NATIONAL INSTITUTE FOR CLINICAL EXCELLENCE

INTERVENTIONAL PROCEDURES PROGRAMME

Interventional procedures overview of coil embolisation of unruptured intracranial aneurysms

Introduction

This overview has been prepared to assist members of the Interventional Procedures Advisory Committee (IPAC) advise on the safety and efficacy of an interventional procedure previously reviewed by SERNIP. It is based on a rapid survey of published literature, review of the procedure by Specialist Advisors and review of the content of the SERNIP file. It should not be regarded as a definitive assessment of the procedure

Date prepared

This overview was prepared in January 2004

Procedure name

- Coil embolisation of unruptured intracranial aneurysms.

Specialty societies

- British Society of Interventional Radiology.
- Society of British Neurological Surgeons.
- British Society of Neuroradiologists.

Description

Indications

Intracranial aneurysm.

Intracranial aneurysms are dilated blood vessels within the skull. Sometimes they are present from birth, or they may develop as a result of damage to the wall of the blood vessels by high blood pressure or fatty deposits. People with genetic causes of weak blood vessels are more likely to develop aneurysms. Often the cause is unknown.

Rupture of intracranial aneurysms (subarachnoid haemorrhage) has a poor prognosis. About 30% of people die within 24 hours and a further 25–30% more die within 4 weeks (Source: protocol of the International Subarachnoid Aneurysm trial)

Current treatment and alternatives

Traditional treatment for ruptured or unruptured intracranial aneurysm involves open surgery to clip the abnormal blood vessels inside the skull. The coil technique involves approaching the aneurysm from inside the diseased blood vessel, avoiding the need to open the skull (an endovascular technique). This is claimed to be less invasive and risky. The technique is suitable only for people with aneurysms in which the entrance to the dilated part of the blood vessel (the aneurysm neck) is relatively narrow

What the procedure involves

A thin tube, containing the coil on a guidewire, is inserted into a large artery, usually in the groin, and passed up into the skull under X-ray control. The coil is placed inside the aneurysm and detached from the guidewire. Multiple coils may be placed the aneurysm through the same tube until the aneurysm is densely packed.

The coil technique is mainly carried out on ruptured aneurysms but may also be used to treat unruptured aneurysms.

Efficacy

In a large observational study it was reported that overall morbidity and mortality associated with endovascular repair at one year was 9.5% (41/451) and 12.2% (233/1917) for surgery. Similar results were reported in smaller studies comparing the two techniques. However these comparisons are of limited validity in that patient characteristics differed between the two groups; for example those undergoing endovascular repair were often older than those who had surgery.

For those patients undergoing endovascular repair by coil embolisation in the ISUIA study, obliteration was complete in 55% (207/451) of patients, incomplete in 24% (91/451), unsuccessful in 18% (67/451), and unknown in 3% (12/451) of patients. At 1 year less than one per cent of patients (4/451) had a moderate or severe disability as measured by the modified Rankin score. However, in a case series of 116 patients, moderate or severe disability was reported in 5.2% (6/116) of patients, which is comparable to the figure of 6.7% reported in the systematic review.

Specialist Advisors considered that the main uncertainty related to the long-term durability of the procedure.

Safety

In a retrospective study of 62 patients the procedure-related complication rate was 23% (14/62) following coil embolisation. Major complications resulting in reduced functional status were reported in five patients (8%) and minor complications causing prolonged hospitalisation were reported in nine patients (15%). Adverse events during initial and follow-up hospitalisation included intra- or postoperative rupture (4/62) and cranial neuropathy (7/62).

In the large observational study perioperative haemorrhage was noted in 2% (10/451) and cerebral infarction in 5% (26/471) of patients who underwent endovascular repair.

Specialist Advisors considered that this was a safe procedure. One Advisor noted that technical complications during the procedure may lead to the rupture of the aneurysm or thrombo-embolic occlusion of intracranial vessels, but that these

complications occurred in a minority of patients. There is also a small risk of delayed haemorrhage.

Literature reviews

Appraisal criteria

Studies of coil technique in the treatment of unruptured intracranial aneurysms were included.

List of studies found

One systematic review was found (described in table). It includes 18 studies reporting on patients with unruptured intracranial aneurysms.

Six additional studies were also identified, including the recently published International Study of Unruptured Intracranial Aneurysms (ISUIA).

Appendix A gives a list of references not included in the main data extraction tables.

Table 2 Summary of key efficacy and safety findings

Study details	Key efficacy findings	Key safety findings	Comments
Weibers 2003 [1] International Study of Unruptured Intracranial Aneurysms (ISUIA) December 1991–December 1998 61 centres in the USA 4060 patients • 1692 did not have aneurysm repair (unoperated) • 1917 had open surgery • 451 had endovascular procedures (379 with coil technique) Compared with the surgical group, endovascular patients were older patients with larger unruptured aneurysms and a higher proportion of aneurysms in the posterior circulation Mean follow up was 3.7 years for those who had endovascular procedures	Outcomes reported: occlusion, neurological status, survival, morbidity. 451 had endovascular procedures 379 patients had procedure done by coil technique 264 had more than one procedure (treatment group was defined by first procedure that they had) **Aneurysm occlusion- Endovascular** **All (451)** / **Coiling (379)** Complete obliteration 231 (51%) / 207 (55%) Partially successful/incomplete 95 (21%) / 91 (24%) No obliteration 104 (23%) / 67 (18%) Unknown 21 (5%) / 12 (3%) **Overall morbidity and mortality 30 day – Endovascular group** Group 1 (409) / Group 2 (42) / Combined Surgery-related death 8 (2.0%) / 0 (0%) / 8/451 (1.8%) Disability Rankin 3–5 9 (2.2%) / 1 (2.4%) / 10/451 (2.2%) Impaired cognitive status 13 (3.2%) / 2 (4.8%) / 15/451 (3.3%) Rankin score 3–5/cognitive 8 (2.0%) / 0 (0.0%) / 8/451 (1.8%) Overall morbidity and mortality 38 (9.3%) / 3 (7.1%) / 41/451 (9.1%) **Overall morbidity and mortality 1 year – Endovascular group** Surgery-related death 14 (3.4%) / 0 (0%) / 14/451 (3.1%) Disability Rankin 3–5 4 (1.0%) / 0 (0%) / 4/451 (0.89%) Impaired cognitive status 13 (3.2%) / 3 (7.1%) / 16/451 (3.5%) Rankin score 3–5/cognitive 9 (2.2%) / 0 (0%) / 9/451 (2.0%) Overall morbidity and mortality 40 (9.8%) / 3 (7.1%) / 43/451 (9.5%) **Overall morbidity and mortality 1 year – Open surgical group** Group 1 (1591) / Group 2 (326) / Total Surgery-related death 43 (2.7%) / 2 (0%) / 45 Disability Rankin 3–5 22 (1.4%) / 3 (0.9%) / 25 Impaired cognitive status 87 (5.5%) / 23 (7.1%) / 110 Rankin score3-5/cognitive 48 (3.0%) / 5 (1.5%) / 53 Overall morbidity and mortality 200 (12.6%) / 33 (10.1%) / 233 (12.2%)	**Complications** Specific details - 10 patients (2%) perioperative haemorrhage 26 patients (5%) had cerebral infarction 5-year cumulative rupture rates are also reported in the paper for all patients (n = 4060).	Two cohorts – operated (surgery and endovascular) or unoperated (natural history) Two groups – Group 1 without subarachnoid haemorrhage; Group 2 with subarachnoid haemorrhage. Study was also interested in looking at the natural history of the disease. Wide exclusion criteria. Authors note that the characteristics of patients in the endovascular cohort differed greatly from those in the surgical groups, and hence a direct comparison of rates of morbidity and mortality between the groups is not possible. Authors also noted that morbidity and mortality rates might be overestimates because in the endovascular group because compared with the surgery group, it had older patients with larger unruptured aneurysms and a higher proportion of aneurysms in the posterior circulation.

Study details	Key efficacy findings	Key safety findings	Comments
Brilstra et al (1999) [2] Systematic review (generally case-series/cohort) Search dates 1990 to 1997 37 studies; study designs not described 90 patients with unruptured aneurysms (18 studies) Studies included 1256 patients (mean age 51) with ruptured or unruptured intracranial aneurysms receiving treatment with controlled detachable coils; 1136 received Guglielmi coils	Outcomes reported: occlusion, neurological outcomes, disability Aneurysm occlusion (n = 87) > 90% 72 patients (82.8%) 100% 39 patients (44.8%) Neurological outcomes (n = 73) Follow up (73 patients) 71 patients (97.3%) independent (Rankin score 0–2) 1 patient (1.4%) dependent (Rankin score 3–5)	**Complications** 18 patients (20%) had complications 15 patients (16.7%) had ischemic complications 6 (6.7%) had permanent complications 3 patients with unruptured aneurysms had a subarachnoid haemorrhage. 1 patient died (not related to procedure)	Search strategy described (Medline, Hand-searching, science citation) – limited and does not include a wide spectrum of articles. Review includes papers from Non-English journals. Study design and quality not described – however noted that many were retrospective studies – only 7 studies were considered high quality. Unclear as to what studies were included for unruputred aneurysms.

Study details	Key efficacy findings	Key safety findings	Comments
Raftopoulos et al (2003) [3] February 1996 and November 2001 72 consecutive patients with 101 UIAs 38 patients with 41 aneurysms (Coil) 13 UIAs in patients with a previous history of subarachnoid hemorrhage, 17 were in patients with multiple aneurysms at presentation. 39 patients with 51 aneurysms (Surgical) 15 UIAs in patients with a previous history of subarachnoid hemorrhage, 28 were in patients with multiple aneurysms at presentation. Mean age was 51 years (range 20–71 years) Types: 10 aneurysms symptomatic, 65 aneurysms part of a multiple constellation, 39 incidental aneurysms. Follow up CE mean: 44.4 months (6–85 months) SC mean: 38.3 months (6-74 months)	Outcomes reported: occlusion, neurological outcomes **Coil embolisation** (CE group) – 40 procedures/41 aneurysms • 23 cases totally obliterated (56%) • 6 cases subtotal obliteration (14.6%) • 29 cases success (70.7%) • 12 cases failed. (29.3%) • 6 unsuccessful attempt • 3 recanalisation • 2 partial occlusion • 1 precocious aneurysms **Surgical clipping** (SC group) - 49 procedures/59 aneurysms • 55 aneurysms were totally obliterated (93.2%) • 1 aneurysm was subtotally obliterated (1.7%) • 56/59 cases success (94.9%) • 3 cases failed (5.1%) **Neurological outcomes** **Coil embolisation** 3 months postoperatively – 35 (92%) patients had scores of 5 Glasgow outcome score and 0 on the Modified Rankin Score **Surgical clipping** 1 case of permanent mild cognitive impairment (Glasgow Outcome Score 4; Modified Rankin Score score 3)	**Complications** Coil embolisation (CE group) • 4/38 had transient deficits • 2 vasospasms • 1 amaurosis • 1 intraprocedural rupture • 3/38 (7.9%) had permanent deficits Surgical clipping (SC group) – 40 procedures • 8 episodes of transient postoperative deficit • 1 mild aphasia • 3 VIth cranial nerve paresis • 1 general seizure • 1 left quadranopsia • 1 flap infection • 1 asymptomatic vasospasm 1 patient had permanent deficit (thromboembolic stroke two weeks after surgery)	Study population was divided into three groups: 1. Follow up groups (those deemed unsuitable for treatment) – 6 aneurysms 2. CE group 3. Surgical clipping groups Surgical clipping group compromised people who had SC as first intervention (33 patients) and those that failed after CE (6 patients) – as such caution is needed when making comparisons. Neurosurgeon did all the clipping, two interventional radiologists did the CE Authors did not use balloon-assisted procedure or new coils. Assessment of outcome: postoperative angiograms – treatment considered success if no residua or less than 5% stable residua were observed. Independent observer assessed using Glasgow Outcome Scale (GOS) and the modified Rankin score (MRS).

Study details	Key efficacy findings	Key safety findings	Comments
Johnston et al (2000) [4] Retrospective case series/cohort 62 endovascular cases 68 surgical cases Patients undergoing surgical clipping were more likely to be younger. Endovascular group more likely to have presented with compressive symptoms. Cases were identified through a computerised search using ICD 9 codes and then selected by clinicians.	Outcomes reported: Disability, hospitalisation. **Coil embolisation** (CE group) Rankin score change of two or more 5/62 patients (8%) p = 0.01 **Rankin score** / **Admission** / **Discharge** No handicap: 45 (73%) / 43 (69%) Minor handicap: 8 (13%) / 6 (10%) Mod. Handicap: 7 (11%) / 7 (11%) Mod-Severe: 2 (3%) / 4 (6%) Severe handicap: 0 (0%) / 1 (2%) Death: - / 1 (2%) **Glasgow Outcome Scale Discharge** Good recovery: 54 (87%) Moderate disability: 3 (5%) Severe disability: 4 (6%) Persistent vegetative state: 0 (0%) Death: 1 (1%) Length of stay, Total stay 5.0, Intensive care days 1.9 **Surgical clipping** (SC group) Rankin score change of two or more 17/68 patients (25%) p = 0.01 **Rankin score** / **Admission** / **Discharge** No handicap: 53 (78%) / 31 (46%) Minor handicap: 13 (19%) / 15 (22%) Mod. Handicap: 2 (3%) / 11 (16%) Mod-Severe: 0 (0%) / 9 (13%) Severe handicap: 0 (0%) / 1 (1%) Death: - / 1 (1%) **Glasgow Outcome Scale Discharge** Good recovery: 42 (62%) Moderate disability: 18 (26%) Severe disability: 7 (10%) Persistent vegetative state: 0 (0%) Death: 1 (1%) Length of stay, Total stay 5.0, Intensive care days 2.9	**Complications:** Adverse events during initial and follow-up hospitalisations **Adverse events** / **Endovascular** / **Surgical** Perioperative death: 1 / 3 **Neurolgic** Cranial neuropathy: 7 (11%) / 21 (31%) Cortical deficit: 6 (10%) / 21 (31%) Intra or post op.rupture: 4 (6%) / 4 (6%) Pain: 2 (3%) / 2 (3%) Haematoma: 0 (0%) / 2 (3%) Seizures: 0 (0%) / 2 (3%) Cerebral spinal fluid leak: 0 (0%) / 1 (1%) **Cardiac** Arrhythmia: 1 (1%) / 1 (1%) Myocardial infarction: 0 (0%) / 1 (1%) Congestive heart failure: 0 (0%) / 1 (1%) **Other** Anaemia: 0 (0%) / 5 (7%) Pneumonia: 2 (3%) / 1 (1%) Urinary tract infection: 1 (2%) / 2 (3%) Groin/wound complications: 2 (3%) / 0 (0%) Respiratory decompensation: 1 (2%) / 1 (1%) Unknown fever: 0 (0%) / 2 (3%) Line infection: 1 (2%) / 1 (1%) Sodium disturbance: 1 (2%) / 1 (1%) Bowel ischemia: 1 (2%) / 0 (0%) Vessel dissection: 1 (2%) / 0 (0%) **Procedure-related complications** Major: 5 (8%) / 19 (28%) Minor: 9 (15%) / 13 (19%) Any: 14 (23%) / 31 (46%)	Cases were chosen by 'blinded' and independent clinicians – unsure about representativeness of population. A change of 2 or more in the Rankin score from admission to hospital discharge was defined as a poor outcome and taken as the primary outcome measure.

Study details	Key efficacy findings	Key safety findings	Comments
Johnston et al (2000) [5] California Retrospective case series/cohort January 1994 – June 1997 60 hospitals within the University HealthSystem consortium 255 endovascular cases 2,357 surgical cases Patients undergoing surgical clipping were more likely to be younger, admitted from the emergency room and more likely to be African American. Cases were identified through a computerised search using ICD 9 codes and then selected by clinicians.	Outcomes reported: adverse outcomes (hospital death or transfer to nursing home) **Coil embolisation** (95% CI) Univariate analysis Adverse outcomes 10.6% (6.8–14.4) In-hospital deaths 0.4% (0–1.2) Length of stay 4.6 days (4.0–5.1) Not reported: Rankin score **Surgical clipping** (SC group) Adverse outcomes 18.5% (16.9-20.1) In-hospital deaths 2.3% (1.7-2.9) Length of stay 9.6 days (9.1-10.0) Not reported: Rankin score **Differences between two groups** Adverse outcomes p = 0.002 In-hospital deaths p = 0.039 Length of stay p < 0.001 Sensitivity analysis was conducted excluding patients admitted from the emergency room – no change in direction of strength of findings **Multivariate analysis** (Odds Ratio 95% CI) Surgical/endovascular Adverse outcomes Univariate 1.9 (1.3–2.9) p = 0.002 Adjusted for confounders 2.1 (1.4–3.3) p = 0.001 In-hospital deaths Univariate 6.1 (1.1–44.0) p = 0.039 Adjusted for confounders 6.3 (0.9–46.1) p = 0.07 Multivariate analysis (Difference 95% CI) Surgical/endovascular Length of stay mean Univariate 5.0 days (3.6–6.3) Adjusted for confounders 4.5 days (3.2–5.9)	See efficacy section	Cases were chosen by 'blinded' and independent clinicians – unsure about representativeness of population. Adverse outcome was defined as a an in-hospital death or transfer to a nursing home or rehabilitation hospital at discharge (patients who were admitted from a nursing home etc were excluded). Limited outcomes. Authors note the limitations of the study including: Possible misclassification of outcomes; limited outcomes; inadequate control of confounding variables (difficult to ascertain data from records); only events that occur during hospitalisation can be tracked.

Study details	Key efficacy findings	Key safety findings	Comments
Leber et al (1998) [6] Retrospective Case series Graz, Austria 1992 to 1995 248 people with ruptured or unruptured aneurysms • 61 unruptured • 16 clipped • 45 embolised • 187 ruptured Mean follow up Coil: 2.6 years (range 1.5-4.5 years) clipping: 1 year	Outcomes reported: death, neurological outcomes **Unruptured** (61 people) Excellent result (Glasgow outcomes scale 1) 87.5% surgical group 77.8% of endovascular group **Minor neurological deficit** (Glasgow scale 2) 6% surgical group 11% of endovascular group **Severe deficit** (Glasgow scale 3) 0% surgical group 7% of endovascular group **Mortality rate** (Glasgow scale 5) 6.2% surgical group 4.5% endovascular group	**Complications** Authors report that none of the unruptured aneurysms in either treatment group had a subsequent haemorrhage during the follow-up period	Not clear how people were selected for treatment groups. Glasgow outcome scale in this paper reported as 1 no deficit, 5 death. Follow up different for different groups. Text and figures in the study do not reconcile. No absolute figures given. Limited outcomes.

Study details	Key efficacy findings					Key safety findings	Comments
Roy et al (2001) [7] Case series August 1992 – June 1999 116 patients (125 unruputred aneurysms) Mean age: 50.6 years (range 30–78) Size of aneurysm (range 0-4mm – 20-24mm) Mean follow up: 32.1 months	Outcomes reported: occlusion, disability **Months** **Immediate** **2-12** **12-30** **> 30** Obliterated 59 (47.2%) 52 (52%) 25 (47.2%) 18 (48.6%) Residual neck 53 (42.4%) 41 (41%) 23 (43..4%) 14 (37.8%) Residual 6 (4.8%) 7 (7.0%) 5 (9.4%) 5 (13.5%) Failure 7 (5.6%) - - - Total 125 (100%) - - - Total treated 118 100 53 37(31.4%)					**Complications** Thromboembolic (n = 9) 7.8% Asymptomic 2 patients (1.7%) Temporary 3 patients (2.6%) Permanent 4 (3.5%) (rankin scale) Aneurysmal rupture (n=3) 2.6% Asymptomic 1 patient (0.86%) Temporary 1 patient (0.86%) Permanent 1 patient (0.86%) Total (n=12) 10.3% Asymptomic 3 patients (2.6%) Temporary 4 patients (3.5%) Permanent 5 patients (4.3%) 5 patients died from unrelated causes during follow-up. 5.2% permanent complications, including those from follow-up angiograms.	No strict inclusion criteria. Patients with extradural or giant aneurysms were excluded. The majority of the unruptured aneurysm were located in ophthalmic region (40%). Patients are a selected group; patients were referred by neurosurgeons who did not believe that surgical or conservation treatment was the best options for these patients.

Validity and generalisability of the studies

- In the majority of the studies characteristics of patients in the endovascular cohort differed from those in the surgical group. For example patients included in the endovascular cohort in the ISUIA study were older, had larger aneurysms and a higher proportion of aneurysms in the posterior circulation [1.] As such, morbidity and mortality estimates are likely to be overestimated.
- It also raises questions about the representiveness of the population included in the majority of studies and the inclusion and exclusion criteria used. Three of the studies were also retrospective reviews. This has implications for the generalisability of the results.
- Limited data are provided in the systematic review on study quality and patient characteristics [2.] The results are also based on a relatively limited literature search.
- There is some suggestion that the experience of the clinician performing the procedure is a strong predictor of good functional outcome, however most studies do not report this information.
- The technology associated with this procedure would also seem to be evolving. In one of the studies there was some suggestion that occlusion rates were influenced by the type of technology used. [3]
- Most of the studies had short-term follow up. Further follow up would seem to be important in regards to this procedure in order to assess long-term rupture rate and durability of the treatment.

Specialist Advisor's opinions

Specialist advice was sought from consultants who have been nominated or ratified by their Specialist Society or Royal College.

- The procedure is well tolerated compared with the alternative surgical treatment.
- The main uncertainly regarding coiling relates to the long term durability of the procedure (beyond 12 years).
- Training is important.
- A registry is under consideration for the UK to include all coiling procedures – ruptured and unruptured aneurysms.

References

1 Wiebers DO, Whisnant JP, Huston J III, Meissner I, et al. Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment.[comment]. *Lancet* 2003; 362(9378):103–10.

2 Brilstra EH, Rinkel GJ, van der GY, van Rooij WJ, et al. Treatment of intracranial aneurysms by embolization with coils: a systematic review. [Review] [52 refs]. *Stroke* 1999; 30(2):470–6.

3 Raftopoulos C, Goffette P, Vaz G, Ramzi N, S et al. Surgical clipping may lead to better results than coil embolization: results from a series of 101 consecutive unruptured intracranial aneurysms. *Neurosurgery* 2003; 52(6):1280–7.

4 Johnston SC, Wilson CB, Halbach VV, Higashida RT, et al. Endovascular and surgical treatment of unruptured cerebral aneurysms: comparison of risks.[comment]. *Annals of Neurology* 2000; 48(1):11–9.

5 Johnston SC, Dudley RA, Gress DR, Ono L. Surgical and endovascular treatment of unruptured cerebral aneurysms at university hospitals. *Neurology* 1999; 52(9):1799–805.

6 Leber KA, Klein GE, Trummer M, Eder HG. Intracranial aneurysms: a review of endovascular and surgical treatment in 248 patients. *Minimally Invasive Neurosurgery* 1998; 41(2):81–5.

7 Roy D, Milot G, Raymond J. Endovascular treatment of unruptured aneurysms. *Stroke* 2001; 32(9):1998–2004.

This overview has been updated by NICE

Appendix A: Studies not included in the summary tables

Study details	Comments
Lozier AP, Connolly ES Jr, Lavine SD, Solomon RA. Guglielmi detachable coil embolization of posterior circulation aneurysms: a systematic review of the literature. *Stroke* 2002; 33(10):2509–18.	Systematic review. Includes both ruptured and unruptured aneurysms
Malisch TW, Guglielmi G, Vinuela F, Duckwiler G, et al. Unruptured aneurysms presenting with mass effect symptoms: response to endosaccular treatment with Guglielmi detachable coils. Part I. Symptoms of cranial nerve dysfunction. *Journal of Neurosurgery* 1998; 89(6):956–61.	Small number of patients (19 patients)
Eskridge JM, Song JK. Endovascular embolization of 150 basilar tip aneurysms with Guglielmi detachable coils: results of the Food and Drug Administration multicenter clinical trial. *Journal of Neurosurgery* 1998; 89(1):81–6.	Just looking at basilar tip aneurysms Includes both ruptured and unruptured aneurysms
Cloft HJ, Kallmes DF. Cerebral aneurysm perforations complicating therapy with Guglielmi detachable coils: a meta-analysis.: *American Journal of Neuroradiology* 2002; 23(10):1706–9.	Includes both ruptured and unruptured aneurysms
Regli L, Dehdashti AR, Uske A, de Tribolet N. Endovascular coiling compared with surgical clipping for the treatment of unruptured middle cerebral artery aneurysms: an update. *Acta Neurochirurgica* - Supplement 2002; 82:41–6.	Only 1 patient had endovascular repair
Wanke I, Doerfler A, Dietrich U, Egelhof T, et al. Endovascular treatment of unruptured intracranial aneurysms. Ajnr: *American Journal of Neuroradiology* 2002; 23(5):756–61.	34 patients who had endovascular repair.
Goddard AJ, Annesley-Williams D, Gholkar A. Endovascular management of unruptured intracranial aneurysms: does outcome justify treatment? *Journal of Neurology, Neurosurgery & Psychiatry* 2002; 72(4):485–90.	62 patients who had endovascular repair.
Ng P, Khangure MS, Phatouros CC, Bynevelt M, et al. Endovascular treatment of intracranial aneurysms with Guglielmi detachable coils: analysis of midterm angiographic and clinical outcomes. *Stroke* 2002; 33(1):210–7.	Includes both ruptured and unruptured aneurysms
Qureshi AI, Suri MF, Khan J, Kim SH, et al. Endovascular treatment of intracranial aneurysms by using Guglielmi detachable coils in awake patients: safety and feasibility. *Journal of Neurosurgery* 2001; 94(6):880–5.	Retrospective review. 92 procedures for unruptured aneurysms