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Long-term outcome and determinants of quality of life after temporal lobe epilepsy surgery in adults

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Summary
Aim of the study: To find determinants of quality of life (QOL) in long-term follow-up after temporal lobe epilepsy (TLE) surgery in adults.
Methods: The QOLIE-31 questionnaire was sent to 400 of 524 patients who were operated on for refractory TLE between 1991 and 2003 in the Bethel Epilepsy Centre fulfilling the inclusion criteria of this study. Mainly patients with severe cognitive deficits and patients with progressive brain disorders were excluded. There were 222/400 patients who replied to the QOLIE-31 questionnaire and 147/222 of these patients replied to an additional questionnaire.
Results: Univariate analyses showed that seizure freedom, presence of auras, intake of antiepileptic drugs (AEDs), severity of AED side effects, and driving a car were significantly correlated with all subscales of QOLIE-31. Furthermore, employment status, psychiatric problems, tumors and hippocampus sclerosis pathology, the presence of a partner, age at reply, age at surgery and medical co-morbidities were significantly correlated with some subscales of the QOLIE-31. Multivariate analyses (stepwise regression analyses) revealed that especially the time since the last seizure and the severity of AED side effects had a strong impact on QOL. However, aura at last follow-up, psychiatric treatment and employment were seen in the multivariate analyses as significant predictors of some QOL subscales as well. Most subscales of QOL showed a steep, non-linear increase within the first years of seizure freedom and remained relatively stable except for cognitive function which showed continuous improvement parallel to seizure freedom. For patients who were seizure free since surgery, side effects of AED and/or psychiatric treatment were the strongest determinants of QOL.
Conclusion: Duration of seizure freedom and AED side effects have the strongest impact on QOL in the long-term follow-up. Therefore it is important not only to register intake of AEDs

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but also to assess side effects of AEDs. Persistence of auras also had an impact on different facets of QOL, but was significantly correlated with intake of AEDs. Apart from factors directly related to epilepsy QOL was dependent of psychosocial factors as employment status, psychiatric complications, and driving a car underlining the necessity of postoperative rehabilitation in this group.

Introduction

The importance of assessing the quality of life after epilepsy surgery is as old as the roots of modern epilepsy surgery. Penfield and Paine (1955) wrote, ''It is not enough to know whether the surgery procedure has stopped attacks or not. We must know its effect upon the patient's ability to work, to hold a job, to study; the effect on physical and mental function, the effect on behavior and on the happiness of the patient and friends'' (Penfield and Paine, 1955).

Studies focusing on short-term outcomes, including the only randomized clinical trial of surgery in temporal lobe epilepsy (TLE), have shown that epilepsy surgery significantly improves quality of life and health status (Wiebe et al., 2001).

Most epilepsy surgery patients report a positive overall impact of the procedure on their lives and a high willingness to undergo surgery again if that choice had to be made (Chin et al., 2006). The improvement of health-related quality of life (HRQOL) has been reported in short-term studies (Mikati et al., 2006), in studies concerning long-term outcome beyond 5 years (Lowe et al., 2004; Langfitt et al., 2007) and in studies with 10 years and more of follow-up (Tanriverdi et al., 2008). Even among non-seizure-free patients, improvement of HRQOL has been reported (Ahmad et al., 2007). Two reports have found that patients in remission for 3—5 years shifted to normalization of quality of life (Mikati et al., 2006; Spencer et al., 2007). Previous reports have aimed mainly to assess the changes of QOL after surgery (Spencer et al., 2007) and the main focus was on comparing seizure-free versus non-seizure-free patients (Stevanovic, 2007). Our center has already published the outcome of QOL in short-term follow-up (Thorbecke and Högter, 2008). The aim of this study was to evaluate the determinants of HRQOL in long-term follow-up in a large group of patients who underwent refractory TLE surgery at least 5 years prior to the study.

Methods

Patients

All adult patients (≥16 years when having TLR) who had undergone temporal lobe epilepsy surgery for refractory partial epilepsy between 1992 and 2003 in the Bethel Epilepsy Center, Bielefeld, Germany, were included in the study. We excluded patients with mental retardation, patients with Rasmussen encephalitis (progressive disease with special characters) and patients who were operated on for malignant tumors. Four hundred of 524 patients remained.

Duration of follow-up ranged between 5 and 17 years; 5—10 years ($n = 141$, 63.5%), 11—15 years ($n = 77$, 34.7%), and >15 years ($n = 4$, 1.9%).

Data concerning demographics, video-EEG monitoring, presurgical examinations, surgical procedures, postoperative outcome, and medication after surgery were available for all patients. The German QOLIE-31 questionnaire as well as an additional questionnaire (including details of AEDs used, self-reported side effects, psychiatric and psychological treatment, car-driving status, social and working situation) were sent by post to the 400 patients. Eighty of these questionnaires (20%) were returned due to a change in the patient's address. Of the remaining 320 patients, 233 (72.8%) replied to the questionnaires. We excluded 11 replies because other family members answered the questionnaires which could have been an indication that the patient had a cognitive deficit. This left 222 patients included in our analysis (69.4% of those patients who received the questionnaires and 55.5% of the whole sample sent out). All questionnaires were self-administered, completed at home, and returned by post. Only 147 (66.2%) patients replied to the additional questionnaire regarding employment, psychiatric treatment and a driving license. Demographic data and clinical characteristics are listed in Table 1.

Non-responders

As mentioned above, there were 178 patients for whom we either had no correct addresses or who did not reply to the questionnaires. Furthermore, our study excluded the replies from 11 patients who did not answer the questions by themselves. The clinical data of all patients (independent responders, non-independent responders and non-responders) were analyzed regarding demographic variables, as well as clinical and seizure outcome to exclude any bias in the respondent group. The demographic and clinical data did not significantly differ between responders and non-responders ($p > 0.05$; Mann—Whitney test and Chi-square test).

The quality of life in epilepsy-31 questionnaire

The QOLIE-31 is an internationally used epilepsy-specific questionnaire of quality of life whose psychometric properties have been investigated in various studies (Leone et al., 2005). We used the German version of QOLIE-31 (May et al., 2001). The QOLIE-31 is comprised of 7 subscales: overall quality of life, seizure worry, emotional well-being, energy/fatigue, cognitive and medication effects, and social function. Responses produced seven individual scores (one per subtest) and a total (composite) score. The raw values of QOLIE-31 were converted to 0—100 scores, higher values reflected better HRQOL. The total score and the scores for the subscales were calculated according to the QOLIE-31 scoring form.

Statistical analysis

As the first step, univariate ANOVAs and correlation analyses were performed to investigate the effect of various factors on quality of life. Correlation coefficients (r, Pearson correlation coefficient) or 'Eta' were used to describe the effect size of these factors. Eta is a generalization of the point biserial correlation coefficient and of the Pearson correlation coefficient for the case of curvilinear relationship. Eta is closely related to the effect size 'f' of Analysis of Variance (ANOVA) proposed by Cohen (1977). A small ($f = 0.1$),

Table 1 Summary of clinical characteristics and risk factors in the patient group.

Demographic and epilepsy related data (years) in the total group ($n = 222$)		
Mean age at seizure onset (mean ± S.D.)		12.7 ± 9.3
Mean epilepsy duration (mean ± S.D.)		21.3 ± 11.2
Mean age at surgery (mean ± S.D.)		34.1 ± 10.9
Mean duration of follow-up (mean ± S.D.)		9.7 ± 2.7
Mean age at reply (mean ± S.D.)		43.6 ± 11.1
Pathological category		
Hippocampal sclerosis		147 (66.2%)
Tumor		42 (18.9%)
FCD		8 (3.6%)
Other pathology		25 (11.3%)
Side of surgery:	right: 104 (46.8%)	left: 118 (53.2%)
Having a partner:	yes: 126 (57.3%)	no: 94 (42.7%)
Additional data ($n = 147$)		
Co-morbidities:	yes: 68 (46.3%)	no: 79 (53.7%)
Employed[a]:	yes: 82 (56.9%)	no: 62 (43.1%)
Psychiatric treatment[a]:	yes: 20 (14.6%)	no: 117 (85.4%)
Driving a car[a]:	yes: 71 (49.3%)	no: 73 (50.7%)

[a] Due to missing values the sum of yes/no answers was less than 147.

medium (0.25) or large (0.5) effect size corresponds to Eta values of 0.1, 0.24, 0.37, respectively. According to Nunnally and Bernstein (1994), Eta values >0.3 can be regarded as 'important'.

At the second step, multivariate analyses were performed in order to identify those factors that had the strongest impact on quality of life. Therefore, stepwise regression analyses (forward) were performed using those variables as predictors that were significantly related to QOL in univariate analysis. In the ''final'' regression analyses only those independent variables were included which were significant in stepwise regression. Thus, the number of cases included in the regression analyses varied, depending on the variables included, especially due to missing values for the additional data (see Table 1).

The variance inflation factors (VIF) were reported as a check of multicollinearity (Mason and Perreault, 1991). The relationship between the QOLIE-31 and the following variables was investigated:

- Sociodemographic data: age, gender, marital status (y/n), partner* (y/n), occupation*, driver's license (y/n)*, driving a car (y/n)*.
- Epilepsy-related: time since last seizure (months), 3-year remission (y/n), and seizure freedom since surgery (y/n), aura at last follow-up (y/n), age at epilepsy onset, age at surgery, side of operation (left/right), and pathology.
- Antiepileptic drugs (AED): AED intake (y/n), presence of side effects (y/n), severity of AED side effects (none, mild, moderate, severe).
- Co-morbidity: other diseases (y/n)*, psychiatric treatment (or psychotherapy during the last 12 months) (y/n)*.

Marked variables (*) were only assessed in the subgroup of patients.

The relationship between QOL and the amount of time since the last seizure was analyzed using the following variables/model assumptions:

- 'Dichotomic models': 3-year remission (y/n); seizure free since surgery (y/n).
- 'Linear model': time elapsed since last seizure (months).
- Non-linear model: non-linear transformation of time elapsed since last seizure assuming that the impact of the last seizure on quality of life decreases exponentially with time (exp[−time since last seizure]).

In addition, the regression analyses were performed in the patients seizure-free and aura-free since surgery (best outcome group).

For statistical analysis, SPSS for Windows (Version 16.0, SPSS Inc., Chicago, IL) was used.

Results

Seizure outcome

In our study, 167 patients (75.2%) had been seizure free for a period of at least 1 year before the last follow up, whereas 106 patients (47.7%) had been seizure free since surgery (best outcome group). The duration of seizure freedom in this study ranged from 0.08 to 16 years. There were 172 patients (77.5%) who were free of auras and 50 patients (22.5%) who had various types of auras in the year before the last follow-up. There were 22 patients (13.2%) who were seizure free but reported various types of auras.

Medication outcome

In this analysis 61 patients (27.5%) had successful AED discontinuation without relapse of seizures for a minimum of 1 year before this study. Side effects (self-reported) were reported by 62 (38.5%) of 161 patients still on AED treatment. The severity of self-reported side effects was mild in 38 patients (23.6%) and moderate or severe in 24 patients (14.9%). Our AED treatment protocol has been published elsewhere (Elsharkawy et al., 2009).

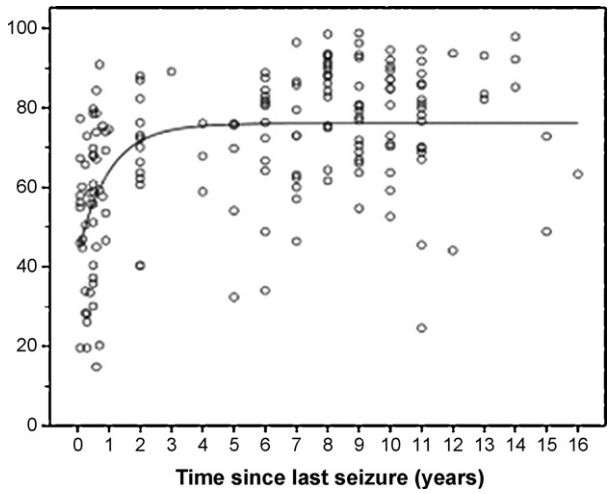

Figure 1 Non-linear relationship between time since last seizure and observed QOLIE-31 total score (non-linear, exponential model). The significance for the subscales are in Table 2.

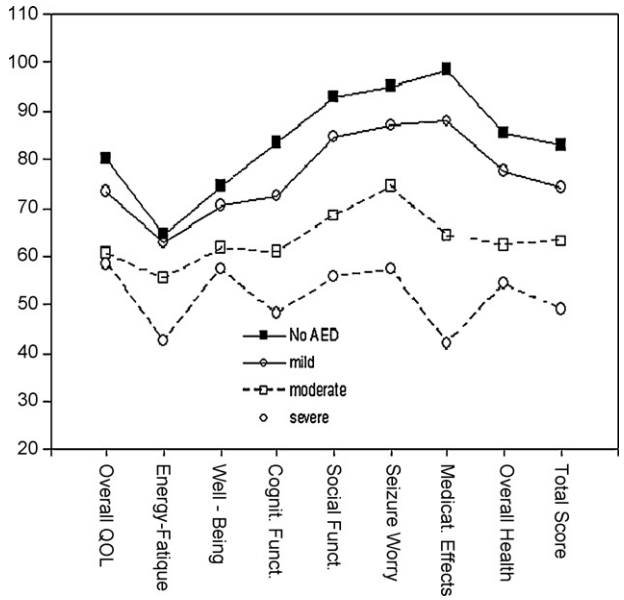

Figure 2 Mean scores of QOLIE-31 subscales and total score related to side effects from AEDs.

Quality of life

Univariate analysis of quality of life

Factors correlated with quality of life

Time since the last seizure (linear and non-linear), the presence of auras at the last follow-up, intake of antiepileptic drugs, the presence of AED side effects and driving a car were significantly correlated to HRQOL in all subscales of QOLIE-31 (Table 2 and Fig. 1). However, the side of surgery, age at surgery, age at reply, hippocampal sclerosis and tumor in pathology, the presence of a partner, employment, psychiatric treatment and the presence of co-morbidities were also slightly or moderately but significantly correlated with QOL in some subscales (see Table 2).

Impact of auras on QOL in seizure-free patients at last follow-up

In addition, the impact of an aura was investigated in patients who were seizure free at their last follow-up examination. Patients ($n = 22$) who had been seizure free at the last follow-up (minimum 1 year of seizure freedom) but reported auras between the surgery date and the last follow-up had significantly lower scores in all subscales of QOLIE-31 except overall health status, compared to patients who had been seizure free and who had no auras ($n = 145$). The impact of auras in seizure-free patients was especially prominent on the subscales overall quality of life (61.8 ± 17.3 vs. 77.0 ± 16.5, $p = 0.003$), energy/fatigue (53.2 ± 17.6 vs. 65.0 ± 17.2, $p = 0.003$), well-being (62.0 ± 16.0 vs. 72.9 ± 20.2, $p = 0.003$), and seizure worry (80.9 ± 20.9 vs. 92.3 ± 15.5, $p = 0.003$). Seizure-free patients with or without auras at the last follow-up did not differ significantly in the amount of time elapsed since the last seizure (8.4 ± 3.1 years. vs. 7.6 ± 4.0 years, $p = 0.332$).

AEDs and AED side effects

AED intake, occurrence of side effects from AEDs and the severity of side effects (none, mild, moderate or severe) were associated with lower QOL. The total score was 48.9 ± 18.8 in patients with severe side effects, 63.1 ± 17.7 with moderate side effects, and 74.1 ± 17.4 in patients who had no side effects; however it reached 83.0 ± 10.3 in patients who had stopped taking AEDs (Fig. 2).

Driving, employment status, partnership, psychiatric treatment and age

Driving a car was correlated to all subscales of the QOL and patients allowed to drive a car had clearly higher QOL scores in comparison to those who were not allowed to drive. The total score was 62.8 ± 18.2 in patients who did not drive compared to 76.4 ± 16.9 in patients who did ($p < 0.001$). However, it should be taken into account that driving was significantly correlated with the amount of time since the last seizure ($r = 0.35$, $p = 0.002$).

Holding a job had a positive effect on ratings for overall quality of life, energy/fatigue, well-being, cognitive function, and the overall health state. The presence of a partner had a positive effect on social function and the overall score for health. The presence of psychiatric disease requiring treatment (either in hospital or as an outpatient) had negative effects on the QOLIE-31 subscales overall quality of life, well-being, cognitive function, and social function. The age at surgery had an inverse relationship to the cognitive function scale. The age at the reply to the questionnaire had an inverse relationship with HRQOL cognitive function and on the overall score/health.

Other factors

Left-sided surgery had a negative effect on the cognitive function rating. Patients with HS in pathology showed low overall health scores in comparison with other pathology types. However, compared to other types of pathology, patients with tumors showed higher scores in overall quality of life, cognitive function, overall score/health and QOLIE-31 total scores.

Table 2 Factors related with quality of life (univariate analyses) — Pearson correlation coefficients or Eta coefficients.

Predictor	Overall quality of life	Energy/fatigue	Well-being	Cognitive function	Social function	Seizure worry	Medication effects	Overall score health	Total score QOLIE-31
Partner (y/n)	.13	.04	.07	.09	**.21****	.08	.13	**.15***	.12
Driving a car (y/n)	**.30*****	**.21***	**.21***	**.26****	**.35*****	**.31*****	**.35*****	**.38*****	**.39*****
Employed (y/n)	**.36*****	**.16***	**.27****	**.23****	.13	.11	.06	**.25****	**.27****
Age at surgery	−.10	−.05	−.07	**−.14***	−.06	.06	−.01	**−.15***	−.08
Age at reply	−.11	−.07	−.08	**−.15***	−.09	.05	−.02	**−.17***	−.10
Duration of seizure freedom (linear)	**.38*****	**.31*****	**.30*****	**.40*****	**.51*****	**.54*****	**.44*****	**.47*****	**.48*****
Duration of seizure freedom (non-linear)	**.42*****	**.38*****	**.35*****	**.37*****	**.60*****	**.61*****	**.43*****	**.54*****	**.53*****
Seizure free or not since surgery (y/n)	**.38*****	**.35*****	**.30*****	**.29*****	**.42*****	**.48*****	**.46*****	**.39*****	**.43*****
Presence of aura (y/n)	**.36*****	**.25*****	**.28*****	**.20****	**.25*****	**.44*****	**.29*****	**.31*****	**.32*****
AED (y/n)	**.33*****	**.17***	**.23****	**.40*****	**.34*****	**.31*****	**.39*****	**.38*****	**.36*****
Severity of Side effects of AED	**.29*****	**.32*****	**.26****	**.33*****	**.40*****	**.39*****	**.60*****	**.40*****	**.40*****
Side effect (y/n)	**.29*****	**.28*****	**.25*****	**.30*****	**.38*****	**.35*****	**.55*****	**.38*****	**.37*****
Comorbidity (y/n)	.17	.10	.13	.12	.13	.06	.15	**.21***	.12
Psychiatric treatment (y/n)	**.24****	.10	**.30*****	.13	**.19***	.06	.10	**.27****	.17
Hippocampus sclerosis (y/n)	.10	.01	.04	.08	.03	.06	.04	**.17***	.03
Tumor (y/n)	**.18****	.07	**.14***	**.19****	.10	.09	.14	**.17***	**.19***
Side of surgery (left/right)	.06	.03	.01	**.13***	.00	.10	.04	.09	.09

Bold numbers signify significant value.
** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

Multivariate analysis of quality of life

Stepwise regression analyses were used for multivariate analyses.

Predictors of QOL in the total patient group

The analysis revealed that the time elapsed since the last seizure was significantly correlated with all subscales of QOLIE-31. The results indicate that, compared to a linear model, a non-linear model is more appropriate to describe the relationship between the duration of seizure freedom and QOL. That means that there is a steep increase of QOL in the first 2 years of freedom of seizures, then stabilizing at that level. An exception is the cognitive function subscale which shows a linear increase. The presence of auras has an impact on well-being, seizure worry and overall quality of life. The severity of AED side effects is related to low scores on the subscales energy/fatigue, social function, seizure worry and medication effects as well as to low scores on the total score of QOLIE-31, whereas intake of AEDs was related to lower scores on subscale cognitive functioning. Psychiatric treatment has an impact on the overall quality of life, well-being and overall health. Employment is correlated with overall quality of life, well-being, and the total score of QOLIE-31 The variance inflation factor (VIF) indicates that no substantial collinearity of the predictors appeared in stepwise regression analyses (VIF <10 in almost all cases; Table 3).

Predictors of QOL in patients seizure-free and aura-free since surgery (best outcome group)

In this group, stepwise regression revealed that the presence of psychiatric treatment and the severity of side effects of AEDs have the most significant impact on QOL. Furthermore, driving a car was correlated with social functioning, overall score health and the total score QOLIE-31 (Table 4). Duration of seizure freedom (amount of time elapsed since the last seizure) has no significant effect on quality of life. This seems to be in contrast to the total group. However, all patients of this group were seizure free for at least 4 years. Therefore, according to the non-linear model of duration of seizure freedom (see section ''Predictors of QOL in the total patient group''), only slight changes of QOL are to be expected after such a long duration of seizure freedom.

Table 3 Results of regression analyses (multivariate analysis) in the total patient group.

Predictor	Overall quality of life	Energy/fatigue	Well-being	Cognitive function	Social function	Seizure worry	Medication effects	Overall score health	Total score QOLIE-31
Employed (y/n)	.30** (2)		.24** (3)						.19** (3)
Duration of seizure freedom non-linear	.26** (1)	.33*** (1)	.20** (1)		.53*** (1)	.49*** (1)	.30*** (2)	.46*** (1)	.46*** (1)
Duration of seizure freedom linear				.27*** (1)					
Aura at last follow-up (y/n)	−.25** (3)		−.24** (4)			−.20** (3)			
AEDs (y/n)				−.27*** (2)					
Severity of side effects		−.25*** (2)			−.28*** (2)	−.23*** (2)	−.52*** (1)		−.29*** (2)
Psychiatric treatment (y/n)	−.16* (4)		−.23** (2)					−.22* (2)	
VIF	3.7	4.9	3.8	6.4	4.9	5.5	5.0	1.9	5.0
n	129	216	129	217	208	185	184	130	172
R/R^2	.57/.30	.45/.20	.52/.24	.47/.21	.66/.42	.69/.47	.66/.44	.53/.27	.60/.36

For each stepwise regression analysis the standardized regression coefficients, their statistical significance [*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$], order of inclusion in parentheses, VIF (variance inflation factor), *n* = number of included patients, *R* = multiple regression coefficient, and corrected R^2 (explained variance) were reported.

Discussion

Quality of life has been established as a cornerstone in the evaluation of surgery as a treatment for refractory temporal lobe epilepsy because of an increasing understanding of the complex impact of epilepsy on patient QOL (Raty and Wilde Larsson, 2007). This analysis shows that QOL in long-term follow-up depends on multiple factors and not only on seizure freedom, although seizure freedom has the strongest impact on QOL. Previous studies reported that seizures are not the sole criteria in evaluating social outcome (Gueguen et al., 2008). Medical and psychiatric conditions were significant predictors of QOL after accounting for demographic variables (Pulsipher et al., 2006). Moreover, the positive anticipation of change prior to surgery and learning to discard roles associated with chronic epilepsy

Table 4 Results of regression analyses (multivariate analysis) for patients who were seizure and aura free since surgery (best outcome group).

Predictor	Overall quality of life	Energy/fatigue	Well-being	Cognitive function	Social function	Seizure worry	Medication effects	Overall score health	Total score QOLIE-31
Driving (y/n)					.24* (4)	n.s.		.25* (3)	.33* (2)
Partner (y/n)	.28* (1)				.27** (3)	n.s.			
Severity of side effects				−.27* (2)	−.37** (1)	n.s.	−.38*** (1)	−.39** (1)	−.43** (1)
Psychiatric treatment (y/n)	−.25* (2)	−.31* (1)	−.38** (1)	−.34** (1)	−.37*** (2)	n.s.			
VIF	3.3	1.4	1.4	6.1	10.3	No predictors included	7.4	7.8	9.0
n	66	67	67	68	58		79	60	45
R/R^2	.40/.13	.30/.09	.38/.13	.50/.23	.74/.51		.39/.14	.60/.33	.54/.26

For each stepwise regression analysis the standardized regression coefficients, their statistical significance [*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$], the order of inclusion of predictors (in parentheses), VIF (variance inflation factor), n = number of included patients, R = multiple regression coefficient, and corrected R^2 (explained variance) were reported.

after surgery have significant effects on QOL (Wilson et al., 1999).

Epilepsy surgery is an important life event for patients with epilepsy and most patients are eager to discard epilepsy from their self-image (Wilson et al., 2007). Seizure outcome shapes many aspects of life after surgery: seizure-free patients undergo a process of adjustment during the transition from chronic disability to sudden wellness. This transition is relatively smooth but may be accompanied with what is known as the burden of normality (Wilson et al., 2007). On the other hand, patients who have seizures after surgery experience significant disappointment and a sense of ''failure'' (Bladin, 1992).

Surprisingly, our study in patients with a long-term follow-up (≥5 years) showed that QOL was also determined mainly by the duration of seizure freedom comparable to studies which focused on the first years after surgery. This effect is non-linear that means that there is a strong increase in QOL during the first 2 years after the last seizure afterwards stabilizing at the reached plateau. These results are in agreement with previous studies with a shorter follow-up which showed that seizure freedom appeared to be the most important factor determining the HRQOL after epilepsy surgery (Kellett et al., 1997; Malmgren et al., 1997; Spencer et al., 2007; Cascino, 2007).

The negative impact of having an aura has been reported previously (Markand et al., 2000). Freedom of auras has been found to be essential for continuing improvement of QOL after the first 2 years after surgery (Spencer et al., 2007). However, in our study, the persistence of an aura was significantly correlated with AED intake; AEDs were withdrawn in only 2 out of 22 (9.1%) patients with auras, compared to 59 out of 145 (40.7%) patients without seizures and without an aura at the last follow-up ($p = 0.004$, Fisher's Exact Test). Therefore, the impact of AED intake or the presence of AED side effects might interfere with the measured effect of an aura on QOL.

QOL in the best outcome group depended mainly on the factors making possible a ''normal life'' — the presence of a partner, and driving a car, no need for psychiatric treatment, no AED side effects — all having a significant influence on QOL. Some prior studies showed that patients in remission for 3—5 years shift to normalization (Mikati et al., 2006; Spencer et al., 2007).

Psychiatric symptoms and psychiatric disorders are frequent in patients with treatment resistant TLE (Devinsky, 2003; Kanner et al., 2004). Various studies carried out within the last 10 years showed presurgical psychiatric comorbidity between 27 and 65%, with similar rates after surgery (Anhoury et al., 2000; Glosser et al., 2000; Inoue and Mihara, 2001; Cankurtaran et al., 2005). In addition to severe postoperative conditions such as depressive disorders in about 10% of operated patients (Glosser et al., 2000; Kanemoto et al., 2001) and psychoses in about 2% (Anhoury et al., 2000; Kanemoto et al., 2001; Cankurtaran et al., 2005), many patients are confronted with adaptation problems on their way to living without epilepsy (burden of normality) (Bladin et al., 1999). Postoperative improvement in depression scores is concomitant with good seizure outcome (Derry et al., 2000), and in several studies psychiatric (depressive) symptoms were relevant predictors of quality of life (Loring et al., 2004; Tracy et al., 2007). Our results are in concor-

dance with these findings showing that being in psychiatric treatment affects quality of life negatively also in those with an optimal seizure outcome.

Several authors found that cognitive abilities are the most critical feature associated with seizure control (von Lehe et al., 2006). Of importance is that cognitive function in our patients who had been seizure-free since surgery showed a continuous improvement lasting 10 years or more after last seizure suggesting that cognitive function need a long duration of seizure freedom and extended periods of normal life to be achieved.

Some authors have found a minimal effect of continuous AED intake (vs. withdrawal of AED) on QOL (Spencer et al., 2007), whereas other authors have reported that AED intake is an important postoperative predictor of QOL (Stevanovic, 2007; Gilliam et al., 1999).

In our study AED intake had only a minimal impact on QOL. However, the presence and severity of side effects reported by the patients has a strong impact on QOL in the total group as well as in the best outcome group. The disappointment not to be cured from ones epilepsy although having become seizure free for many years might bear a more critical perception of side effects. In view of the strong effects of side effects on QOL it seems important not only to register intake of AEDs but also to assess side effects of AEDs and their severity.

In our analysis, other variables besides seizure freedom and side-effects of AED had an influence on other subdomains of QOL. Employment had a positive effect on the overall quality of life. Previous reports found that to gain full employment is a good predictor of overall well-being and patient satisfaction postoperatively (Carran et al., 1999). These results confirm the need for vocational rehabilitation after surgery (Thorbecke and Högter, 2008; Chin et al., 2006). In the best outcome group, having a partner was correlated with high scores on overall quality of life and social function and driving a car predicted high scores on social functioning, overall health score, and total score QOLIE-31. These results are in agreement with findings of other authors as being allowed to drive a car is repeatedly stated by patients to be a major factor that improves their quality of life (Kellett et al., 1997). The elimination of seizures by epilepsy surgery creates new opportunities for changing social relationships (Ray et al., 2002) and having a partner means normalization of social functioning.

Limitation of the study

Admittedly, our study has limitations. The QOL data presented was for only 58% of the whole patient group with temporal epilepsy surgery, comparing between responder and non-responder for the QOLIE-31 were done at one point of follow-up. The study was done at only one point of follow-up. Nevertheless, our study offers new and valuable insights regarding QOL in a large group of temporal lobe surgery patients with long-term follow-up in one center.

Conclusions

Our results confirmed that the duration of seizure freedom and absence of AED side effects have the strongest impact on QOL in long-term follow-up. Most QOL subscales showed a steep, non-linear increase in the first 2 or 3 years of seizure freedom and then remained relatively stable or showed only a slight increase.

In view of the strong effects of side effects on QOL it seems important not only to register intake of AEDs but also to assess side effects of AEDs and their severity.

Furthermore, persistence of auras also had an impact on different facets of QOL. However, persistence of auras was significantly correlated with intake of AEDs and probably with their side effects.

Apart from factors directly related to epilepsy QOL was dependent of psychosocial factors as employment status, psychiatric complications, and driving a car underlining the necessity of postoperative rehabilitation in this group.

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