Neuro-Ophthalmic Presentation and Surgical Results of Unruptured Intracranial Aneurysms—Prospective Helsinki Experience of 142 Patients

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Key words
- Fourth nerve palsy
- Intracranial aneurysm
- Sixth nerve palsy
- Third nerve palsy
- Visual field defect
- Weber syndrome

Abbreviations and Acronyms
BA: Basilar artery
CCA: Carotid cavernous aneurysm
EMD: Eye movement disorder
ICA: Internal carotid artery
UIA: Unruptured intracranial aneurysm
VFD: Visual field defect

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■ OBJECTIVE: **To assess prospectively neuro-ophthalmic findings associated with unruptured intracranial aneurysms and treatment morbidity and to identify factors predicting these findings.**

■ METHODS: **Patients admitted to Helsinki University Central Hospital and treated surgically or endovascularly during 2011 underwent a neuro-ophthalmic examination, including formal visual field testing, before operation, at discharge, and 2–4 months and ≥6 months postoperatively. Univariate and multivariate analysis was used to identify factors predicting eye movement disorders.**

■ RESULTS: **Study participants included 142 patients with 184 treated aneurysms: 7 (5%) had a third, fourth, or sixth nerve palsy or skew deviation preoperatively, and 16 (11%) had a third, fourth, or sixth nerve palsy or skew deviation postoperatively; the frequency was 8 (6%) at the last follow-up evaluation. Other findings included compressive optic neuropathy (n = 4), ischemic optic neuropathy (n = 1), Weber syndrome (n = 3), Benedikt syndrome (n = 1), and Wallenberg syndrome (n = 1). Of the 140 survivors at 6 months, 7 (5%) presented with visual field defects resulting from the aneurysm or its treatment. In the best bivariate model, factors independently predicting postoperative eye movement disorders were aneurysm location in the posterior circulation with an odds ratio of 142.02 (95% confidence interval = 20.13–1002.22) and aneurysm size (odds ratio = 1.28 for each 1-mm increase in diameter, 95% confidence interval = 1.12–1.47).**

■ CONCLUSIONS: **Management of unruptured intracranial aneurysms is fairly safe from a neuro-ophthalmic perspective, with some treatment-related morbidity being transient and minor. Although rare, an irreversible deficit is possible and should be taken into account when considering preventive treatment.**

INTRODUCTION

Unruptured intracranial aneurysms (UIAs) affect about 2%–5% of the general population (32, 34, 39); they are often incidental findings on brain magnetic resonance imaging, magnetic resonance angiography, or computed tomography angiography detected during investigation of another symptom. The frequency as an incidental finding is likely to increase in the future because of widespread availability and technical advancements of noninvasive imaging. As preventive treatment has become more active, accurate data on neuro-ophthalmic findings and treatment morbidity are essential.

Published data with a wide range of reported treatment-related morbidity rates focus mainly on major neurologic deficits, often ignoring neuro-ophthalmic problems (29, 36, 40). Prospective studies of detailed neuro-ophthalmic findings, including formal visual field testing, in patients with UIAs are scant. Reports are mainly highly selected retrospective case series of aneurysms at specific locations—usually representing symptomatic large and giant aneurysms (5, 24). The proportion of "complete resolution" of oculomotor nerve palsies may be based on retrospective record review or subjective questionnaires without neuro-ophthalmic examination (16, 20, 31).

In the present prospective study, we aimed to evaluate the prevalence of preoperative and postoperative eye movement disorders (EMDs), visual field defects (VFDs), and other neuro-ophthalmic findings in patients undergoing microsurgical or endovascular treatment for UIA and to identify independent clinical and radiologic factors predicting these findings.

MATERIALS AND METHODS

The Helsinki University Central Hospital operative ethics committee approved the study protocol. All consecutive patients with UIAs who were admitted for surgical or endovascular treatment to the Department of Neurosurgery, Helsinki University Central Hospital, in 2011 participated in this prospective study after giving their informed consent. All patients with an intracranial aneurysm within our catchment area are treated at our department (serves a population of 1.8 million in southern Finland) without selection bias. In addition, some challenging cases from other health care districts in Finland or abroad are annually referred to our department for treatment. Foreign residents and patients with subarachnoid hemorrhage and an additional UIA were excluded from the study because of difficulties in arranging preoperative and long-term examinations. Aneurysms were identified by computed tomography angiography, magnetic resonance angiography, digital subtraction angiography, or a combination of these.

A qualified radiologist and neurosurgeon (R.K.) who was unaware of the clinical findings reviewed all patients' radiologic data for aneurysm locations and dimensions (width, length, and largest diameter) and presence of perioperative or postoperative infarction or bleeding. The aneurysm was classified as partially occluded if any filling existed on postoperative angiography. We also graded the clinical condition before operation and at 6 months after operation according to the modified Rankin Scale grading system (7). Follow-up time after surgery or endovascular treatment was 6 months. We compared clinical and radiologic data with neuro-ophthalmic findings.

Neuro-Ophthalmic Examination

All patients underwent a neuro-ophthalmic examination at the Division of Neuro-Ophthalmology a few days to weeks before the operation, at discharge, and 2–4 months and ≥6 months postoperatively. We report only findings related to the aneurysm treated in 2011. The examination included best-corrected visual acuity, oculomotor assessment, alternating cover test, Maddox rod and Hess screen tests, pupillary examination, and dilated funduscopy. Patients with third nerve palsy were evaluated for the presence of Weber syndrome (concomitant contralateral hemiparesis indicating involvement of the cerebral peduncle) or Benedikt syndrome (oculomotor palsy with contralateral hemitremor owing to involvement of the red nucleus) (11). Recovery of a third, fourth, or sixth nerve palsy was partial if any limited eye movement was observable on a detailed examination. Complete recovery of third nerve palsy included a partial or a complete improvement of pupillary reaction.

Visual field testing was performed on each patient with the Octopus 900 perimeter (dynamic or TOP strategy; Haag-Streit AG, Koenic, Switzerland) or the Goldmann Kinetic perimeter (Haag-Streit Inc., Bern, Switzerland) by a skilled perimetrist in a standardized fashion or the confrontation test. The choice of test strategy was based on the patient's individual capacities to optimize patient performance.

Statistical Analyses

The data were analyzed with IBM SPSS Statistics for Windows version 20.0 (IBM Corp, Armonk, New York, USA). All tests were two-sided. For statistical analysis, only EMDs (presence of third, fourth, or sixth nerve palsy or skew deviation) resulting from the aneurysm or the operation performed were included. The presence of aneurysm-related or treatment-related EMDs was compared statistically with the following characteristics: age, gender, largest aneurysm diameter, aneurysm location in the posterior circulation, presence of perioperative or postoperative infarction or bleeding, operation modality, and modified Rankin Scale grade at 6 months.

Unordered and singly ordered contingency tables were analyzed with Fisher exact or Pearson χ^2 test and Kruskal-Wallis test, respectively. Continuous variables between groups were compared with the Mann-Whitney U test. The level of significance was set at $P < 0.05$.

To identify independent clinical and radiologic factors for the presence of postoperative EMD, we used univariate and bivariate logistic regression analysis modeling EMD as a dependent variable (14, 21). Independent variables with $P < 0.10$ were allowed in the model, and bivariate models were compared using the likelihood ratio test (21). We present the results of the analyses as odds ratios with 95% confidence intervals.

RESULTS

General Outcome

Of 176 patients who underwent surgery or endovascular treatment for UIA in 2011, 8 foreign residents and 18 patients with subarachnoid hemorrhage and an additional UIA were excluded. Because of communication delay, 8 other patients were excluded. No patient refused to participate in the study. Participants comprised 142 patients with 184 aneurysms treated in 155 procedures (Tables 1–3). Multiple aneurysms (range, 2–8) were present in 52 patients (37%). There were 12 patients (8%) who had 2 or 3 operations during the year, and 23 (16%) patients had >1 aneurysm treated in 1 operation. Of the 184 treated aneurysms, 175 (95%) were totally occluded. One patient without EMD or VFD immediately postoperatively did not attend follow-up visits. One patient with polycystic kidney disease and a fusiform basilar artery (BA) aneurysm died of

Table 1. Characteristics of 142 Patients with Unruptured Intracranial Aneurysm

Sex	
Male	40 (28%)
Female	102 (72%)
Age (years), mean (range)	58 (21–81)
Maximum diameter of aneurysm (mm), median (range)	5 (1–43)
Treatment	
Microsurgical	137 (96%)
Endovascular	5 (4%)
Change in mRS grade (pretreatment and 6 months posttreatment)*	
Same or better	122 (87%)
Worse	19 (13%)

Values are number (%) unless indicated otherwise.
mRS, modified Rankin Scale.
*Data available for 139 patients.

Table 2. Clinical Condition Preoperatively and 6 Months After Treatment for 142 Patients with Unruptured Intracranial Aneurysm

Modified Rankin Scale Score	Preoperative	6 Months After Treatment*
0	80 (56)	73 (52)
1	42 (30)	40 (28)
2	10 (7)	9 (6)
3	5 (4)	8 (6)
4	5 (4)	8 (6)
5	0	1 (1)
6 (dead)	0	2 (1)

Values are number (%).
*Data available for 141 patients.