Endovascular treatment of cerebral aneurysms — a cost analysis

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Objectives. To determine if endovascular treatment of cerebral aneurysms is cost effective when compared with conventional surgical treatment.

Design. A retrospective study.

Subjects. Seventeen patients treated between August 2002 and August 2003 had posterior communicating artery aneurysms. This group was selected for detailed analysis.

Outcome measures. Total treatment costs, in South African rands (R), were calculated for each patient. Average treatment costs for each group were then compared.

Results. Surgically clipped and endovascularly coiled groups were comparable for age, sex and clinical condition. The average cost for endovascular treatment per patient was R37 041. Surgical treatment was more expensive at R44 104, a difference of 16%.

Conclusions. Despite the high cost of endovascular devices, appropriate use of this technology ultimately offers less expensive treatment than microsurgical clipping of aneurysms.

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Endovascular treatment of intracranial aneurysms as an alternative to surgical clipping has gained increased recognition since its introduction in the early 1990s. However, like all new treatment modalities it has had to prove its usefulness as an alternative under sceptical scrutiny. Various aspects of this form of treatment are still being investigated and evaluated. One of these is the cost of endovascular treatment. This is especially pertinent in our setting as a developing country where one has to ask whether the cost of a treatment is justified. With this in mind we looked at the costs of the treatment incurred in treating posterior communicating artery (PCom) aneurysms at our hospital over a 1-year period.

Method

All aneurysm patients admitted to Groote Schuur Hospital between August 2002 and August 2003 were analysed retrospectively. As some aneurysms are treated more successfully with clipping and some with coiling we were concerned that comparing unmatched groups would introduce bias. We therefore selected posterior communicating aneurysms of the carotid artery for cost analysis. In our opinion PCom aneurysms are equally well treated with either modality and in our series there was an almost even split in that of the 17 PCom aneurysms 9 were coiled and 8 were clipped. Using tariffs for hospital costs based on the National Price Reference List we proceeded to calculate the costs of surgical and endovascular treatment. Variables used were time spent in hospital (to the nearest day), time spent in an intensive care unit (ICU) (to the nearest hour), time spent in theatre or the angiogram suite (to the nearest 15 minutes), gases used during the procedure (to the nearest 15 minutes) and the cost of surgical or endovascular disposables. Patient folders were used to determine admission and discharge dates, ICU charts were used to assess time spent in ICU, and anaesthetic records were used to assess duration of procedures. With regard to the disposables used in surgical treatment we used an average figure for surgically treated patients. In the case of endovascularly treated patients we added up the costs of all the disposables, specifically catheters and coils (Table I).

The costs were added up and the two groups compared.

Results

Over a 1-year period from August 2002 to August 2003, 58

Table I. Derivation of costs

Patients coiled	Patients clipped
Time spent in hospital to nearest day	Time spent in hospital to nearest day
Time spent in ICU to nearest hour	Time spent in ICU to nearest hour
Time spent in angiogram suite	Time spent in theatre
Consumables	Consumables
Catheters	Sutures
Coils	Clips
Guidewires	Patties
Sheath	Plates

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patients with aneurysms were admitted to our institution. Of these, 17 had PCom aneurysms. Eight patients were treated surgically and 9 endovascularly. Patient age varied from 36 to 62 years for those treated surgically and from 36 to 79 years for those treated endovascularly. Mean ages were 49.1 and 57.6 years and medians 49 and 57.5 years respectively.

Eight of the 17 patients presented with subarachnoid haemorrhage (SAH), 4 in each group. Of the patients who presented with SAH and who were treated surgically 1 had a WFNS (World Federation of Neurosurgeons) grade I score, 2 were grade II and 1 was grade III. Of those treated endovascularly 2 were grade I and 2 were grade II.

The mean cost for patients treated surgically was R44 104, while the cost of endovascular treatment was R37 041. With regard to how these figures were reached, the average times spent in hospital for surgical and endovascular treatment were 441 and 186 hours respectively. The average times spent in ICU were 61.8 and 42.2 hours respectively. Patients treated endovascularly were charged a flat rate for using the angiogram suite which was equivalent to 2 hours in theatre. This translates into the surgical option being more expensive (Table II).

The time taken from admission to procedure was always shorter for endovascularly treated cases. The median times for surgical versus endovascular treatment were 18 and 6 days respectively, with averages of 12 and 5 days respectively (Table II).

Discussion

New and innovative treatment techniques are usually expensive, especially when the benefits of economy of scale have not been realised. The International Subarachnoid Aneurysm Trial (ISAT)[1] has done much to establish the validity of endovascular treatment as an alternative to surgical clipping and since the early 1990s over 125 000 patients have been treated successfully using this modality. The ISAT showed a relative and absolute risk reduction in dependency or death after allocation to endovascular versus neurosurgical treatment of 22.6% and 6.9% respectively. The trial was stopped by the steering committee after 1 year because of the favourable outcome. Questioning the appropriateness of perceived cutting-edge technology in the South African setting is completely justifiable where costs are an issue. With this in mind we undertook to establish the exact costs of treating cerebral aneurysms endovascularly. At Groote Schuur Hospital we started treating cerebral aneurysms in 2001 and have treated over 90 patients, establishing the efficacy of this modality. We hope that we have now also established the cost effectiveness of endovascular treatment.

It is clear from analysis of the results that endovascular coiling of aneurysms is not more expensive, and in fact looks to be more cost effective than surgical clipping. Patients stay in hospital for a shorter period of time, spend less time in the ICU, and the procedure is shorter and cheaper. In fact most patients treated endovascularly do not need to go to an ICU post procedure but could go to a high care facility. With time and experience and if the patient is compliant, we are often finding it more appropriate to do endovascular procedures under local anaesthetic.

These findings are in keeping with those of Baker *et al*.[2] who found endovascular patients 40% cheaper to treat than surgical patients. They also found that patient stay was shorter for endovascularly treated patients (2 days v. 5 days), and again this was found to be significant ($p < 0.001$).

Time from admission to procedure was considerably less among the endovascularly treated patients. There are a number of reasons for this, including difficulty at our institution in getting a timely angiogram because of limited resources and the number of trauma cases that occupy the angiography suite and personnel time. Secondly, we often proceed straight from the diagnostic angiogram to the endovascular coiling. Theatre time is also at a premium, again because of trauma. Other institutions may not experience these problems and one can argue that the delay in admission to procedure time accounts for a large proportion of the increased cost in the surgically treated group. However, the reality is that within our setting the problems we describe are real and difficult to overcome. We have found that being able to treat aneurysms endovascularly and especially under local anaesthetic has paradoxically freed up theatre time, allowing other surgical procedures to be done.

Table II illustrates that the procedure time was much shorter

Table II. Summary of results

	Clipped (average)	Coiled (average)	Clipped (max)	Clipped (min)	Coiled (max)	Coiled (min)
Hours spent in hospital	441	186	168	1 035	48	437
Hours in ICU	61.8	42.4	20	115	17	113
Time (h) for procedure	3.5	1.5	3.5	5.25	1.5	2.25
Time (d) from admission to procedure	12	4.8	3	36	1	11
Cost in rands	44 104	37 041	78 929	30 753	61 395	23 288

for patients treated endovascularly. We pay a fixed rate for the angiogram suite which is the equivalent of 2 hours in theatre. At no time was an operative procedure cheaper to perform than the endovascular procedure and for 7 of the 9 patients treated endovascularly we were charged for time we did not require. Patients with PCA aneurysms often present with third nerve palsies or retro-orbital pain and then do not experience the morbidity and mortality associated with SAH. In both groups the patients who accounted for a long stay in hospital had SAHs. While it is possible to expedite the treatment and prevent re-bleeding using endovascular techniques, the SAH and its complications remain.

In conclusion, while endovascular treatment of cerebral aneurysms is new and perceived as cutting-edge treatment, we have been able to show that within our health care system its utilisation is cost effective and justifiable. Other advantages with regard to cost include minimal infection risk, potential to perform treatments under local anaesthetic and, with time, a reduction in the cost of disposables as a result of economy of scales. These factors will further help reduce the cost of this new and effective treatment.

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References

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2. Barker FG II, Amin-Hanjani S, Butler WE, *et al*. Age-dependent differences in short term outcome after surgical or endovascular treatment of unruptured aneurysms in the United States, 1996-2000. *Neurosurgery* 2004; **54:** 18-29.

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IN BRIEF

Additions to the list of cardiac risk factors

A news item in the *BMJ* (2004; **329:** 527) gives a list of nine risk factors which explain most heart attacks: an abnormal ratio of apolipoprotein A to apolipoprotein B — a more sensitive marker than the ratio of high- to low-density lipoprotein; smoking; high blood pressure; diabetes; abdominal obesity; low daily fruit and vegetable consumption; a lack of exercise; and stress. These findings were presented at the European Society of Cardiology congress in Munich in October. Adding to these, an article in the *Quarterly Journal of Medicine* (204; **97:** 637-643) examines the effect of traffic air pollution during exercise, and suggests that exposure to air-borne toxins should be minimised. The exhaust from fuel combustion contains a diverse mixture of suspended particles and gases containing reactive free radical species. Recent epidemiological studies have confirmed earlier suspicions that there is a consistent association between ambient concentrations of particulate matter and cardiovascular morbidity. Exercising individuals exposed to automotive air pollution may be at heightened risk because, even at low intensities, a significant rise in pulmonary ventilation and diffusion capacity occurs, increasing the amount of inspired particles. Adding 'fuel to the fire' is an article in the *New England Journal of Medicine* (2004; **351:** 1721-1730) concluding that transient exposure to traffic may increase the risk of myocardial infarction in susceptible persons. The subjects' use of a car was the most common source of exposure to traffic, but time spent on public transportation also showed an association.