The impact of endovascular treatment on cerebral aneurysm outcome at Groote Schuur Hospital

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Objectives. Neuro-endovascular treatment was introduced at Groote Schuur Hospital in 2001. We sought to assess whether this has resulted in a change in overall outcomes for patients treated for cerebral aneurysms.

Design. Retrospective cohort study. The first cohort included cerebral aneurysm patients seen between 1994 and 1998 when only surgical treatment was available. The second cohort consisted of a group treated using both surgical and endovascular methods between 2002 and 2004.

Subjects. Patients with ruptured and unruptured aneurysms were included in the study.

Outcome measures. The Glasgow Outcome Score (GOS) was used to assess outcome. The primary comparator between groups was major disability (GOS 3 and 2) and death (GOS 1).

Results. Cohorts were comparable regarding age, sex and presenting clinical condition as assessed using the World Federation of Neurological Surgeons grading for subarachnoid haemorrhage. There was an absolute reduction in major disability and death of 16% in the later cohort where 55% of patients had endovascular treatment.

Conclusions. The option of endovascular treatment for cerebral aneurysms at Groote Schuur Hospital has allowed for more rapid treatment of patients, which has reduced morbidity and mortality from re-bleeding. We are also able to select the best treatment option for each patient and believe this has contributed to our improved results.

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Since the acceptance of surgery as a treatment strategy for ruptured cerebral aneurysms in the 1960s there has been constant improvement in patient outcomes. Initially this was because of improvements in operative technique such as use of the operating microscope and new clip designs for aneurysm occlusion. Later improvements were due to an evolving understanding of the pathology of subarachnoid haemorrhage (SAH) and intensive care advances. In the early 1990s further progress was made with the development of the Gugliemi detachable coil (GDC). This allowed for the occlusion of cerebral aneurysms without the need for a craniotomy and brain retraction. It now became possible to treat an aneurysm endovascularly by passing a microcatheter from the groin into the aneurysm dome through the arterial system. Once the catheter was in place platinum GDC coils could then be introduced through the catheter into the aneurysm until it was completely occluded. Thrombosis and later healing by endothelialisation allowed for exclusion of the aneurysm from the arterial system (Fig. 1). The recent International Subarachnoid Aneurysm Trial (ISAT) which randomised patients with ruptured aneurysms to either surgical or endovascular treatment, showed reduced death and serious morbidity in the endovascular group, validating this therapy.[1]

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In 2001, through a process of subspecialisation, we began endovascular treatment and microsurgical treatment of aneurysms at Groote Schuur Hospital and the University of Cape Town academic complex. To date we have treated over 90 aneurysm patients endovascularly and in doing this have built up a neurovascular unit that serves to treat patients, teach students and train specialists. It was our impression that in developing this expertise we had improved our overall care of patients with neurovascular disease. To assess this we examined outcomes of patients treated for cerebral aneurysms before and after our use of endovascular techniques in a retrospective cohort study.

Methods

Over a period of 3 years and 8 months, spanning October 1994 to July 1998, 245 cerebral aneurysm patients were treated in our unit. Demographic, clinical, complication and outcome data in the form of a Glasgow Outcome Score (GOS) were available for this group from a previously unpublished study. This information was obtained initially by reviewing hospital records. During this period only surgery was used as a treatment strategy. Over a 19-month period from July 2002 to February 2004 similar information was collected for 82 patients treated either surgically or by endovascular occlusion, or with a combination of both. This information was obtained from the patients' hospital folders.

In order to standardise evaluation, patients with multiple

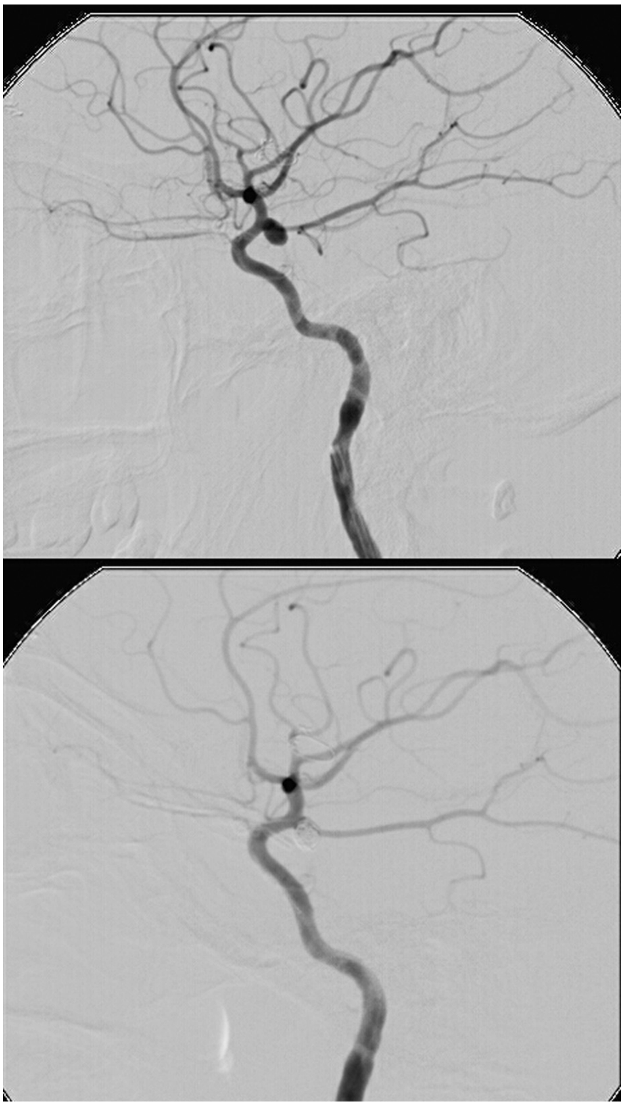

Fig. 1. Cerebral angiogram showing a posterior communicating region aneurysm before and after endovascular coiling.

aneurysms who received treatments at different times were treated as new admissions. After treatment of a ruptured aneurysm patients with another aneurysm were reflected in the unbled aneurysm group as new patients. However, if multiple aneurysms were treated during the same procedure this was reflected as 1 admission.

During the period 1994 - 1998 our standard approach to cerebral aneurysms was a pterional craniotomy and microsurgical clipping of the aneurysm. Because of resource limitation we had a policy of only admitting patients with good neurological status (WFNS score of I or II); however if poor-grade patients were admitted to our service they were also treated surgically if their condition improved. As far as possible patients were managed in high care or intensive care. Hypervolaemia was the primary strategy for treating SAH-related vasospasm. From 2001 and during the treatment period of the second cohort our admission criteria remained the same; however we introduced some changes to aneurysm management. The most significant change was the capacity to treat aneurysms endovascularly. Over 50% of aneurysms in the second cohort were treated endovascularly. We also started to use angioplasty for patients who developed vasospasm and who were unresponsive to hypervolaemia. As far as possible patients were treated in a high-care setting, but endovascularly treated patients were often treated under local anaesthetic and recovered in a normal ward. Changes were also made with regard to our microsurgical approaches. In addition to the pterional approach many patients had their aneurysms clipped through a minimally invasive 'key hole' supraorbital craniotomy.

Analysis

Parametric variables were analysed using descriptive statistics, and cohorts were compared using an unpaired *t*-test. Non-parametric variables were analysed using either a chi-squared test or Fisher's exact test. The timing of outcome assessment was at the point of patient discharge. This is not ideal when examining for subtle neurological differences between groups but is acceptable when using death and major disability as outcome. Mortality tends to be related to aneurysm rupture or treatment complications and occurs early rather than after discharge from hospital. Few patients who have a major disability are likely to improve to the point where they are independent so time should not alter outcome assessment significantly. Outcomes were compared by stratifying cohorts into two groups, namely favourable and unfavourable outcome. Favourable outcome included patients who were normal or who had only minor disability, i.e. GOS 4 and 5. Unfavourable results included patients with major disability, and those who were vegetative or dead. These were GOS 1 - 3 patients. Results were then analysed using a Fisher's exact test looking for a significant difference between them. Statistical analysis was performed using Graphpad software.

Results

Over a 44-month period (October 1994 - July 1998) 245 patients with cerebral aneurysms were treated; an average of 66.8 patients per year. During the later collection period of 19 months, 83 patients with aneurysms were treated, giving an average of 52.4 patients per year. Patients in both groups were comparable with regard to age, with the average age in the first cohort being 47.8 years and in the second 46.6 years. The percentage of female patients in each group was also similar, with 67% in the first group and 70% in the second group. The most important determinant of outcome, the admission World Federation of Neurological Surgeons (WFNS) score, also showed good correlation between cohorts, with no significant differences between groups for unruptured, poor or good-grade patients (Table I).

In the early group 75% of patients had a craniotomy; the remaining 25% had no treatment as they died before surgery could be performed. In the later cohort 35% had surgery and 55% were treated endovascularly, with the balance undergoing a combination of the two. Analysis of outcomes between the two groups showed a significant difference, with reduced morbidity and mortality in the later cohort. In the early cohort the management mortality and major morbidity across all patients was 24% as opposed to 8% in the later cohort ($p = 0.0015$, Fisher's exact test). Cause of death in the early group was primarily re-bleeding, with 34 of 51 patients dying before surgery was performed. Ischaemic complications from vasospasm were also high in this group, with 14 patients dying from this complication. In the later series there were only 4 deaths. One was related to re-bleeding and 1 to vasospasm. As re-bleeding is directly related to a delay in securing a ruptured aneurysm, time to treatment was reviewed in each cohort. In the early group the average time to surgery was 7.5 days (95% confidence interval (CI): 6.4 - 8.6) and in the later group the time to treatment using either surgical or endovascular methods was 9.3 days (95% CI: 6.9 - 11.7). This difference was not statistically different; however there was a difference between endovascular and surgical timing of treatment in the second group. On average endovascular patients were treated on day 4.4 and surgical patients on day 17.9. When the time to treatment was analysed between the first group and endovascular patients in the second group the difference was significant ($p = 0.008$, *t*-test) suggesting that early endovascular treatment may have protected against re-bleeding (Table I).

Discussion

Management-related adverse outcome for all patients admitted with aneurysmal SAH is reported in the literature to range from 27% to 44%.[2-5] This is substantially higher than the 8 - 24% reported in our selected series. Because of resource limitation we have had a policy of only admitting patients who have a high chance of making a functional recovery. Most of our patients have good WFNS scores at the time of admission, which results in a skew to improved outcomes. Despite this we were still able to improve further on our patient outcomes by introducing new treatment techniques. An absolute reduction of 16% in mortality and major morbidity was achieved primarily through starting an endovascular programme at our hospital. This effect has been noted by other researchers.[6,7] Johnston[7] examined the impact of endovascular services at university hospitals in North America. Institutions offering endovascular treatment showed a 9% reduction in inpatient hospital mortality per 10% of patients treated endovascularly for ruptured cerebral aneurysms.[7] In another study, Berman *et al.*[6] showed that both endovascular treatment and procedural volume were independently associated with better outcomes in aneurysm treatment.

Whether the reduced mortality and morbidity in this and other studies is due solely to endovascular treatment is unclear. The ISAT trial,[1] which compared outcomes in patients randomised to surgery versus endovascular treatment, showed an absolute risk reduction of dependence or death of 6.9% in the endovascular group. This latter study has been largely responsible for the increasing numbers of patients referred for endovascular treatment since 2002. We have demonstrated that in our environment we were able to treat patients sooner using endovascular management. Not only are waiting times

Table I. Summary of results

	Surgical treatment October 1994 - July 1998	Surgical and endovascular treatment July 2002- February 2004	*p*-value
Number of patients	245	83	
Method of treatment (%)			
Surgical	183 (75)	29 (35)	
Endovascular		46 (55)	
Patient age (yrs)	47.8	46.6	0.45
95% CI	46.3 - 49.3	43.6 - 49.6	
Male/female ratio			
Female (%)	67	70	0.78
Male (%)	33	30	
Clinical grade (%)			
Unbled	41 (17)	9 (11)	0.292
Good grade	154 (63)	60 (72)	
Poor grade	50 (20)	14 (17)	
Outcome (%)			
Unfavourable	59 (24)	7 (8)	0.001
Favourable	186 (76)	76 (92)	

shortened because we can proceed without anaesthesia or an operating list, but the risk of aggravating vasospasm is less of a concern with endovascular approaches than it is with surgery.[8] In so doing we have reduced re-bleeding and vasospasm as causes of death. However, other possibilities exist for improved patient outcome. We believe that in having two treatment strategies we are able to choose the safest procedure for each individual, taking into account variables such as age, co-morbidity and aneurysm anatomy. This approach undoubtedly also improves surgical outcomes because high-risk surgical candidates, such as patients with basilar artery or paraclinoid aneurysms, are often low-risk endovascular cases.[9]

Of course costs of endovascular treatment are cause for concern. The platinum coils and microcatheters used are expensive compared with the consumables used for surgery. However if factors such as admission time, anaesthetic costs, theatre time and rehabilitation expenses are taken into account, endovascular treatment is less expensive overall.[10] This is especially true of unruptured aneurysms where cost reduction is dramatic. In a public health care system where budgets are limited and focused on containing consumable costs it is hard to justify expensive therapies. We have been fortunate to receive support from our hospital for starting and continuing our programme. Because of this we have been able to improve patient outcomes, and benefits have extended to other patients as well. Our work is performed in an angiogram suite and procedures are often done under local anaesthetic; because of this more operating time is available for other patients. Endovascularly treated patients also spend less time in intensive care units, again freeing up a constrained resource. We believe that these and other advantages easily compensate for the consumable costs incurred.

Endovascular approaches to cerebrovascular pathology offer the exciting possibility of further reducing the burden of disease. Advances are ongoing and it is important that we build up and maintain this growing field in South Africa.

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