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Clinical Article

Quality of life after treatment for incidental, unruptured intracranial aneurysms

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Summary

Background. Discovering an intracranial aneurysm may profoundly affect the patient's quality of life. Patients living with unruptured and untreated aneurysms often report symptoms of anxiety and depression. There are few trials studying the quality of life after treatment of unruptured intracranial aneurysms. We aimed to compare the quality of life and symptoms of anxiety or depression after endovascular coiling or open surgery clipping of unruptured intracranial aneurysms, in patients with no prior subarachnoid haemorrhage.

Method. 73 living patients were included. 44 had undergone open surgery clipping and 31 had undergone endovascular coiling within the last 5.5 years. We registered a number of parameters from medical records and the patients' current quality of life was assessed by a questionnaire. 63 of 73 (86.3%) returned our questionnaire, which included the Norwegian version of SF-36 and the Hospital Anxiety and Depression Scale (HAD).

Findings. Many patients treated for unruptured intracranial aneurysms have a relatively low quality of life. The low scores indicate that the patients experience limitations in their ability to work or accomplish desired activities due to perceived physical or mental handicaps. There were no significant differences between the open surgery group and the endovascular group when comparing quality of life parameters after treatment. A subgroup analysis of patients with a favourable functional outcome also showed reduced quality of life without any differences in the two treatment groups. There were no signs of improvement in quality of life over time.

Conclusion. Quality of life after treatment does not seem to be a strong argument for choosing one modality of treatment over the other in patients with unruptured intracranial aneurysms. There are no significant differences in the quality of life of patients successfully treated using endovascular technique and patients who underwent craniotomy and clipping. We speculate that the low quality of life scores are due to factors unrelated to the aneurysms. The scores possibly reflect characteristics of a patient group where incidental aneurysms are more frequently diagnosed while undergoing extensive imaging procedures due to unrelated symptoms.

Keywords: Intracranial aneurysm; quality of life; anxiety; depression.

Introduction

Prophylactic treatment of unruptured intracranial aneurysms is often beneficial. The poor prognosis of subarachnoid haemorrhage from ruptured aneurysms commonly outweighs a significant procedure-related morbidity. With the increasing use of high resolution imaging of the brain in different medical settings, incidental, unruptured intracerebral aneurysms are more frequently encountered. The prevalence of unruptured intracranial aneurysms in the general population is approximately 2%, but there is a great variation in different studies [1]. However, most aneurysms never rupture. A meta-analysis of 11 studies following a total of 30,204 patient years reports an average rupture rate of 1.8% in the posterior circulation and only 0.49% in the anterior circulation [2]. Different rupture rates have been reported in other studies. The International Study of Unruptured Intracranial Aneurysms Investigators (ISUIA) reported from a prospective observational trial, that risk of rupture is greater with symptomatic aneurysms and when there is a history of prior subarachnoid haemorrhage [3]. Based on data from the ISUIA study, it has been calculated and postulated that patients with a remaining life expectancy of less than 15–35 years, depending on aneurysm size and location, and patients with anterior circulation aneurysms with a diameter less than 7 mm and no prior subarachnoid haemorrhage, will most likely not benefit from treatment [4]. Even if this postulation is controversial, many factors are important and need to be evaluated when considering elective

treatment of an intracranial unruptured aneurysm, including size, location, aneurysm morphology, patient age, general state of health and over-all prognosis.

Treatment modalities are evolving and an increasing number of aneurysms are now sealed using endovascular techniques instead of conventional open surgery clipping. The International Subarachnoid Aneurysm Trial (ISAT) randomized 2143 of a total of 9559 patients with subarachnoid haemorrhage to either one of the two modalities of treatment, and reported a 23.7% 1-year-mortality after endovascular coiling compared to 30.6% after open surgery clipping, but with a possibly higher risk of rebleeding after endovascular technique [5]. The early survival advantage is maintained and significant for up to 7 years follow-up [6]. Prophylactic treatment using either method involves risk of serious procedure-related complications. The ISUIA study group reported a 2.3% mortality rate and a 10% risk of stroke after open surgery clipping and a mortality rate of 3.1% and a 5% risk of stroke after endovascular treatment. One year after treatment the risk of an unfortunate functional status, defined as mRS >2, was 12% in the open surgery group and 9.5% in the endovascular group [3, 7]. There are, however no randomized trials comparing the two treatment modalities in unruptured aneurysms.

Most published papers on the treatment of unruptured intracranial aneurysms report outcome in terms of mortality rates and gross function scores. Survival and functional outcome are of course the most important end points when evaluating treatment results. However, since

Table 1. *Base-line characteristics of patients eligible for inclusion and questionnaire responders*

Base-line characteristics	Open surgery clipping		Endovascular coiling		Total	
	n = 44	n = 37*	n = 31	n = 26*	n = 75	n = 63*
Age at treatment-yr mean	55.2	55.2	54.2	54.8	54.8	55.0
– Range	40–70	41–70	30–75	39–75	30–75	30–75
– SD	±8.4	±7.6	±12.1	±11.7	±10.0	±9.5
Female sex – no. of patients (%)	30 (68.2)	25 (67.6)	22 (70.9)	17 (65.4)	52 (69.3)	42 (66.7)
Smoking – no. of patients (%)						
– Yes	19 (43.2)	15 (40.5)	20 (64.5)	17 (65.4)	39 (52.0)	32 (50.8)
– Former smoker	6 (13.6)	6 (16.2)	3 (10.3)	3 (11.5)	9 (12.0)	9 (14.3)
– No	11 (25.0)	10 (27.0)	3 (10.3)	2 (7.7)	14 (18.7)	12 (19.0)
– Missing data	8 (40.9)	6 (16.2)	5 (16.1)	4 (15.4)	13 (17.3)	10 (15.9)
Diagnosis – no. of patients (%)						
– Incidental	26 (59.1)	21 (56.8)	23 (74.2)	20 (76.9)	49 (65.3)	41 (65.1)
– After screening	6 (13.6)	6 (16.2)	1 (3.2)	1 (3.8)	7 (9.3)	7 (11.1)
– Symptomatic	4 (9.1)	3 (8.1)	4 (12.9)	3 (11.5)	8 (10.7)	6 (9.5)
– Possibly symptomatic	8 (18.2)	7 (18.9)	3 (9.7)	2 (7.7)	11 (14.7)	9 (14.3)
Location of aneurysm – no. of patients (%)						
– Anterior circulation	43 (97.7)	36 (97.3)	25(80.6)	22 (84.6)	68 (90.7)	58 (92.1)
– Ophthalmic artery	0 (0)	0 (0)	3 (9.7)	3 (11.5)	3 (4.0)	3 (4.8)
– Internal carotid artery	2 (4.5)	2 (5.4)	6 (19.3)	5 (19.2)	8 (10.7)	7 (11.1)
– Anterior cerebral artery	0 (0)	0 (0)	1 (3.2)	1 (3.8)	1 (1.3)	1 (1.6)
– Middle cerebral artery	39 (88.6)	32 (86.5)	5 (16.1)	4 (15.4)	44 (58.7)	36 (57.1)
– Anterior communicating artery	2 (4.5)	2 (5.4)	10 (32.3)	9 (34.6)	12 (16.0)	11 (17.5)
– Posterior circulation	1 (2.3)	1 (2.7)	6 (19.4)	4 (15.4)	7 (9.3)	5 (7.9)
– Posterior communicating artery	1 (2.3)	1 (2.7)	2 (6.5)	2 (7.7)	3 (4.0)	3 (4.8)
– Basilar artery	0 (0)	0 (0)	2 (6.5)	0 (0)	2 (2.7)	0 (0)
– Vertebral artery	0 (0)	0 (0)	1 (3.2)	1 (3.8)	1 (1.3)	1 (1.6)
– Inferior posterior cerebellar artery	0 (0)	0 (0)	1 (3.2)	1 (3.8)	1 (1.3)	1 (1.6)
Size of aneurysms						
– Mean largest diameter – mm	8.3	8.5	9.1	9.3	8.6	8.8
– Range	4–20	4–20	4–27	4–27	4–27	4–27
– SD	±3.3	±3.4	±5.4	±5.8	±4.1	±4.4
No. of preoperative imaging procedures						
– Mean	2.0	2.1	1.9	1.9	2.0	2.0
– Range	1–4	1–4	1–4	1–4	1–4	1–4
Additional unruptured aneurysm – no. of pat. (%)	7 (15.9)	7 (18.9)	1 (3.2)	1 (3.8)	8 (10.7)	8 (12.7)

* Questionnaire responders.

evaluating an elective procedure, a potential impact on the patients' quality of life is also important. There are few trials studying the quality of life after treatment of unruptured intracranial aneurysms. Only one small patient series totalling 51 patients reports a comparison of quality of life after open surgery clipping and endovascular coiling of unruptured intracranial aneurysms. In the short term, open surgery was reported to cause a significant reduction in the quality of life where as endovascular treatment had no impact [8]. In the present study on patients with no history of subarachnoid haemorrhage, we aimed to compare the quality of life and symptoms of anxiety or depression, after endovascular coiling and open surgery clipping of unruptured intracranial aneurysms.

Methods and materials

Study design and objectives

The study consists partly of a retrospective recording of parameters from medical records of patients treated for unruptured intracranial aneurysms in our department over a period of 5.5 years. The treatment was either open surgery clipping or endovascular coiling. Patients eligible for inclusion received a questionnaire by mail in August of 2005. Subjects who had not responded within four weeks received a written reminder including a new questionnaire.

The objective of the study was to record the quality of life in patients who have been treated for unruptured intracranial aneurysms. We aimed to compare the quality of life and symptoms of anxiety or depression, after endovascular coiling or open surgery clipping of unruptured intracranial aneurysms, in patients with no prior subarachnoid haemorrhage.

The study was approved by the Regional Ethics Committee and the Norwegian Social Science Data Services (NSD).

Table 2. *Treatment results, complications and functional outcome (from hospital records)*

Treatment results	Open surgery clipping		Endovascular coiling		Total	
	n = 44	n = 37*	n = 31	n = 26*	n = 75	n = 63*
Success of aneurysm repair – no. of pat. (%)						
– Successful occlusion/isolation of aneurysm	40 (90.9)	34 (91.9)	20 (64.5)	18 (69.2)	60 (80.0)	52 (82.5)
– Some circulation in the base of the aneurysm	3 (6.8)	2 (5.4)	4 (12.9)	4 (15.4)	7 (9.3)	6 (9.5)
– Recirculation of aneurysm	1 (2.3)	1 (2.7)	1 (3.2)	1 (3.8)	2 (2.7)	2 (3.2)
– Failed treatment	0 (0)	0 (0)	6 (19.4)	3 (11.5)	6 (8.0)	3 (4.8)
No. of control images postoperatively						
– Mean	0.6§	0.6§	2.9§	2.5§	1.6	1.4
– Range	0–2	0–2	0–3	0–3	0–3	0–3
Major complications – no. of patients (%)						
– Cerebral infarction	3 (6.8)	2 (5.4)	1 (3.2)	1 (3.8)	4 (5.3)	3 (4.8)
– Subarachnoid haemorrhage	0 (0)	0 (0)	1 (3.2)	0 (0)	1 (1.3)	0 (0)
– Other intracranial haemorrhage	1 (2.3)	0 (0)	0 (0)	0 (0)	1 (1.3)	0 (0)
– Transient Ischemic Attack	1 (2.3)	1 (2.7)	0 (0)	0 (0)	1 (1.3)	1 (1.6)
– Epilepsy	1 (2.3)	1 (2.7)	0 (0)	0 (0)	1 (1.3)	1 (1.6)
– Visual field defect	1 (2.3)	1 (2.7)	0 (0)	0 (0)	1 (1.3)	1 (1.6)
– Paresis n. frontalis	4 (9.1)	4 (10.8)	0 (0)	0 (0)	4 (5.3)	4 (6.3)
– Other	1 (2.3)	0 (0)	0 (0)	0 (0)	1 (1.3)	0 (0)
Additional procedure or re-operation, no. of pat. (%)						
– Due to unsuccessful repair of aneurysm	7 (15.9)	4 (10.8)	5 (16.1)	4 (15.4)	12 (16.0)	8 (12.7)
– Endovascular recoiling			3 (9.7)	3 (11.5)	3 (4.0)	3 (4.8)
– Open surgery clipping after failed coiling			2 (6.5)	1 (3.8)	2 (2.7)	1 (1.6)
– Open surgery clipping after suboptimal clipping	1 (2.3)	0 (0)			1 (1.3)	0 (0)
– Due to surgical complication						
– Wound infection	1 (2.3)	1 (2.7)	0 (0)	0 (0)	1 (1.4)	1 (1.6)
– Deeper infection	1 (2.3)	0 (0)	0 (0)	0 (0)	1 (1.4)	0 (0)
– Subdural effusion	2 (4.5)	1 (2.7)	0 (0)	0 (0)	2 (2.7)	1 (1.6)
– CSF-fistula	1 (2.3)	1 (2.7)	0 (0)	0 (0)	1 (1.4)	1 (1.6)
– Evacuation of haematoma	1 (2.3)	1 (2.7)	0 (0)	0 (0)	1 (1.4)	1 (1.6)
Functional outcome						
– Glasgow Outcome Scale (1–5)						
– Mean	4.79	4.78	4.84	4.96	4.81	4.86
– Range	3–5	3–5	3–5	4–5	3–5	3–5
– GOS 3 – no. of patients (%)	1 (2.3)	1 (2.7)	1 (3.2)	0 (0)	2 (2.7)	1 (1.6)
– GOS 4 – no. of patients (%)	7 (15.9)	6 (16.2)	3 (9.7)	1 (3.8)	10 (13.3)	7 (11.1)
– GOS 5 – no. of patients (%)	36 (81.8)	30 (81.1)	27 (87.1)	25 (96.2)	63 (84.0)	55 (87.3)

* Questionnaire responders, § significant difference between open surgery and endovascular coiling, $p < 0.05$.

Inclusion

From operation records and medical records we identified all patients treated for or attempted to be treated for intracranial aneurysms at the St. Olav University Hospital (Trondheim, Norway) over a period of 5.5 years, from January 2000 until July 2005. Inclusion criteria were 1) treated or attempted treatment for unruptured intracranial aneurysm; 2) no prior history of subarachnoid haemorrhage. Patients who were treated for more than one aneurysm with different techniques were excluded in order to make a comparison between methods of treatment. If patients were treated for more than one unruptured aneurysm in the study period, only the last procedure was studied and recorded.

Parameters registered

We recorded a number of parameters from medical records including 1) age at time of treatment 2) sex 3) smoking habits: smoking/quit/never smoked/unknown 4) how the aneurysm was diagnosed: incidental/symptomatic/possibly symptomatic/after screening. Symptomatic aneurysms include aneurysms that caused cranial nerve paralysis. Possible symptomatic aneurysms include aneurysms with possible associated TIA or embolic stroke 5) size and location of the treated aneurysm 6) multiplicity of aneurysms: single/multiple 7) number of radiological imaging procedures undergone to diagnose, control or evaluate the aneurysm before treatment 8) method of treatment: endovascular coiling/open surgery clipping 9) radiological result of treatment: successful/some circulation in the base of the aneurysm/recirculation of aneurysm/failed treatment 10) functional scores estimated from medical records of post-operative outpatient controls, typically done 6–12 weeks after treatment, assessed by Glasgow Outcome Scale (GOS 1–5). GOS <5 was recorded if patients had significant clinical signs or symptoms after treatment, usually due to neurological complications. GOS 4 was recorded in patients who had a loss of function after treatment, but who were independent in daily activities. GOS 3 was recorded in patients who were disabled and dependent in daily activities. GOS 2 was reserved for patients in a persistent vegetative state. GOS 1 denotes death. From the questionnaires we received the following data 1) the eight multi-item scales of quality of life from the Norwegian version of SF-36, including physical functioning, role limitations due to physical problems, role limitations due to emotional problems, bodily pain, mental health, vitality, general health perception and health transition 2) symptoms of anxiety or depression assessed by the Hospital Anxiety and Depression Scale (HAD) 3) current working status 4) regrets after undergoing treatment: yes/no/do not know.

Statistical analysis

Data were analyzed using SPSS 13.0 for Windows. The SF-36 and HAD result scores are presented using mean values and 95% confidence intervals. Independent-samples *t*-tests were used to compare difference in means of continuous data. P-values of less than 0.05 were considered statistically significant.

Results

Patients included

75 patients were eligible for inclusion. Of these were 2 dead at the time of inclusion. 63 of 73 (86.3%) returned our questionnaire.

Base-line characteristics of patients eligible for inclusion and questionnaire responders

Table 1 shows the base-line characteristics of the patients eligible for inclusion in comparison with questionnaire responders. There are only minor differences between the patients eligible for inclusion and patients who responded to our questionnaires. There are, however some differences between patients who underwent open surgery clipping and endovascular coiling. In the open surgery group there is a predominance of aneurysms in the middle cerebral artery. Only one patient with an aneurysm in the posterior circulation underwent open surgery clipping. Additional aneurysms were more common in the open surgery group. Symptomatic aneurysms were more common among patients who underwent endovascular coiling. There were only minor differences between the groups when comparing patient age, sex, size of aneurysm and number of preoperative imaging procedures.

Treatment results

Table 2 shows the treatment results in the two study groups. There are only minor differences between patients eligible for inclusion and the questionnaire responders when comparing most result parameters. There are some differences between the open surgery group and the endovascular coiling group, the most

Table 3. *Daily thoughts, working status, and treatment regrets from follow-up questionnaires*

From questionnaires	Open surgery clipping n = 37	Endovascular coiling n = 26	Total n = 63
Have you thought about your risk of cerebral haemorrhage during the last 4 weeks?			
No. of patients (%)			
Yes, often	2 (5.4)	0 (0)	2 (3.2)
Yes, some times	15 (40.5)	6 (23.1)	21 (33.3)
Yes, but seldom	7 (18.9)	9 (34.6)	16 (25.4)
No	12 (32.4)	11 (42.3)	23 (36.5)
Missing data	1 (2.7)	0 (0)	1 (1.6)
Employment status – no. of patients (%)			
Working	12 (32.4)	11 (42.3)	23 (36.5)
Out on sick-leave	6 (16.2)	1 (3.8)	7 (11.1)
Receiving disability insurance	12 (32.4)	8 (30.8)	20 (31.7)
Retired	7 (18.9)	6 (23.1)	13 (20.6)
Regrets about undergoing treatment?			
No. of patients (%)			
Yes	1 (2.7)	1 (3.8)	2 (3.2)
Do not know	2 (5.4)	0 (0)	2 (3.2)
No	34 (91.9)	25 (96.2)	59 (93.7)

obvious being the difference between the number of imaging procedures performed postoperatively. This reflects the department policy of performing 2–3 angiographic controls after uncomplicated endovascular coiling, and only 0–1 controls after uncomplicated open surgery clipping. Successful aneurysm repair was more prevalent in the open surgery group, whereas failed treatment was only seen after attempted endovascular coiling. Complications were more common in the open surgery group, but additional procedures or re-operations were equally common in the two groups. Typical surgical complications were naturally only seen in the open surgery group. Functional outcome scores were somewhat better in the group who underwent endovascular treatment. Among the responders of our questionnaires, a favourable functional score with Glasgow outcome scale 5 was seen in 81.1% after open surgery clipping compared to 96.2% of the endovascular coiling group, an almost significant difference.

Results from questionnaires

Table 3 shows the results from questionnaires. A total of 61.9% of the patients reported of having thoughts about cerebral haemorrhage in the last four weeks. Only 36.5% of the patients were working. Only 2 patients reported regrets about undergoing treatment. There were only minor differences between the two modalities of treatment when comparing worries about cerebral haemorrhage, employment rates and regrets.

Table 4 shows mental health and quality of life scores from questionnaires. As many as 30.2% of the total patient pool have anxiety scores >8, a cut-off score often

Table 4. *Mental health and quality of life from follow-up questionnaires*

From questionnaires	Open surgery clipping n = 37	Endovascular coiling n = 26	P-values	Total n = 63
Hospital Anxiety and Depression Scale (HAD)				
– Anxiety score				
– Mean	6.7	5.1	0.19	6.0
– SD	±5.0	±4.2		±4.7
– Anxiety score ≥ 8 – no. of patients (%)	11 (29.7)	8 (30.8)		19 (30.2)
– Depression score				
– Mean	4.5	3.7	0.43	4.2
– SD	±4.1	±3.8		±4.0
– Depression score ≥ 8 – no. of patients (%)	11 (29.7)	4 (15.4)		15 (23.8)
– Total HAD score				
– Mean	11.2	8.9	0.24	10.2
– SD	±8.3	±7.3		±8.0
– Total HAD score ≥15 – no. of patients (%)	11 (29.7)	8 (30.8)		19 (30.2)
– Anxiety or depression score ≥11 or total HAD score ≥19 – no. of patients (%)	10 (27.0)	5 (19.2)		15 (23.8)
Health Related Quality of Life (HRQoL); SF-36				
– Physical Functioning (PF) – mean	75.1	81.0	0.29	77.6
SD	±23.7	±20.3		±22.4
– Role Functioning – Physical (RP) – mean	23.6	42.0	0.09	31.2
SD	±35.8	±44.9		±40.5
– Bodily Pain (BP) – mean	58.1	66.6	0.22	61.6
SD	±27.1	±26.7		±27.0
– General Health (GH) – mean	61.5	65.8	0.51	63.3
SD	±25.9	±24.1		±25.1
– Vitality (VT) – mean	49.5	57.1	0.16	52.6
SD	±15.8	±23.7		±19.6
– Social Functioning (SF) – mean	67.9	77.4	0.15	71.8
SD	±22.3	±26.9		±24.6
– Role Functioning – Emotional (RE) – mean	40.5	46.7	0.61	43.0
SD	±44.5	±46.1		±44.9
– Mental Health (MH) – mean	68.8	77.1	0.06	72.5
SD	±17.4	±19.0		±18.5
– Reported Health Transition (HT) – mean	66.6	58.8	0.25	62.8
SD	±22.0	±23.2		±22.6

Table 5. *Daily thoughts, working status, and treatment regrets from follow-up questionnaires after uncomplicated treatment*

From questionnaires	Open surgery clipping n = 26	Endovascular coiling n = 19	Total n = 45
Have you thought about your risk of cerebral haemorrhage during the last 4 weeks?			
No. of patients (%)			
– Yes, often	0 (0)	0 (0)	0 (0)
– Yes, some times	12 (46.2)	5 (0)	17 (37.8)
– Yes, but seldom	7 (26.9)	9 (47.4)	16 (35.6)
– No	7 (26.9)	5 (26.3)	12 (26.7)
Employment status – no. of patients (%)			
– Working	10 (38.4)	8 (42.1)	18 (40.0)
– Out on sick-leave	3 (11.5)	1 (5.3)	4 (8.9)
– Receiving disability insurance	8 (30.8)	7 (36.8)	15 (33.3)
– Retired	5 (19.2)	3 (15.8)	8 (17.8)
Regrets about undergoing treatment?			
No. of patients (%)			
– Yes	0 (0)	0 (0)	0 (0)
– Do not know	1 (3.8)	0 (0)	1 (2.2)
– No	25 (96.2)	19 (100)	44 (97.8)

Table 6. *Mental health and quality of life from follow-up questionnaires after uncomplicated treatment*

From questionnaires	Open surgery clipping n = 26	Endovascular coiling n = 19	P-values	Total n = 45
Hospital Anxiety and Depression Scale (HAD)				
– Anxiety score				
– Mean	5.7	5.3	0.75	5.5
– SD	±4.5	±4.3		±4.4
– Anxiety score ≥8 – no. of patients (%)	7 (26.9)	6 (31.6)		13 (28.9)
– Depression score				
– Mean	3.8	3.4	0.73	3.6
– SD	±4.1	±3.4		±3.8
– Depression score ≥ 8 – no. of patients (%)	5 (19.2)	2 (10.5)		7 (15.6)
– Total HAD score				
– Mean	9.5	8.7	0.73	9.2
– SD	±8.1	±7.2		±7.7
– Total HAD score ≥15 – no. of patients (%)	5 (19.2)	5 (26.3)		10 (22.2)
– Anxiety or depression score ≥11 or total HAD score ≥19 – no. of patients (%)	4 (15.4)	2 (10.5)		6 (13.3)
Health Related Quality of Life (HRQoL); SF-36				
– Physical Functioning (PF) – mean	81.5	82.7	0.81	82.0
SD	±17.3	±15.3		±16.3
– Role Functioning – Physical (RP) – mean	28.8	39.0	0.42	33.2
SD	±37.2	±44.0		±40.1
– Bodily Pain (BP) – mean	59.5	65.5	0.45	62.0
SD	±27.9	±24.5		±26.4
– General Health (GH) – mean	67.3	66.8	0.95	67.1
SD	±26.0	±21.2		±23.8
– Vitality (VT) – mean	53.3	56.8	0.56	54.8
SD	±15.3	±23.2		±18.9
– Social Functioning (SF) – mean	72.6	80.3	0.29	75.8
SD	±23.2	±23.7		±23.5
– Role Functioning – Emotional (RE) – mean	47.4	47.4	0.99	47.4
SD	±45.4	±47.6		±45.8
– Mental Health (MH) – mean	71.1	75.8	0.43	73.1
SD	±19.1	±19.6		±19.2
– Reported Health Transition (HT) – mean	67.0	56.6	0.14	62.6
SD	±22.0	±23.4		±22.9

used to indicate possible need for psychological follow up. As many as 23.8% of the treated patients had a HAD score equal to or more than 19, a cut-off often used to indicate psychological dysfunction and need for follow-up. There were no significant differences between the two treatment groups when comparing scores from the Hospital Anxiety and Depression scale and health related quality of life scores from Short Form-36. However, there was a tendency in favour of endovascular coiling.

Table 7. *Time since treatment. Daily thoughts, working status, mental health and quality of life from follow-up questionnaires*

From questionnaires	Open surgery clipping		Total	
	n = 37		n = 63	
Time since treatment	<1 yr n = 15	>1 yr n = 22	<1 yr n = 18	>1 yr n = 45
Have you thought about your risk of cerebral haemorrhage during the last 4 weeks?				
No. of patients (%)				
– Yes, often	2 (13.3)	0 (0)	2 (11.1)	0 (0)
– Yes, some times	6 (40.0)	9 (40.9)	7 (38.9)	14 (31.1)
– Yes, but seldom	3 (20.0)	4 (18.2)	3 (16.7)	13 (28.9)
– No	4 (26.7)	8 (36.4)	6 (33.3)	17 (37.8)
– Missing data	0 (0)	1 (4.5)	0 (0)	1 (2.2)
Employment status – no. of patients (%)				
– Working	4 (26.7)	8 (36.4)	5 (27.8)	18 (40.0)
– Out on sick-leave	4 (26.7)	0 (0)	4 (22.2)	1 (2.2)
– Receiving disability insurance	5 (33.3)	9 (40.9)	5 (27.8)	17 (37.8)
– Retired	2 (11.1)	5 (22.7)	4 (22.2)	9 (20.0)
Hospital Anxiety and Depression Scale (HAD)				
– Anxiety score				
– Mean	5.6	7.4	6.2	6.0
– SD	±3.9	±5.6	±4.1	±4.9
– Anxiety score ≥8 – no. of patients (%)	4 (26.7)	8 (36.4)	6 (33.3)	14 (31.1)
– Depression score				
– Mean	3.3	5.4	4.2	4.2
– SD	±3.0	±4.6	±3.8	±4.1
– Depression score ≥8 – no. of patients (%)	2 (13.3)	9 (40.9)	4 (22.2)	11 (24.2)
– Total HAD score				
– Mean	8.9	12.8	10.4	10.1
– SD	±6.4	±9.3	±7.4	±8.3
– Total HAD score ≥15 – no. of patients (%)	3 (20.0)	8 (36.4)	5 (27.8)	14 (31.1)
– Anxiety or depression score ≥11 or total HAD score ≥19 – no. of patients (%)	2 (13.3)	8 (36.4)	4 (22.2)	11 (24.4)
Health Related Quality of Life (HRQoL); SF-36				
– Physical Functioning (PF) – mean	73.7	76.1	74.2	78.9
SD	±25.5	±23.0	±24.0	±21.6
– Role Functioning – Physical (RP) – mean	21.7	25.0	18.1	36.5
SD	±38.8	±34.5	±36.2	±41.3
– Bodily Pain (BP) – mean	54.9	60.3	55.8	63.9
SD	±28.0	±26.8	±28.1	±26.6
– General Health (GH) – mean	56.7	64.8	55.6	66.4
SD	±25.4	±26.4	±23.9	±25.1
– Vitality (VT) – mean	47.2	50.9	46.9	54.9
SD	±12.8	±17.6	±14.8	±21.0
– Social Functioning (SF) – mean	70.0	66.5	67.4	73.6
SD	±21.5	±23.3	±23.1	±25.2
– Role Functioning – Emotional (RE) – mean	51.1	33.3	44.4	42.4
SD	±48.6	±41.2	±47.1	±44.5
– Mental Health (MH) – mean	72.8	66.0	71.9	72.7
SD	±14.7	±18.9	±16.4	±19.4
– Reported Health Transition (HT) – mean	63.6	66.9	66.6	61.2
SD	±24.5	±20.7	±24.3	±22.0

Subgroup analysis after uncomplicated, successful treatment

Tables 5 and 6 shows the results from questionnaires in a subgroup analysis in patients who underwent uncomplicated, successful treatment, defined as Glasgow Outcome Scale 5 after treatment and successful aneurysm repair. 73.4% in this total patient group have had thoughts about their risk of cerebral haemorrhage in the last four weeks. 40% are currently working. There were no patients who had regrets about undergoing treatment. 28.9% of the patients have anxiety scores >8, indicating a possible need for psychological follow-up. The quality of life assessed by SF-36 show low scores, especially for Role Physical, Role Emotional and Bodily Pain, but without any significant difference between the two treatment groups.

Subgroup analysis of open surgery clipping with period of treatment

Table 7 shows the subgroup analysis with results from questionnaires in patients treated the last year compared to patients treated more than one year ago. The results from the endovascular group are not shown separately since this group was very small. Thoughts about cerebral haemorrhage were somewhat more prevalent in the group treated during the last year compared with the other patients. A higher number of patients were out on sick leave in the group treated last year. There were no significant differences in symptoms of anxiety or depression or quality of life in patients treated last year compared to rest of the patients. However, there was a tendency toward better quality of life and less symptoms of anxiety or depression among patients treated last year.

Discussion

Evaluating the potential of saving lives or preventing future disability through prophylactic treatment of unruptured intracranial aneurysms is highly dependent on the rupture rate in the population studied. Aneurysm size, morphology and location are important factors to consider when estimating the risk of rupture. There is however a great variation in rupture rates reported by different study groups. Treatment results and possible benefits are not only influenced by aneurysm or patients' characteristics, but also on the quality of the treatment offered. The experience and skills in different surgical techniques and the experience with endovascular treatment procedures are important. High volume hospitals and high-volume physicians and surgeons demonstrate better treatment results [9, 10]. Our treatment results are similar to results from international multi centre trials.

Discovering an incidental aneurysm may profoundly affect the patient's quality of life, even if left untreated [11]. Patients living with unruptured untreated aneurysms often report symptoms of anxiety and depression. Repetitive imaging procedures or consultations before and after the treatment may also contribute to the stress. Symptoms of anxiety are reported to decrease significantly after treatment of aneurysms [12]. However, the natural history of anxiety when aneurysms are left untreated is unknown. The treatment itself may also contribute to a decline in the quality of life, either from medical or surgical complications or from the mental stress from the perception of having lived through a life-threatening condition. Most unruptured aneurysms are incidental findings in patients undergoing imaging procedures due to non-related symptoms. Our study demonstrate that many patients treated for unruptured intracranial aneurysms may have a relatively low quality of life, assessed by Short Form-36, especially for Role Physical, and Role Emotional. The low scores of these item scales indicate that the patients experience limitations in their ability to work or accomplish desired activities due to perceived physical or mental handicaps. Some patients also report that they suffer from pain. The confidence intervals are relatively wide, indicating a substantial variation in symptoms from patient to patient. There is a lack of a good control group, but the results from all variables tested indicate that the quality of life is lower than expected. Figure 1 shows the mean scores of the eight item scales of SF-36 in our two treatment groups. For reference the scores from a general Norwegian population at age 50–59 with a similar sex distribution is shown with standard deviations [13]. The mean quality of life scores in our trial population are actually worse than a Norwegian population of

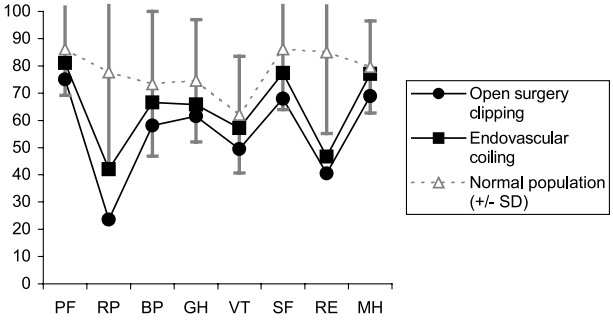

Fig. 1. SF-36 item scores compared to a age- and sex-matched normal population

cancer victims [14]. Interestingly, the frequency of anxiety or depression in our study groups, assessed by the Hospital Anxiety and Depression Scale, was also somewhat higher than in a Norwegian population of cancer patients [15].

We did not find significant differences between the open surgery group and the endovascular group when comparing quality of life parameters after treatment. Thus, quality of life after treatment does not seem to be a strong argument for choosing one modality of treatment over the other in patients with unruptured intracranial aneurysms. There is, however to be found a small, but non-significant difference between the two groups, indicating a possible tendency toward a better quality of life among patients treated with endovascular coiling. Still, our relatively small study may not be adequately significant to detect a difference between the treatment modalities. In our series the mean difference in SF-36 scores was 24.8% between the 26 patients in the endovascular group and the 37 patients in the open surgery group, making the ability of detecting a difference only 74%. Thus, there is a risk of type II errors with a false negative conclusion. A larger trial could perhaps demonstrate a difference. Our trial was also not randomized and the treatment groups are therefore not fairly or easily compared. The base line characteristics of the patients show no differences in age or sex, but there are far more posterior circulation aneurysms in the endovascular group and a predominance of middle cerebral artery aneurysms in the open surgery group.

We made a subgroup analysis of quality of life after successful, uncomplicated treatment. Patients with no history of subarachnoid haemorrhage and Glasgow Outcome Scale 5 after treatment were studied in order to more fairly evaluate the potential impact of the two different treatment methods. Nonetheless, patients with a favourable outcome after treatment also reported high rates of symptoms of anxiety and decreased quality of life. A lower functional outcome is naturally associated with symptoms of anxiety and depression, but the modality of treatment may be unrelated to such symptoms when successfully performed. This could indicate that the high anxiety rates, decreased quality of life and low employment rates are somewhat unrelated to the treatment per se and are perhaps rather characteristics of the patient group studied.

A weakness of our study is the lack of preoperative quality of life scores. Preoperative anxiety scores would presumably be high as well, due to the stress of living with an untreated, newly diagnosed intracranial aneurysm. It is not known whether the high prevalence of symptoms of anxiety and depression in our study groups is due to the procedures per se or represent symptoms after having survived a potential life threatening condition. Another and perhaps plausible explanation would be a possible high prevalence of such symptoms in the treated population, even before being diagnosed. Persons suffering from anxiety are perhaps more likely to undergo extensive diagnostic imaging due to different bodily symptoms and are more likely than others of being diagnosed with incidental aneurysms. A study of patients with aneurysms diagnosed through a screening program or a study of symptomatic unruptured aneurysms, such as aneurysms causing cranial nerve paralysis, could help to evaluate the true impact of treatment on the quality of life, without the possible confounding factors in our study population. In our study the group of patients who were diagnosed due to symptomatic aneurysms is too small to make a meaningful subgroup analysis.

The low level of employment in our studied population is quite puzzling. A weakness in our study is the lack of a recorded preoperative working status. It is therefore unknown whether the patients dropped out of work due to symptoms related to the procedures performed or if the population treated has a low employment rate due to factors unrelated to their aneurysms. Since the average age of treatment was 55 and the average follow-up was 2.5 years, some patients in the study retired due to age alone.

Surprisingly, patients who received open surgery within the last year demonstrate similar psychological impairment and reduced quality of life as patients with a longer follow-up. If there is no improvement over time, unlike most often observed after organic brain lesions, the reduction in quality of life might therefore be unrelated to biological effects of the procedure itself in most patients. Both deficits from organic cerebral injury, and the effects of a psychological trauma tend to improve with long-term follow-up. We therefore postulate that the reduced quality of life observed in our patient groups is largely unrelated to the aneurysms or modality of treatment. However, another study found improvement in quality of life the first year after craniotomy and clipping of unruptured aneurysms [8]. Yet another study on the neuropsychological impacts of craniotomy for treatment of unruptured aneurysms found no evidence of deficits after 3 months [16].

In conclusion, our study seems to demonstrate that the quality of life in patients treated for non-ruptured intra-

cranial aneurysms is reduced. Significant differences in the quality of life of patients successfully treated using endovascular technique and patients who underwent craniotomy and clipping were not found. We speculate that the low quality of life scores may be due to factors unrelated to the aneurysms. The scores possibly reflect characteristics of a patient group likely to have incidental aneurysms diagnosed while undergoing extensive imaging procedures because of unrelated symptoms.

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Comments

This is an interesting and thought-provoking follow-up study of patients treated for unruptured aneurysms. The patient group is well-described and the assessment is relevant. There are some obvious limitations – retrospective recruitment, lack of randomization, and a fairly small N – but the study should serve to stimulate further work on the outcome of these patients.

The study shows that patients treated for unruptured aneurysms have low quality of life on the SF36 and high levels of anxiety and depression assessed by the HADS. Patients were unlikely to be working, and a high proportion were on sick leave or disability insurance even a year or more after treatment. Quality of life and emotional adjustment are reported to be poor regardless of whether aneurysms were clipped or coiled, or whether the analysis was confined to patients with uncomplicated successful treatment, or patients treated more recently. The authors suggest that the problems identified in patients may pre-date treatment, and reflect a tendency for patients with poor emotional adjustment or other symptoms to have imaging investigations and therefore to have aneurysms detected. However, it also seems plausible that for patients the discovery of a potentially life-threatening condition and undergoing subsequent procedures are in themselves stressful life events that could be responsible for later emotional difficulties.

Lindsay Wilson
Stirling

This is an interesting and timely study on an important subject of controversy. Although the authors point out themselves to the flaws of the study they are to be congratulated on their endeavour and their results which are in agreement with previous thoughts but never had been so clearly demonstrated.

There seems to be an advantage of endovascular over open surgical therapy, if applicable based on the aneurysm location and configuration, also from a patient's perspective of quality of life.

However, as (1) the study-design was retrospective and no preoperative data are reported and (2) patients were not randomly assigned to treatment-groups, this cannot be said with surety.

The results show, however, also that even the therapy which we consider the best may leave the patient with a major doubt concerning his further life.

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Kiel

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