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Early surgery for ruptured cerebral arteriovenous malformations

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Summary

Acute surgery on cerebral arteriovenous malformations (AVMs) has seldom been reported or used. We reviewed 49 patients of ages 2 months to 78 years (mean 32.8 years), 32 male (65%) and 17 female (35%), treated acutely (within 4 days of bleed) in Helsinki Neurosurgery during 1997–2002. The following variables were assessed in regards to the outcome (Glasgow outcome score; GOS; 2–3 months after bleed): age, sex, Hunt and Hess Grade (HH), Spetzler-Martin Grade (SMG), location of AVM, size of intraparenchymal haematoma (ICH), and presence of intraventricular haemorrhage (IVH).

Most of the patients were in a poor clinical condition on admission (two thirds were HH 4–5). 45 (92%) patients underwent extirpation of AVM and evacuation of ICH, within 4 days after bleed. Over 55% had good functional outcome. GOS correlated significantly with HH ($p = 0.001$), age ($p = 0.006$), and IVH ($p = 0.049$). On the other hand, SMG, location of AVM, and size of haematoma did not significantly predict the outcome. Microneurosurgery with preoperative embolization has made possible the excision of 90% of AVMs. It is our experience that it can be done acute and early, and it saves lives as compared to natural history of cerebral AVMs or late surgery, and accelerates rehabilitation of the patients.

Keywords: Arteriovenous malformation; vascular malformation; subarachnoid haemorrhage; intracerebral haematoma, acute surgery.

Introduction

Arteriovenous malformations (AVMs) are relatively rare but, nevertheless, a major cause of haemorrhagic stroke in the young population. It has been suggested that 45–70% of the adult AVM patients present with an acute intracranial haemorrhage [1, 3, 10, 12]. Several previous studies of the natural history of AVMs have estimated that there is a 2 to 4% annual risk of haemorrhage from an AVM [1, 3, 8, 12], and a risk of recurrent haemorrhage of 7 to 14% per year initially, declining to a prehaemorrhage level after 5 years [3, 8].

While most ruptured cerebral aneurysms are operated on acutely since more than 25 years, acute surgery on cerebral AVMs has seldom been reported or used. It has been claimed to be contraindicated and dangerous leading to persistent deficits [11, 14]. On the other hand, surgery has the clear advantage of enabling a complete removal of an AVM in one session, and thus, abolishing the risk of the most dreaded event, recurrent haemorrhage. The aim of this review of acutely operated patients with ruptured cerebral AVM was to find predicting factors for the outcome.

Materials and methods

Out of more than 1000 cerebral AVMs treated during years 1932–2004 in Helsinki and Kuopio, we reviewed all patients with ruptured cerebral AVM that were operated within 4 days after haemorrhage between 1997 and 2002 in the Department of Neurosurgery, Helsinki University Central Hospital. During this time period, altogether 179 cerebral AVMs were operated on, 100 of them unruptured. The 49 patients scrutinised – being close to one sixth of more than 300 cerebral AVMs operated on by the senior author (JH) [5] – 32 male (65%) and 17 female (35%), had a mean age of 32.8 years (range 0.2–78 years). Data were obtained from medical records and radiographic studies including demographics, Hunt and Hess Grade (HH) [7] at admission, Glasgow outcome score (GOS; GR = good recovery; MD = moderate disability; SD = severe disability; V = vegetative; D = dead) [9] 2–3 months after haemorrhage, size of intraparenchymal haematoma (ICH), presence of intraventicular haemorrhage (IVH), location of AVM, Spetzler-Martin Grade (SMG) [15], and operative treatment.

45 (92%) patients underwent craniotomy and extirpation of AVM, and evacuation of ICH, if necessary. Of the remaining four patients (8%), three were acutely treated with ventricular drainage (one pa-

tient primarily in Thailand) and one patient had trephination and evacuation of ICH primarily in Estonia. All patients had preoperatively head CT, DSA and/or CTA, and most patients also a MRI. Embolization was used if feasible in association to DSA. A postoperative angiography was always performed and repeated, if necessary.

Data were analyzed with the SPSS for Windows (release 9.0.1.1999, SPSS Inc.). Univariate association of continuous variables was tested by Spearman rank (r_s) correlation coefficients. Analysis of factors that may contribute to the outcome was undertaken by unconditional logistic regression. Maximum-likelihood stepwise forward elimination procedures were used, with selection of variables based on the magnitude of their probability values (<0.05). A two-tailed p-value < 0.05 was considered significant.

Results

Most of the patients were HH 4 and 5 at admission: 13 (27%) and 19 (39%), respectively. Size of ICH was smaller than 2.5 cm in 10 patients (20%), 2.5–5 cm in 27 patients (55%), and more than 5 cm in 12 patients (25%). Twenty-one patients (43%) had a complicating IVH. Twenty-one (43%) of the AVMs were SMG 2, almost 60% of the AVMs were grades 1 and 2. More than half of the patients had good functional outcome (GOS GR or MD) 2–3 months after bleed. The outcome correlated significantly with HH ($p = 0.001$), age ($p = 0.006$), and IVH ($p = 0.049$). The correlations of GOS with HH, SMG, size of ICH, and IVH are shown in Table 1. Figure 1 demonstrates radiological findings of two patients. Only one postoperative angiography showed a small residual AVM, this was not re-treated during the follow up time.

Table 1. *The Glasgow outcome score (GOS)*

GOS						
HH	*GR*	*MD*	*SD*	*V*	*D*	*Total*
1	3	0	0	0	0	3
2	4	3	2	0	0	9
3	3	0	2	0	0	5
4	4	3	5	0	1	13
5	5	2	4	3	5	19
Total	*19*	*8*	*13*	*3*	*6*	*49*
SMG						
1	6	0	1	1	0	8
2	9	1	9	0	2	21
3	1	6	3	1	2	13
4	2	1	0	1	2	6
5	1	0	0	0	0	1
Total	*19*	*8*	*13*	*3*	*6*	*49*
ICH ∅						
<2.5 cm	4	3	1	0	2	10
2.5–5 cm	12	3	8	0	4	27
>5 cm	3	2	4	3	0	12
Total	*19*	*8*	*13*	*3*	*6*	*49*
IVH	5	4	6	2	4	*21*

GR Good recovery; *MD* moderate disability; *SD* severe disability; *V* vegetative; *D* dead: 2–3 months after haemorrhage in correlation with Hunt and Hess *(HH)* and Spetzler-Martin Grades *(SMG)*, size (∅) of intraparenchymal haematoma *(ICH)*, and presence of intraventricular haematoma *(IVH)*.

Discussion

These data of 49 patients with ruptured AVM, operated acutely after haemorrhage show that most of the patients were in a poor clinical condition on arrival (two thirds were HH 4–5). Almost 80% of the patients had a significant ICH, and more than 40% also a complicating IVH. In 92% of the patients AVM was acutely extirpated. Over 55% of the patients had good functional outcome 2–3 months after bleed. Factors that clearly predicted the outcome were HH and age. Also, presence of IVH correlated with GOS.

We evaluated the outcome 2–3 months after bleed. A longer recovery period is required to detect more final outcome. The follow up of the patients will be extended up to one year in our next studies.

Earlier studies have considered variables such as SMG (AVM size, location in the eloquent areas, and deep venous drainage) [6, 11, 15] and patient's clinical condition at the time of surgery [4, 6, 13, 16] to influence the management outcome. However, morbidity and mortality rates have varied in some previous studies because of patient selection (exclusion of patients in primarily poor condition [2]). We included all admitted patients consecutively in our series. One recent study has suggested an independent effect of age on the risk of AVM surgery [4]. Our data shows age to have significant influence on the outcome. It is the primary severity of the bleed, not SMG, location of AVM, and size of ICH, that significantly influences the outcome. This might be due to our aggressive and acute treatment, i.e., within 4 days of bleed, careful evacuation of ICH, when needed, and 98% success in excising AVM totally in the same session.

Microneurosurgery with preoperative embolization has made possible the excision of 90% of arteriovenous malformations; and it is our experience that it can be done early to save lives and to accelerate rehabilitation of the patients. A few surgeons specialising in the surgery of AVMs and aneurysms should be available in every country.

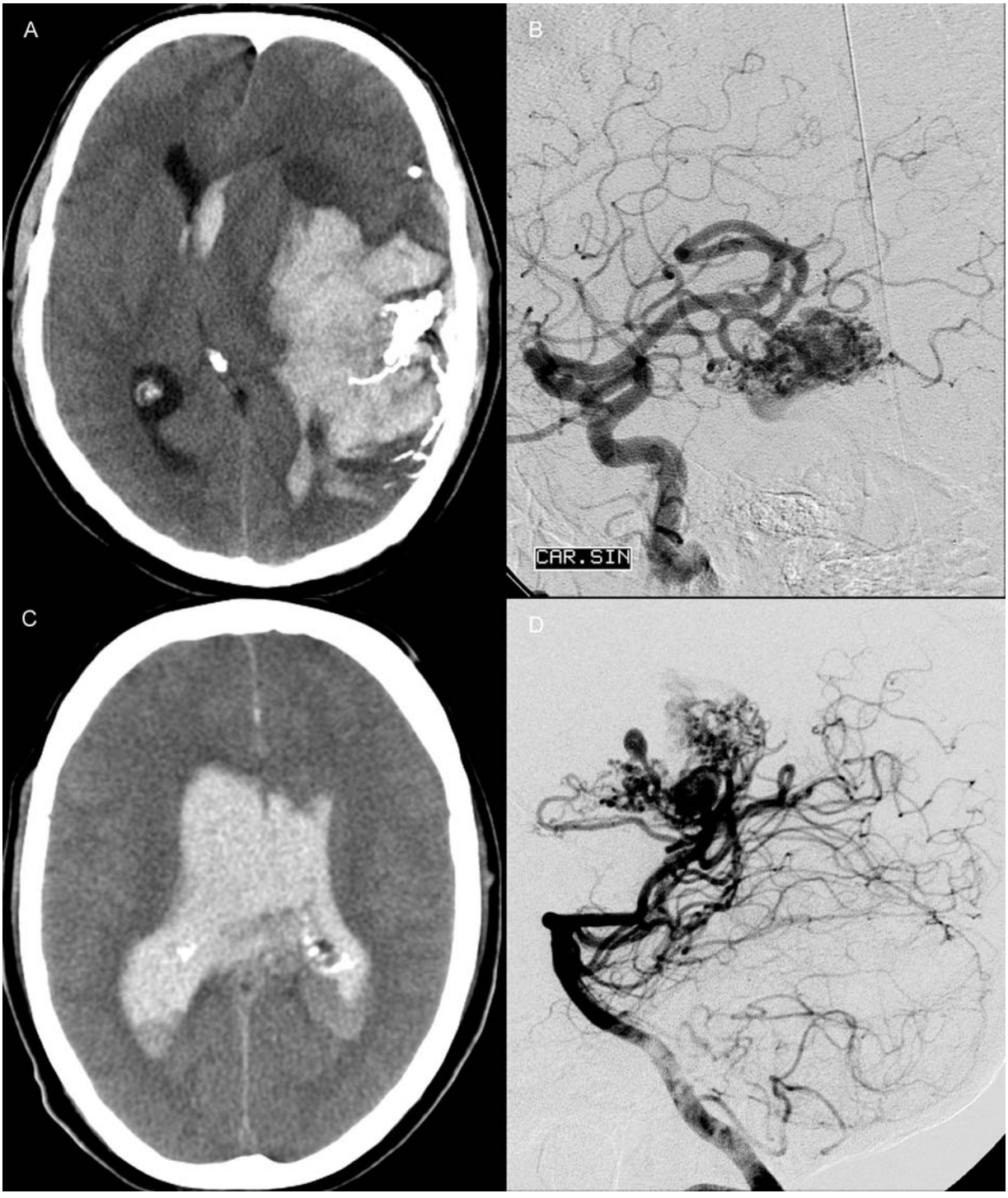

Fig. 1. (A) A huge intraparenchymal haematoma *(ICH)* two days after embolization of (B) a left temporal arteriovenous malformation *(AVM)* in 39-year-old male. Preoperatively Hunt and Hess Grade *(HH)* was 5. ICH was evacuated and AVM extirpated, resulting in vegetative state at 3 months after bleed, and finally severe disability. (C–D) 38-year-old male admitted deeply unconscious *(HH 5)* to hospital. (C) CT scan showing massive intraventricular haematoma. (D) Vertebral angiography revealed a trigonal AVM, which was extirpated. Unfortunately the patient did not survive

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