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# Health-Related Quality of Life in Patients with Subarachnoid Haemorrhage

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**Key Words**
Subarachnoid haemorrhage · Quality of life · Coiling · Clipping

**Abstract**
***Background:*** Aneurysmal subarachnoid haemorrhage (SAH) is a devastating disease with high mortality and disability. The data from large longitudinal studies on health-related quality of life (HRQoL) in patients with SAH are limited. The objective was to investigate HRQoL in patients after SAH and to identify predictors of HRQoL. ***Methods:*** 113 patients with aneurysmal SAH were assigned to either neurosurgery (n = 57) or endovascular coiling (n = 56). Clinical assessments (Barthel Index, modified Rankin Scale) and evaluation of HRQoL [36-Item Short-Form Survey, EuroQol (EQ5D), EQ visual analogue scale (EQ VAS)] were performed at discharge, and at 6 and 12 months of follow-up. Independent predictors of HRQoL were determined using multiple regression analysis. ***Results:*** HRQoL in SAH patients was considerably reduced compared to the normal population. At discharge, 92.2% of the patients had moderate or severe problems on the EQ5D. The EQ VAS score was 57.8 ± 19.3. However, HRQoL still showed improvement from 3 months up to 1 year. At 12 months after SAH, the EQ VAS score was approximately 12–14% higher than at discharge. The independent predictors of decreased HRQoL included female gender, severe SAH, functional disability, depression, a lower level of education and the lack of a stable partnership. ***Conclusions:*** The long-term HRQoL outcome after SAH is unfavourable. HRQoL outcome measures should be included in future studies to provide better evidence of the long-term outcomes after SAH. In addition, the independent determinants of HRQoL identified in this study should be considered in the healthcare programmes aimed at increasing the HRQoL in SAH survivors.


## Introduction

The incidence of subarachnoid haemorrhage (SAH) caused by ruptured intracranial aneurysm is 4–19 cases per 100,000/year in most Western populations [1]. In Germany, approximately 11,400 people are diagnosed as having aneurysmal SAH annually [2]. Aneurysmal SAH accounts for approximately 5% of all strokes and thus places a significant economic burden on societies and patients' families [3–7].

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Although neurosurgical interventions to clip aneurysms have been refined, the 1-year outcomes after craniotomy remain unfavourable. Approximately 30% of the SAH survivors die within 12 months or remain dependent on help in daily activities [8–10]. The International Subarachnoid Aneurysm Trial (ISAT) evaluated neurosurgical clipping versus endovascular coiling in 2,143 patients with SAH and found significantly better outcomes in terms of survival free of disability with endovascular coiling [8, 11]. This finding has led to obvious changes in the treatment of cerebral aneurysms with endovascular coiling being regarded as the first tier therapy in most instances.

Traditionally, clinical trials use clinical rating scales [NIHSS, modified Rankin Scale (mRS), etc.] as primary outcome measures. However, the clinical scales that are currently available do not consider multiple dimensions of patient life and do not address all aspects of recovery after SAH [12]. They do not take into account patient perception of physical and psychological well-being or social participation. In recent years, the concept of health-related quality of life (HRQoL) has been established in order to close this gap.

The importance of HRQoL assessments in patients following SAH has increasingly been recognized through a growing number of studies investigating different dimensions of HRQoL in SAH survivors [12–19]. Studies comparing HRQoL outcome measures in patients who underwent endovascular coiling versus those who underwent neurosurgical clipping were performed either for unruptured intracranial aneurysms [20, 21] or only included small numbers of patients with SAH [16, 17, 22].

The objective of this longitudinal study was to investigate HRQoL in patients following SAH who were treated according to an ISAT consensus protocol and to systematically explore determinants of long-term HRQoL. HRQoL outcome measures for endovascular coiling and neurosurgical clipping were compared in a non-randomized fashion.

## Patients and Methods

*Patient Selection*

Patients (n = 143) with ruptured and unruptured cerebral aneurysms treated at the Department of Neurosurgery and Neuroradiology at the University of Bonn (catchment area of approximately 500,000 people) between January 2004 and December 2005 were screened for participation in the study. The patients were enrolled in the study if they met the following criteria: (1) they had a definite SAH proven by cCT, cMRI or lumbar puncture; (2) they had an intracranial aneurysm as demonstrated by intra-arterial or by cCT angiography that was considered to be the cause of SAH, and (3) they were in a clinical state that justified treatment with either coiling or clipping. Based on these inclusion criteria, 113 patients with aneurysmal SAH were enrolled for participation in the study. The study protocol was approved by the local ethics committee of the University of Bonn. All participants in the study gave informed consent. In cases of inability of the patients to agree to the study, informed consent was received from their legal caregivers.

The study had 2 treatment arms: neurosurgical clipping (n = 57) and endovascular coiling (n = 56). A flow diagram depicting the study is provided in figure 1. Treatment allocation to endovascular coiling or surgical clipping was performed in accordance with the ISAT study results [8]. All patients with symptomatic aneurysms of the middle cerebral artery or space-occupying intracranial haemorrhages were allocated to surgical aneurysm clipping and haematoma evacuation as necessary. All other aneurysms of the anterior or posterior circulation were evaluated by a neuroradiologist for endovascular coil occlusion.

*Clinical Assessment*

Each patient underwent a complete medical and neurological examination, including a standardized assessment of signs and symptoms at admission prior to treatment, at the time of discharge and at 6 and 12 months of follow-up. The clinical status at admission was evaluated using the World Federation of Neurological Surgeons scale [23] and the Hunt and Hess scale [24].

At discharge as well as at 6 and 12 months of follow-up, functional status and disability [Barthel Index (BI), mRS], depression (Beck Depression Inventory, BDI [25]), cognitive impairment (Mini-Mental State Examination, MMSE [26]) and HRQoL were evaluated. The BI is a measure of disability ranging in 5-point increments from 0 (totally dependent and bedridden state) to 100 (fully independent) [27]. The mRS is a measure of functional status that ranges from 0 (no symptoms) to 5 (severe impairment) and death (6). Patients scoring from 0 to 2 on the mRS were classified as independent in activities of daily living; those scoring 3–5 were categorized as experiencing moderate to severe disability [28]. The total BDI sum scores were grouped into 5 bands that represented normal (<10 patients), mild (11–16 patients), borderline (17–20 patients), moderate (21–30 patients), severe (31–40 patients) and very severe (>40 patients) depressive symptoms [29].

*Health-Related Quality of Life*

Two generic, self-administered instruments were used to measure HRQoL: the 36-Item Short-Form Survey (SF-36) and the EuroQol (EQ5D) [30]. No disease-specific HRQoL scales are currently available for SAH.

The SF-36 quantifies subjective reports of health in terms of functional status, emotional status and general well-being [31]. It includes 36 questions that are divided into 8 domains: (1) physical functioning (PF); (2) role limitations due to physical problems (RP); (3) bodily pain (BP); (4) general health (GH); (5) vitality (VT); (6) social functioning (SF); (7) role limitations due to emotional problems (RE), and (8) mental health (MH). A lower score indicates a reduced HRQoL which can range from 0 to 100 in each domain. The data analysis was performed according to German recommendations [32].

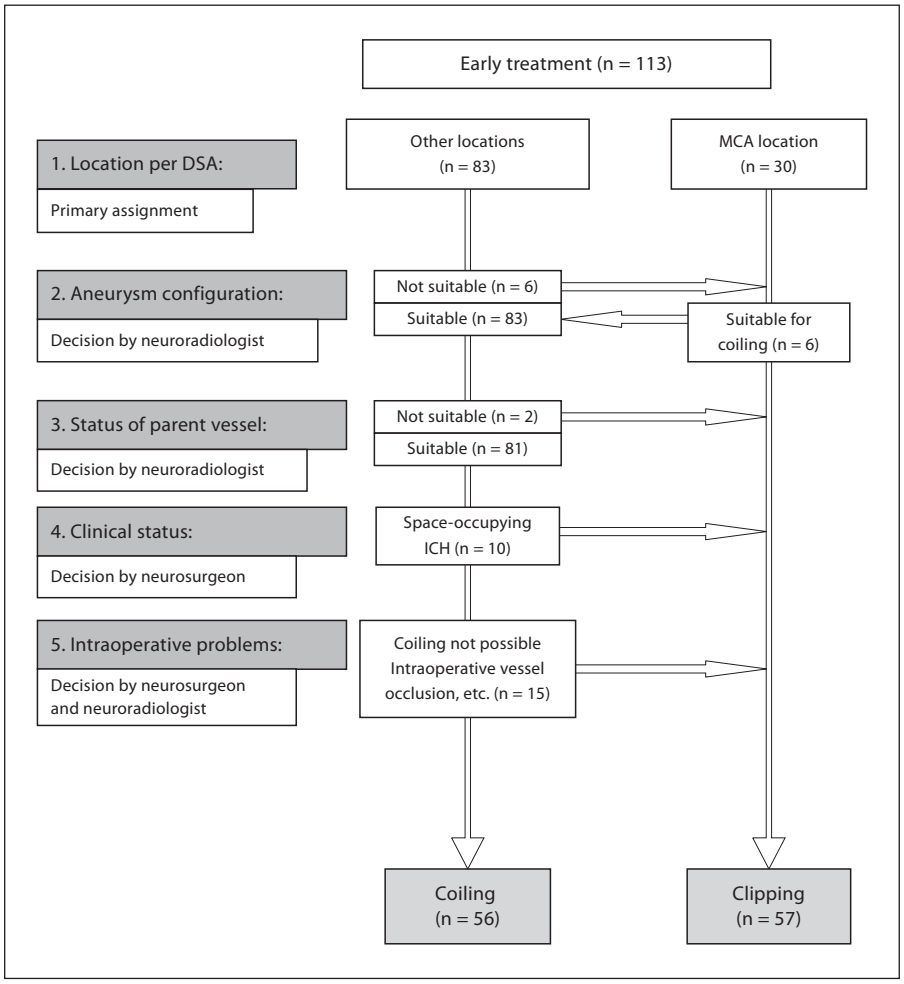


**Fig. 1.** Flow diagram. DSA = Digital subtraction angiography; MCA = middle cerebral artery; ICH = intracerebral haemorrhage.

The EQ5D consists of 2 parts. The first part is a questionnaire that includes 5 questions/dimensions ('mobility', 'self-care', 'usual activities', 'pain/discomfort', 'anxiety/depression') with 3 possible answers for each question (1 = no problem, 2 = moderate problem, 3 = severe problem) [30]. The calculation of the EQ5D index score was based on a recent European study [33]. The second part of the EQ5D consists of a visual analogue scale (EQ VAS). In this section, the respondent provides a subjective rating of his/her health status on a scale that ranges from 0 to 100, with 0 representing the worst and 100 the best imaginable health state.

*Statistical Analysis*

The software used in the statistical analysis was STATA 9.2 [34]. The results are presented as means ± standard deviation (SD) and proportions (percent) as appropriate. Comparisons between groups were assessed using parametric and non-parametric tests (t test, Mann-Whitney U test; Wilcoxon; analysis of variance and a Kruskal-Wallis test in cases with >2 groups). We used multivariate regression analyses to identify independent determinants of HRQoL at the 12-month follow-up. Since there are no international recommendations on the definition of HRQoL in cases of death, the regression model was designed only for survivors of SAH. The model was developed in 2 steps: first, we determined the crude (i.e. unadjusted) bivariate association between selected variables and HRQoL measures. Second, all variables were tested for interactions and collinearity. The variables 'World Federation of Neurological Surgeons score at admission', 'time to treatment' and 'income' were excluded due to collinearity with other variables. The remaining variables (allocation to clipping or coiling, age, sex, marital status, education, Hunt and Hess at admission, BDI, MMSE and mRS after 12 months) were included in the multiple regression analysis with backward selection (selection criterion $p < 0.05$).

## Results

*Demographics and Clinical Features*

The study cohort consisted of 113 patients with SAH, of which 32.7% (n = 37) were male and 67.3% (n = 76) female. Of these, 49.6% (n = 56) were allocated to endovascular treatment and 50.4% (n = 57) to neurosurgery. The

**Table 1.** Demographics and clinical parameters at the time of the preoperative evaluation

| | Clip | Coil | Total | p value |
|---|---|---|---|---|
| Age, years | | | | |
| Total | 53.70 ± 15.05 | 55.09 ± 13.17 | 54.39 ± 14.10 | 0.371 |
| Male | 52.44 ± 11.42 | 53.00 ± 12.09 | 52.73 ± 11.61 | 0.831 |
| Female | 54.28 ± 16.56 | 56.16 ± 13.72 | 55.20 ± 15.17 | 0.291 |
| Gender | | | | 0.790 |
| Male | 18 (31.6) | 19 (33.9) | 37 (32.7) | |
| Female | 39 (68.4) | 37 (66.1) | 67 (67.3) | |
| Marital status | | | | 0.109 |
| Married | 37 (64.9) | 38 (67.9) | 75 (66.4) | |
| Single | 9 (15.8) | 2 (3.6) | 10 (8.8) | |
| Divorced | 7 (12.3) | 13 (23.2) | 21 (18.6) | |
| Widowed | 4 (7.0) | 3 (5.4) | 7 (6.2) | |
| Income | | | | 0.890 |
| EUR <1,000 | 27 (47.4) | 29 (51.8) | 57 (50.4) | |
| EUR 1,000–2,000 | 19 (33.3) | 15 (26.8) | 32 (28.3) | |
| EUR >2,000 | 11 (19.3) | 12 (21.4) | 24 (21.2) | |
| Educational level | | | | 0.728 |
| <12 years | 45 (78.9) | 46 (82.1) | 91 (80.5) | |
| ≥12 years | 12 (21.1) | 10 (17.9) | 22 (19.5) | |
| Time to treatment | | | | 0.273 |
| <12 h | 38 (66.7) | 37 (66.1) | 75 (66.4) | |
| ≥12 h | 19 (33.3) | 19 (33.9) | 38 (33.6) | |
| Hunt and Hess scale at admission | | | | 0.311 |
| Grade 1 | 4 (7.0) | 2 (3.6) | 6 (5.3) | |
| Grade 2 | 13 (22.8) | 10 (17.9) | 24 (21.2) | |
| Grade 3 | 18 (31.6) | 21 (37.5) | 39 (34.5) | |
| Grade 4 | 16 (28.1) | 18 (32.1) | 33 (29.2) | |
| Grade 5 | 6 (10.5) | 5 (8.9) | 11 (9.7) | |
| WFNS scale at admission | | | | 0.126 |
| Grade 1 | 19 (33.3) | 8 (14.3) | 28 (24.8) | |
| Grade 2 | 9 (15.8) | 17 (30.4) | 26 (23.0) | |
| Grade 3 | 9 (15.8) | 10 (17.9) | 19 (16.8) | |
| Grade 4 | 8 (14.0) | 14 (25.0) | 21 (18.6) | |
| Grade 5 | 12 (21.1) | 7 (12.5) | 19 (16.8) | |

Figures are means ± SD or numbers of cases with percentages in parentheses. WFNS = World Federation of Neurological Surgeons scale.

demographic, social and clinical parameters at admission did not significantly differ between clipping and coiling (table 1).

At the time of discharge, 49.6% (n = 56) of the patients had moderate or severe disability (BI ≥30). The clinical scores measured using BI and mRS improved at 6 and 12 months of follow-up and these improvements were statistically significant (table 2). The clinical and HRQoL data at the 6-month follow-up demonstrated the same pattern as that found at the 12-month follow-up and, therefore, are not presented here. There were no statistically significant differences in clinical outcome scores at discharge or at 6 and 12 months of follow-up between the patients in the 2 treatment arms (table 2). A total of 19 patients died during the observation period: 8 in the clipping group and 11 in the coiling group (p = 0.43, table 2). The proportion of patients with depressive symptoms (BDI >9) increased from 24.8% (n = 25) at discharge to 61.7% (n = 58) at the 12-month follow-up ($p < 0.001$).

*Health-Related Quality of Life*

At discharge, the patients with SAH had a considerably lower HRQoL than that reported in the German population. The total EQ VAS score in the study cohort at discharge was 57.8 ± 19.3 versus 73.2 ± 17.0 in the general population [35]. Overall, 92.2% of the patients reported moderate or severe problems in at least 1 dimension of the EQ5D following SAH compared to 36% in the general German population [35]. The dimensions of 'mobility', 'usual activities' and 'pain/discomfort' were most affected, with 54.9, 70.6 and 68.6% of the patients experiencing moderate or severe problems, respectively. The corresponding values in the general population were substantially lower (16.6, 10.2 and 27.9%) [35].

At the 12-month follow-up, the total EQ VAS score was 12.5% higher than the value at discharge (table 2). At the 12-month evaluation, 81.3% of the patients had moderate or severe problems in at least 1 dimension of the EQ5D. Overall, all HRQoL values except for those in 3 domains of the SF-36 (GH, RE and MH) were significantly improved at the 12 month follow-up (table 2). However, the SF-36 domains of PF and RP were still significantly lower than in the general population (fig. 2).

Statistically significant differences in HRQoL between the patients allocated to endovascular treatment and those allocated to neurosurgery were only observed at discharge. The patients who underwent neurosurgical clipping had increased values in 2 domains of the SF-36 (VT and RE) and an increased EQ VAS score (table 2). No significant differences in HRQoL values between the 2 treatment arms were found at the 12-month follow-up. There was a trend towards better scores in the RE domain of the SF-36 in patients at 12 months after endovascular intervention (p = 0.095).

The association between demographic, social and clinical parameters and the EQ VAS or EQ5D index scores at the 12-month follow-up is shown in table 3. The results of the univariate analysis demonstrated that the level of education (<12 years), the presence of depressive

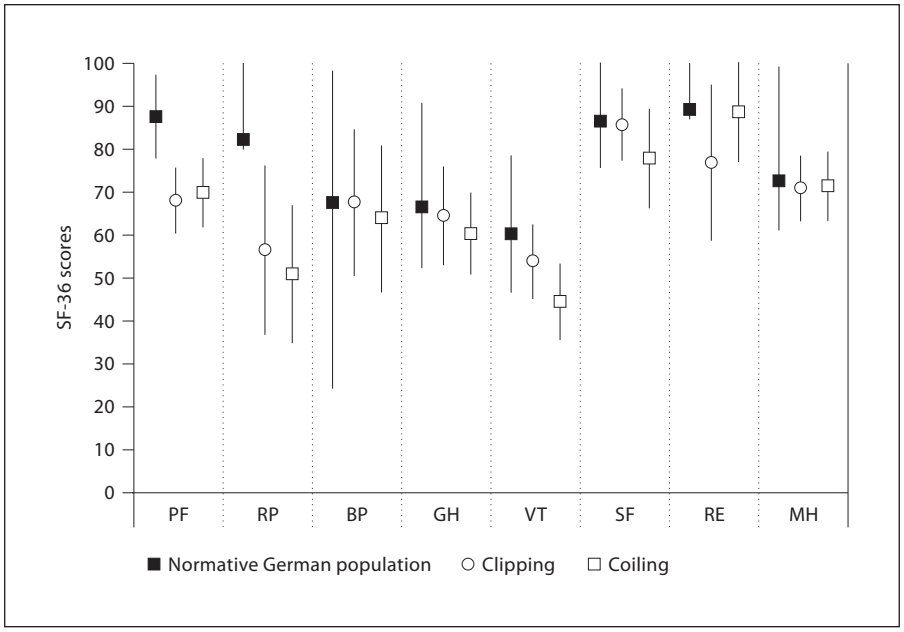


**Fig. 2.** The dimensions of the SF-36 in the study cohort in comparison with the general population.

**Table 2.** Outcome of patients following SAH at hospital discharge and at 12 months of follow-up

| | Discharge | | | | 12-month follow-up | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | clipping | coiling | p value[1] | total | clipping | coiling | p value[1] | total | p value[2] |
| mRS | | | 0.57 | | | | 0.64 | | 0.001 |
| Grade 0–2 | 24 (46.2) | 17 (34.7) | | 40 (39.6) | 31 (63.3) | 33 (73.3) | | 64 (68.1) | |
| Grade 3–5 | 28 (53.8) | 32 (65.3) | | 61 (60.4) | 18 (36.7) | 12 (26.7) | | 30 (31.9) | |
| Mortality (mRS 6) | 5 (8.8) | 7 (12.5) | 0.52 | 12 (10.6) | 8 (14.0) | 11 (19.6) | 0.43 | 19 (16.8) | |
| BDI | 12 (23.1) | 13 (26.5) | 0.74 | 25 (24.8) | 25 (51.0) | 31 (68.9) | 0.24 | 58 (61.7) | 0.001 |
| BI | 60.59 ± 36.60 | 51.53 ± 37.43 | 0.22 | 56.15 ± 37.10 | 81.46 ± 23.52 | 78.00 ± 27.90 | 0.63 | 79.54 ± 25.87 | 0.001 |
| EQ5D | 0.76 ± 0.22 | 0.63 ± 0.28 | 0.08 | 0.69 ± 0.26 | 0.85 ± 0.20 | 0.80 ± 0.24 | 0.28 | 0.82 ± 0.22 | 0.001 |
| EQ VAS | 63.85 ± 19.46 | 49.85 ± 16.28 | 0.01 | 57.76 ± 19.27 | 67.29 ± 28.06 | 62.46 ± 22.08 | 0.24 | 64.78 ± 24.99 | 0.03 |
| SF-36 | | | | | | | | | |
| PF | 44.79 ± 25.60 | 36.43 ± 28.42 | 0.31 | 40.89 ± 26.97 | 68.18 ± 8.97 | 70.93 ± 9.74 | 0.25 | 69.69 ± 9.36 | 0.001 |
| RP | 48.68 ± 46.75 | 21.43 ± 33.77 | 0.07 | 37.12 ± 43.36 | 56.52 ± 45.36 | 50.93 ± 40.72 | 0.65 | 53.50 ± 42.56 | 0.003 |
| BP | 42.52 ± 32.88 | 41.60 ± 28.66 | 0.92 | 42.11 ± 30.74 | 67.65 ± 24.20 | 63.93 ± 36.11 | 0.69 | 65.24 ± 31.66 | 0.001 |
| GH | 62.38 ± 18.58 | 60.30 ± 19.60 | 0.72 | 61.43 ± 18.86 | 64.43 ± 26.70 | 60.30 ± 23.68 | 0.27 | 62.20 ± 24.94 | 0.25 |
| VT | 52.50 ± 21.47 | 33.95 ± 16.80 | 0.004 | 44.30 ± 21.45 | 53.91 ± 19.77 | 44.44 ± 22.16 | 0.26 | 48.80 ± 21.42 | 0.02 |
| SF | 75.52 ± 24.02 | 68.06 ± 25.80 | 0.34 | 72.32 ± 24.78 | 85.67 ± 19.46 | 77.78 ± 29.07 | 0.67 | 83.25 ± 25.58 | 0.005 |
| RE | 78.95 ± 41.89 | 46.15 ± 48.19 | 0.04 | 65.63 ± 46.75 | 76.81 ± 41.97 | 88.89 ± 29.24 | 0.10 | 83.33 ± 35.79 | 0.13 |
| MH | 70.67 ± 17.20 | 67.58 ± 13.98 | 0.53 | 69.30 ± 15.75 | 70.96 ± 17.61 | 71.41 ± 20.05 | 0.45 | 71.20 ± 18.78 | 0.52 |

Figures are means ± SD or numbers of cases with percentages in parentheses.

[1] Comparison of clipping versus coiling.

[2] Comparison of total values of EQ5D and VAS at 12-months of follow-up versus discharge values.

mRS = Modified Rankin Scale; BDI = Beck Depression Inventory; BI = Barthel Index; PF = physical functioning; RP = role physical; BP = bodily pain; GH = general health; VT = vitality; SF = social functioning, RE = role emotional; MH = mental health.

**Table 3.** Associations of EQ5D and EQ VAS with demographic, social and clinical variables

| | EQ VAS | p value | EQ5D index | p value |
|---|---|---|---|---|
| Total (n = 113) | 64.78 ± 24.99 | | 0.82 ± 0.22 | |
| Clipping or coiling | | | | |
| Clip (n = 49) | 67.26 ± 24.54 | 0.50 | 0.85 ± 0.20 | 0.47 |
| Coil (n = 45) | 62.46 ± 22.08 | | 0.80 ± 0.24 | |
| Gender | | | | |
| Male (n = 29) | 63.50 ± 30.66 | 0.71 | 0.81 ± 0.28 | 0.79 |
| Female (n = 65) | 66.97 ± 20.90 | | 0.83 ± 0.20 | |
| Age groups | | | | |
| <50 years (n = 41) | 70.35 ± 24.28 | 0.30 | 0.80 ± 0.25 | 0.53 |
| ≥50 years (n = 53) | 63.21 ± 22.65 | | 0.84 ± 0.20 | |
| Martial status | | | | |
| Married (n = 74) | 67.56 ± 22.86 | 0.99 | 0.92 ± 0.11 | 0.10 |
| Single/divorced/ widowed (n = 20) | 67.48 ± 23.15 | | 0.82 ± 0.24 | |
| Educational level | | | | |
| <12 years (n = 76) | 61.57 ± 21.65 | 0.04 | 0.80 ± 0.24 | 0.01 |
| ≥12 years (n = 18) | 76.25 ± 16.20 | | 0.93 ± 0.10 | |
| Income | | | | |
| EUR <1,000 (n = 47) | 66.15 ± 24.08 | 0.97 | 0.83 ± 0.17 | 0.84 |
| EUR 1,000–2,000 (n = 27) | 64.71 ± 19.97 | | 0.84 ± 0.17 | |
| EUR >2,000 (n = 20) | 67.5 ± 23.27 | | 0.81 ± 0.30 | |
| Time to treatment | | | | |
| <12 h (n = 62) | 62.64 ± 26.72 | 0.37 | 0.80 ± 0.22 | 0.47 |
| ≥12 h (n = 32) | 70.33 ± 20.92 | | 0.85 ± 0.22 | |
| Depression | | | | |
| BDI ≤9 (n = 58) | 76.25 ± 16.20 | 0.04 | 0.93 ± 0.10 | 0.01 |
| BDI >9 (n = 36) | 61.57 ± 21.65 | | 0.80 ± 0.24 | |
| MMSE (at discharge) | | | | |
| ≤24 (n = 32) | 66.36 ± 23.78 | 0.96 | 0.70 ± 0.29 | 0.03 |
| >24 (n = 62) | 65.96 ± 23.14 | | 0.90 ± 0.16 | |
| Hunt and Hess scale at admission | | | | |
| 1–2 (n = 25) | 71.58 ± 19.57 | 0.33 | 0.89 ± 0.17 | 0.11 |
| 3–5 (n = 69) | 63.14 ± 27.26 | | 0.78 ± 0.24 | |
| mRS | | | | |
| 0–2 (n = 65) | 68.48 ± 17.34 | 0.36 | 0.88 ± 0.19 | 0.002 |
| 3–5 (n = 29) | 60.27 ± 26.49 | | 0.65 ± 0.23 | |

Figures are means ± SD.

symptoms, cognitive impairment at discharge (MMSE ≤24) and dependency in activities of daily living (mRS 3–5) were associated with decreased HRQoL.

Independent determinants of HRQoL (EQ VAS and EQ5D index score) at the 12-month follow-up were evaluated using multivariate regression analysis (table 4). The following potential determinants were considered in the regression analysis: allocation to clipping or coiling, demographic parameters (age and gender), social factors (marital status and level of education), BDI, MMSE, severity of SAH at admission (Hunt and Hess scale) and level of dependency at 12 months of follow-up (mRS). The independent predictors of decreased EQ VAS (worse HRQoL) were female gender, an educational attainment of <12 years, severe SAH as measured by the Hunt and Hess scale, and depression. Altogether, these were able to explain 49.7% (adjusted $R^2$) of the variance in EQ VAS scores. Marital status and independency in activities of daily living as measured by mRS were independent predictors of better EQ5D index scores. They were able to explain 37.1% of this variance.

## Discussion

This large longitudinal study that took place over a period of 12 months evaluated outcome measures of HRQoL in patients with SAH. We found a significant decrease in HRQoL in patients following SAH compared to the general population, according to both the EQ5D and the SF-36. The lowest values of the EQ5D index, EQ VAS and SF-36 were measured at discharge from the hospital. One of the most important findings was that HRQoL showed a considerable improvement from 3 months up to 1 year. The HRQoL measures improved at follow-up times of 6 and 12 months; however, they were still lower than in the general population. Similarly, Hop et al. [13] examined patients 4 months after SAH and found significant reductions in HRQoL in all domains of the SF-36 except for BP and GH. At 18 months, the same authors still observed a significant reduction in HRQoL in the domains SF, RP and RE. We also found a significant reduction in HRQoL in the domains of physical health in the longer term; however, the domains of mental health and social functioning improved during the observation period and were similar to the general population at 12 months of follow-up. Unfortunately, Hop et al. did not use depression scales or other neuropsychiatric scales to further stratify the impact of mental health on HRQoL. The proportion of patients with depressive symptoms in our study was similar to that reported for malignant stroke [36].

An evaluation of HRQoL was also performed in patients from the ISAT study, a large multicentre study comparing clipping versus coiling in patients with SAH (n = 2,143). However, the published results from this study contain either comparisons of clinical outcomes between the treatment arms or cumulative data on HRQoL [8, 11, 22]. To the best of our knowledge, no data

**Table 4.** Multiple regression analysis of factors influencing HRQol 12 months following SAH

| | EQ VAS | | | EQ5D index | | |
|---|---|---|---|---|---|---|
| | B | 95% CI | p value | B | 95% CI | p value |
| Female gender | –15.92 | –31.32 to –2.10 | 0.04 | | excluded | |
| Marital status | | excluded | | –0.17 | –0.34 to –0.02 | 0.04 |
| Education | 17.12 | 1.70 to 32.78 | 0.04 | | excluded | |
| BDI | –1.80 | –4.01 to –0.06 | 0.03 | | excluded | |
| Hunt and Hess | –7.03 | –14.82 to –1.98 | 0.02 | | excluded | |
| mRS | | excluded | | –0.22 | –0.38 to –0.09 | 0.03 |
| Adjusted $R^2$ | | 0.497 | | | 0.371 | |

BDI and mRS: scores at 12 months of follow-up. Hunt and Hess: scores at admission. Adjusted $R^2$: total adjusted $R^2$ for each model. Excluded: variables were excluded because they did not fulfill the inclusion criterion ($p < 0.05$) in the regression analysis with backward selection. Allocation to clipping or coiling, age and patient income were also excluded because they did not fulfill the inclusion criterion ($p < 0.05$) in both models. B = Regression coefficient.

comparing HRQoL outcomes between coiling and clipping in patients from the ISAT study have been published to date. Other previous studies comparing HRQoL measures in clipping versus endovascular coiling included small numbers of patients following SAH. Proust et al. [16] used the Reintegration to Normal Living Index to estimate HRQoL and did not find any statistically significant difference between neurosurgical clipping (n = 36) and endovascular coiling (n = 14). Bellebaum et al. [17] investigated HRQoL in a smaller cohort of patients with SAH and found slightly worse HRQoL outcomes after neurosurgical clipping (n = 16) as compared to endovascular coiling (n = 16). However, the results of other studies do not provide evidence favouring either neurosurgery or endovascular treatment in SAH with respect to long-term HRQoL outcomes [8, 11, 16, 17, 22].

We investigated independent determinants of HRQoL at the 12-month follow-up in the multiple regression analysis. Similar to the study by Katati et al. [14], female gender and functional disability as measured on the mRS were associated with worse HRQoL after SAH. Hop et al. also found no deterioration in HRQoL in patients with Rankin 0 following SAH, and severe impairment of HRQoL in patients with Rankin 4 [13]. The Hunt and Hess score was identified as a predictor of worse HRQoL in our study and in 2 other reports [14, 37]. A number of clinical scales have been used to measure SAH severity (Hunt and Hess scale, World Federation of Neurological Surgeons Scale, Glasgow Coma Scale). We included only 1 clinical scale in our multivariate analysis due to the correlation between different scales and the resulting collinearity in the multivariate modeling. In the recent study by Visser-Meily et al. [18], depression was associated with decreased HRQoL in patients following SAH. This was confirmed in our analysis. Depression is also known to be an important determinant of reduced HRQoL in other types of stroke [38, 39]. Many SAH survivors suffer from residual cognitive impairment [40, 41]. Similar to the results of the study by Springer et al. [42], cognitive impairment after SAH was associated with decreased HRQoL in our analysis. However, cognitive impairment was not among the independent determinants of HRQoL in our multivariate model. Less is known about the social determinants of long-term HRQoL outcomes after SAH. We found the absence of stable partnerships and educational levels of <12 years to be associated with worse HRQoL. It is possible that this finding is not specific to the disease because similar associations were observed in the general European population [43].

Despite a careful study design, some limitations should be noted. (1) We used patients' self-reported HRQoL questionnaires and, therefore, HRQoL could not be estimated in patients with aphasia or in cases of severe disturbances in consciousness. As a result, HRQoL measures at the first visit may be biased towards higher quality of life. (2) We did not thoroughly investigate the neuropsychological sequelae of SAH in our cohort. One recent study showed that neuropsychological factors play an important role in the rehabilitation of patients following SAH and influence their HRQoL [18]. However, neuropsychological outcomes fell outside the objective of our study. (3) We were not able to exclude residual confounding by unmeasured variables in the multivariate analyses. (4) A definite favourable outcome with respect to clipping

or coiling could not be concluded as the study recruited and assigned patients in a non-random fashion, which makes a decisive conclusion difficult from a statistical point of view.

In conclusion, SAH leads to a substantial decrease in HRQoL in affected patients, not only in the acute phase but also over the long-term scale. However, there is some improvement in quality of life in SAH patients from 3 months up to 1 year. Unfortunately, only the minority of previous studies concentrated on the identification of independent determinants of HRQoL in SAH. Such data are needed to inform the development of healthcare programmes aimed at improvement of HRQoL in SAH survivors. An important finding was the identification of depression among the independent factors of reduced HRQoL. Depression in haemorrhagic stroke is a prevalent condition (20%) and survivors of SAH should be adequately monitored and treated for depression [39].


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