared to past years.

Overall, 92% of the patients undergoing resective epilepsy surgery for intractable epilepsy thought that it was worthwhile to have epilepsy surgery irrespective of the location of surgery, whether temporal or extratemporal. Satisfaction rates are also similar to other centers [15]. Those who had favorable outcomes were significantly more satisfied than those who did not (98% vs 74%).

The data collection in this study was performed by surveying the patients or their caregivers using limited answers, limiting the detailed information. In addition, there was the possibility that the responders may not have been truthful with their phone responses. To reduce this potential bias, the patients were assured that their responses were confidential and would not impact their medical care at the institution. They were also told that the responses would be reported in an aggregate manner with no individual identification. Recall bias was also possible; however, the information that could be checked was cross-validated with the EMR. Additionally, the retrospective design of the EMR data collection has its own limitations. Nonetheless, considering the large and heterogeneous patient population, we believe this study successfully attempts to capture long-term seizure outcomes and the psychosocial metrics after resective epilepsy surgery.

5. Conclusion

This study demonstrates a significant favorable seizure outcome (75%) or seizure freedom (32%) after resective epilepsy surgery and that seizure outcomes remain stable for over 15 years postsurgery. Improvement in psychosocial metrics after surgery is noted since more patients were able to drive, and those with favorable seizure outcomes were more likely to be employed full-time and less likely to be taking antidepressant medication. Overall, the great majority of patients expressed satisfaction with epilepsy surgery. These encouraging findings will be valuable during the decision-making process and counseling on different aspects of care in patients with epilepsy.

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Conflicts of interest

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of the authors.

None of the authors has any conflict of interest to disclose. We confirm that we have read the Journal's position on issues involved in ethical publication and affirm that this report is consistent with those guidelines.

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