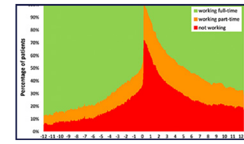
Return to Work after Surgical Clipping versus Endovascular Treatment of Unruptured Intracranial Aneurysms: A Nationwide Registry–Based Study



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ABSTRACT

Purpose: To assess return to work following the treatment of unruptured intracranial aneurysms (UIAs).

Materials and Methods: This retrospective, nationwide registry–based study included all adult patients of working age treated for a UIA in Norway between 2008 and 2018 who had a record of sickness leave on the day of treatment. Data from The Norwegian Patient Registry and The Norwegian Labour and Welfare Administration were linked on an individual level. Daily sickness and recipiency of disability benefits, as an indirect measure of working status, from 1 year before treatment to 1 year after treatment were analyzed. Return to work after endovascular treatment and surgical clipping was compared.

Results: In total, 412 patients were included. Of patients who worked 1 year before treatment, 83% returned to work 1 year after treatment. The number of days from treatment to the first day back at work in a continuous 3-month working period was lower in patients who underwent endovascular treatment than in those treated with surgical clipping (median, 69 days; 95% confidence interval [CI], 51–87; vs 201 days, 95% CI, 163–239; $P < .001$). Return to work was more likely in patients who underwent endovascular treatment at 3 months after treatment (hazard ratio, 3.53; 95% CI, 2.54–4.93; $P < .001$). There was no difference in return to work at 6 and 12 months after treatment.

Conclusions: The treatment of UIAs affects patients' postoperative working status. Patients treated endovascularly return to work earlier than those who undergo open surgery.

ABBREVIATIONS

ICD-10 = International Classification of Diseases, 10th Revision, NAV = Norwegian Labour and Welfare Administration, NPR = Norwegian Patient Registry, UIA = unruptured intracranial aneurysm

Unruptured intracranial aneurysms (UIAs) are common, with a reported prevalence of 2%–3% (1,2). In Norway, the prevalence of UIA has been reported to be 1.9% in individuals aged 50–65 years, with an overall estimated risk of rupture of 0.9% per year in this age group (3).

The risk of aneurysmal subarachnoid hemorrhage can be eliminated by successful preventive surgical or endovascular interventions. However, most intracranial aneurysms do not rupture, and the procedure-related risk can be high (3–6). The choice of surgical clipping versus endovascular treatment in individual patients is still controversial, and there are often large treatment variations among centers (7). The International Subarachnoid Aneurysm Trial showed better functional results but somewhat more occurrences of rebleeding after endovascular treatment for ruptured intracranial aneurysms at 1 year of follow-up (8). However, after 5 years, with pretreatment mortality excluded, the difference in death or dependency between coil embolization and clipping was not significant (9). In unruptured aneurysms, observational data have suggested that the bleeding rate is higher after endovascular treatment; however, early morbidity is higher after surgical clipping (6). Still, the long-term morbidity of clipping versus that of endovascular treatment is not much explored because of short durations of follow-up in existing studies (6,8).

Morbidity due to treatment has traditionally been measured as impaired neurologic function. However, patients may experience fatigue, anxiety, depression, post-treatment pain, cognitive challenges, or other symptoms

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RESEARCH HIGHLIGHTS

- The treatment of unruptured intracranial aneurysms affects patients' postoperative working status.
- Approximately 83% of patients who worked before treatment returned to work 1 year after the treatment of an unruptured intracranial aneurysm.
- Return to work was significantly more likely in patients who underwent endovascular treatment than in those treated with open surgery at 3 months after treatment.
- There was no difference in return to work at 6 and 12 months after treatment.

STUDY DETAILS

Study type: Retrospective, observational, cohort study

Level of evidence: 3 (SIR-C)

that are difficult to assess using gross neurologic function scales. The postoperative total level of function may instead be reflected in the ability to return to work after treatment (10). In addition, the ability to return to work is important for the total cost of treatment for the society. In this study, the authors sought to assess return to work following the treatment of UIAs.

METHODS

This was a nationwide, registry–based study. All adult patients (aged ≥18 years) treated for an UIA in Norway between 2008 and 2018 were identified from the Norwegian Patient Registry (NPR) (11). The coding of neurological and neurosurgical diagnoses in the NPR is of high quality, and data from this registry can be safely used for medical research purposes (12). All included patients had a Norwegian national security number; thus, international patients without a permanent residence permit treated in Norway were excluded. Case identification was performed based on the International Classification of Diseases, 10th Revision (ICD-10) diagnostic code I67.1 (13) and procedural codes for treatment according to the Nomesco Classification of Surgical Procedures (14) (codes AAC00–AAC15 [surgery], AAL00 [endovascular treatment until 2015], and AAY00B [endovascular treatment from 2016]). The patients' age at treatment and the dates of diagnosis and treatment were recorded from the same registry. A history of sickness absence (sickness, temporary, and permanent disability benefits) in the period 1 year before and after treatment was retrieved from The Norwegian Labour and Welfare Administration (NAV) records (15) for all patients. This national registry holds data on all sickness absences certified by a doctor and all disability benefits received by individuals with a Norwegian national security number. The dates of death and retirement were also recorded from the same registry. NPR and NAV data were linked on the individual level using a national security number, which is used as patient identification number in all contacts with health care and social care in Norway.

The retirement age in Norway, for both women and men, is 67 years. Therefore, patients older than 66 years at the time of treatment were excluded (this is because older individuals were most likely going to retire regardless of UIA treatment during the 1-year observational period). The study also excluded patients who underwent multiple aneurysm treatments or experienced subarachnoid hemorrhage (ICD-10 codes I60.0–I60.9) within a year from the initial treatment. In cases in which patients were treated multiple times for intracranial aneurysms outside of the observational period (ie, multiple episodes of aneurysm treatment more than a year apart), only the first treatment for UIA was included in the analyses. If patients were treated for a ruptured aneurysm first and then a UIA (more than a year later), the first treatment for UIA was included in the analyses. All patients included in the analyses had to have a record of a sick leave certificate on the day of treatment. This criterion excluded patients who received 100% disability benefits or were not in employment before treatment and those without a permanent residence permit who are not eligible to receive sickness absence compensation.

Statistical Analysis

Statistical analyses were performed using R (R Foundation for Statistical Computing, Vienna, Austria), SPSS Statistics for Windows (version 32 27.0.1.0; IBM, Armonk, New York), and Stata Statistical Software (release 17; StataCorp, College Station, Texas). The normal distribution of continuous variables was assessed using Q-Q plots. Differences in patient characteristics were analyzed using the Chi-square test for categorical variables and Mann-Whitney U test for comparison of skewed continuous variables. Patients were considered not working if they received sickness or disability benefits for more than 80% of full employment. They were considered working part time if they received any sickness or disability benefits for less than or equal to 80% of full employment. The Kaplan-Meier analysis was performed. Return to work ("event" in the analysis) was defined as the first day at work in at least 20% employment in a continuous 3-month working period. The working status after treatment was compared between patients treated with endovascular treatment and those treated with surgical clipping using the log rank test. A Cox regression model assessing potential predictor factors for return to work was developed. The proportional hazards assumption was tested using the Schoenfeld residuals test.

Ethical Approval

The Regional Committee for Medical and Health Research Ethics in Norway approved the study and waived the requirement of informed consent.

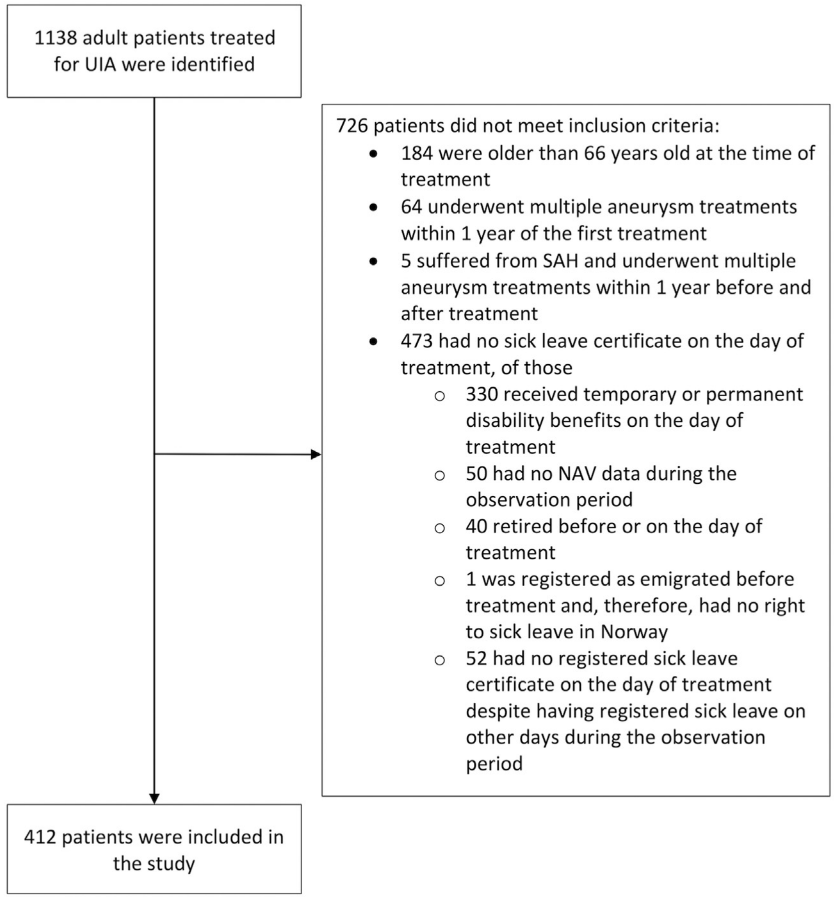

Figure 1. Selection of the study population. NAV = Norwegian Labour and Welfare Administration; SAH = subarachnoid hemorrhage; UIA = unruptured intracranial aneurysm.

RESULTS

The inclusion and exclusion process is shown in Figure 1. As seen, 412 patients were included in the study. Of them, 269 (65%) were women. The median age at treatment was 52 years (range, 19–66 years).

Figure 2 shows the daily proportion of working status of the patients (n = 412) treated for UIAs during a 2-year period, from 1 year before treatment to 1 year after treatment.

Longitudinal analysis of the working status of patients who worked 1 year before treatment was performed. Of patients who worked 1 year before treatment, 83% returned to work 1 year after treatment. Of patients who worked full time at 1 year before treatment, 74% returned to full-time and 8% to part-time employment 1 year after treatment. Of patients who worked part time at 1 year before treatment, 54% worked part time and 39% worked full time 1 year after treatment.

The study population included 172 patients (42%) treated endovascularly and 240 patients (58%) who underwent open surgery. There was no statistical difference in patient sex (65% vs 66% women, respectively; $P = .785$) or age at treatment (median, 52 vs 52 years, respectively; $P = .627$) between the groups.

The Kaplan-Meier analysis with the log rank test showed that the median number of days from treatment to the first day back at work in a continuous 3-month working period was lower in the patients who underwent endovascular treatment than in those treated with open surgical clipping (median, 69 days; 95% confidence interval [CI], 51–87; vs 201 days; 95% CI, 163–239; $P < .001$) (Fig 3). Five patients treated with coil embolization and 1 patient treated with clipping were censored in the analysis because they retired within a year after treatment before they returned to work. This model did not fulfill the proportional hazards assumption.

In order to assess potential predictor factors for return to work after the treatment of UIAs, a Cox regression model was developed. The follow-up in this model was divided into 3 periods: 0–3, 3–6, and 6–12 months after treatment. The hazard ratios for return to work in the different groups are presented in Table 1. The multivariate analysis showed that the patients who underwent endovascular treatment were more likely to be back at work 3 months after treatment than those treated with open surgery (hazard ratio, 3.53; 95% CI, 2.54–4.93; $P < .001$). However, the difference in return to work between the groups gradually diminished, and at 6 and 12 months after treatment, there

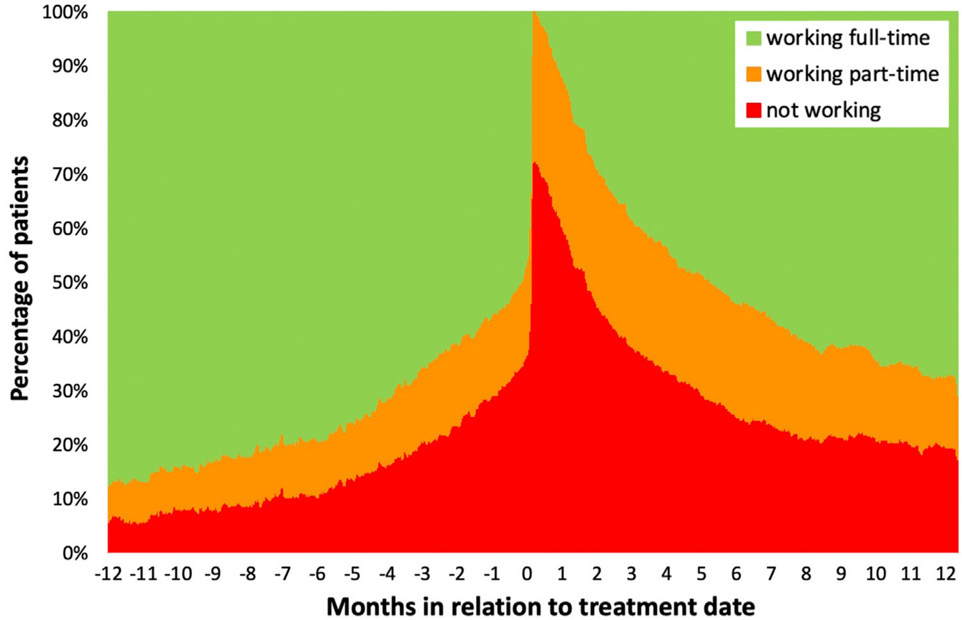

Figure 2. Working status before and after the treatment of unruptured intracranial aneurysm (n = 412).

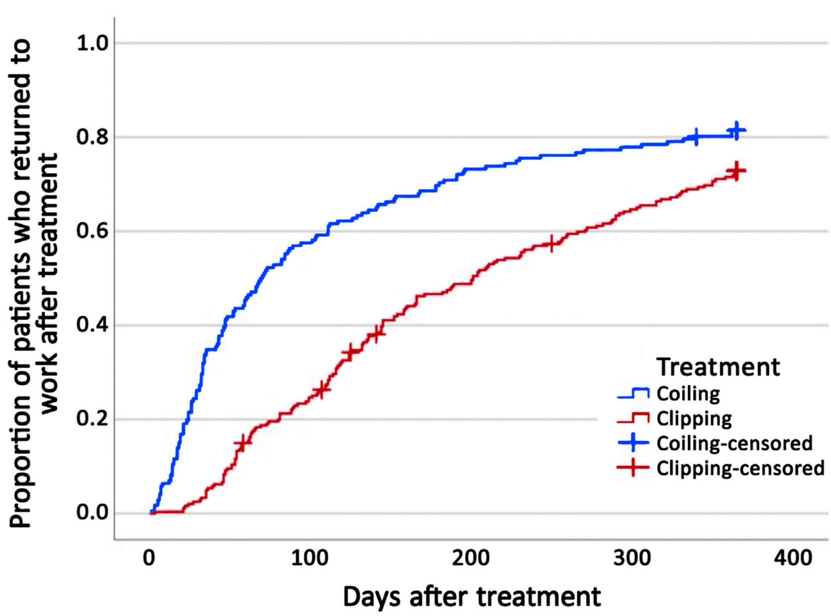

Figure 3. Kaplan-Meier analysis of return to work (defined as the first day back at work in a continuous 3-month working period) of patients treated for an unruptured intracranial aneurysm according to treatment modality.

was no statistical difference. Table 2 shows the returntowork data according to age groups.

DISCUSSION

In this nationwide registry–based study, the work life participation of patients with UIAs decreased after treatment. The patients treated with endovascular techniques returned to work earlier after treatment than those treated with open surgery; however, there was no difference between the groups at 6 and 12 months after treatment. Patients treated with endovascular techniques might return to work earlier because of a lower burden of symptoms after endovascular treatment than those treated with open surgery; however, the difference can also be affected by doctors who can be more conservative with letting patients return to work after open brain surgery compared with those after endovascular treatment.

The present population-based study is the largest study to date investigating return to work following the treatment of UIAs. Return to work after preventative treatment may

Table 1. Predictor Factors for Return to Work

Factor	Hazard ratio (95% confidence interval), *P*		
	3 mo	6 mo	12 mo
Treatment modality*	3.53 (2.54–4.93), <.001	1.03 (0.64–1.66), .900	0.71 (0.42–1.21), .210
Age at treatment (continuous)	1.00 (0.98–1.01), .678	0.99 (0.97–1.02), .615	1.00 (0.98–1.02), .964
Sex†	0.60 (0.44–0.83), .002	0.76 (0.48–1.20), .240	0.63 (0.39–1.00), .048

*Open clipping is the reference category.
†Male sex is the reference category.

Table 2. Return to Work According to Age Group

Age at treatment (y)	n	Proportion of patients who returned to work within 1 y after treatment (95% CI)	Time from treatment to return to work (d), median (95% CI)*
19–29	7	0.57 (0.18–0.90)	362 (22–365)
30–39	48	0.83 (0.70–0.93)	122 (82–247)
40–49	100	0.75 (0.65–0.83)	152 (124–196)
50–59	192	0.78 (0.71–0.83)	113 (87–153)
60–66	65	0.68 (0.55–0.79)	183 (135–260)

*Number of days from treatment to the first day back at work in a continuous 3-month working period.

reflect the total level of postoperative functioning. Therefore, results are of importance for making decisions about whether an individual patient with a UIA should be treated and for selecting the most suitable treatment modality. The results of our study may perhaps be interpreted both ways. One might argue that endovascular treatment is favorable because patients return to work earlier after treatment than those treated surgically. On the other hand, if open surgery provides a more robust and long-term treatment (8), at least in some anatomic locations and aneurysm configurations, a few more months with sick leave might be a small price to pay in the grand scheme of things because the proportion of patients who return to work 6 and 12 months after treatment is the same in both treatment groups. In addition, patients who are treated endovascularly require a longer duration of follow-up than those treated surgically, which increases the total financial cost of treatment.

Three previous studies (16–18) found that between 78% and 100% of patients with UIAs who worked before treatment returned to work after treatment, whereas another study (19) is difficult to interpret because the preoperative working status was not assessed. The varying but rather high number of patients who returned to work after surgery in the mentioned studies might have been affected by their inclusion criteria. However, the inclusion process was poorly described in some studies (18,20). Two of the 4 previously published studies (17,19) compared the working status between patients treated surgically and those treated endovascularly. In line with this study's findings, 1 study (17) reported that more patients treated endovascularly returned to work following treatment. However, this study was limited by a long interval between treatment and the returntowork assessment, exceeding 6 years for the total study population. Conversely, the second study (19) reported that return to work was more frequent after treatment with open surgery than after endovascular treatment. This study, on the other hand, is limited by the lack of registered working status before treatment and the fact that the endovascular group included more symptomatic patients.

The national registry–based collection of data is a major strength of the present study, enabling inclusion of data on all sickness absences certified by a doctor received by all individuals with a Norwegian national security number treated for UIAs in Norway in an 11-year period. However, the study has some limitations. Findings from Norway, which has a public health care system and generous social benefits, might not be directly extrapolated to other countries. The results of this study show that up to approximately 50% of the included patients were not in full employment during the months leading up to treatment. This could suggest that those patients were on sick leave because of the symptoms that led to the diagnosis of UIA or the psychological burden of having an untreated UIA. The threshold of being able to receive a sick leave certificate most likely varies in different countries. Nevertheless, the burden of the treatment of UIAs, as experienced by patients, may still be reflected in the Norwegian employment numbers after treatment, although the number of patients returning to work may differ across nations.

Although the data are considered reliable because the sickness compensation is paid according to the records, the study design assumed that when there are no records of sickness or disability benefits, the individuals are in full employment. Patients who did not have a sick leave certificate on the day of treatment were excluded from the study. Most of those patients were individuals who received disability benefits. Some retired on the day of treatment, and 1 was registered as emigrated and had, therefore, no right to sickness benefits in Norway. Moreover, 50 patients had no NAV data during the observational period. Those patients are most likely individuals without a permanent resident permit and have, therefore, no right to sickness benefits in Norway. Furthermore, 52 patients had no registered sick leave certificate despite having registered sick leave on other days during the observation period. Those patients could have been self-employed individuals who do not receive sickness compensation from the state in Norway during the first 16 days of sickness. Moreover, this group could have also included students or unemployed individuals who are not entitled to sickness benefits.

Although the study was performed during a period of the global financial crisis, the results are unlikely to be significantly affected by this because the unemployment rates in Norway during that time were rather stable at 1.8%–2.9% (21). In addition, return to work in the observation period might have been affected by not only the aneurysm treatment but also symptoms or conditions that led to the diagnosis of UIA in the first place. The comorbidities of the included patients were not assessed. Preoperative working status is rarely a factor that is considered while deciding whether the UIA warrants treatment. In Norway, as in most countries, endovascular procedure is the first-line treatment that is considered, and open surgical clipping is reserved for aneurysms in which successful coil embolization is unlikely or has failed. Preoperative working status is not a deciding factor in the choice of treatment modality. What is more, because ICD-10 diagnostic codes do not differentiate between the location or shape (fusiform vs saccular) of UIAs, the locations or shapes of the treated aneurysms were unknown. This could have introduced confounding to the comparative analysis of return to work between the different treatment groups, and, therefore, this part of the analysis should be interpreted with caution. Furthermore, information on the type of vascular treatment performed (coil embolization, stent-assisted coil embolization, or flow diversion) was not available. Treatment with stent placement or flow diversion may be associated with higher mortality compared with that with coil embolization alone (22). Therefore, further studies investigating the possible differences in postoperative working status among different endovascular treatments are necessary.

Finally, patients who underwent multiple aneurysm treatments within a year were excluded from the study. Because patients treated endovascularly are more likely to require multiple treatments for successful exclusion of the aneurysm from the circulation because of treatment failure or coil impaction (8), the results of this study are presumably most representative of patients who undergo a single successful aneurysm treatment.

In conclusion, the treatment of UIAs often affects the working status of patients, and patients treated with endovascular techniques return to work earlier than those who undergo open surgery.

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