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Rate and clinical impact of intra-procedural complications during coil embolisation of ruptured small (3 mm or less) cerebral aneurysms

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ABSTRACT

Objective: Coiling of small (≤3 mm) cerebral aneurysms can be technically challenging and is associated with increased procedural-related morbidity and mortality. The authors report the clinical and radiological results following coiling of ruptured small cerebral aneurysms in a single-institution, and define the rates of intra-procedural rupture and thromboembolism.
Methods: A retrospective analysis was conducted on consecutive patients from 01/01/2008 to 31/12/2010 with subarachnoid haemorrhage (SAH) from ruptured cerebral aneurysms (≤3 mm) managed in a tertiary neurosurgical institution in the United Kingdom.
Results: Of the 108 patients identified, 72 patients (66.7%) underwent coil embolisation. A favourable outcome, defined as a Glasgow outcome score of 4–5, was achieved in 63 (87.5%) of these patients. Intra-procedural complications were observed in 11.1% (±7.3% 95% CI) of cases, wherein the rate of intra-procedural rupture was determined to be 8.3% (±6.4% 95% CI) and intra-procedural thromboembolism to be 2.8% (±3.8% 95% CI).
Conclusion: Although coil embolisation of small ruptured cerebral aneurysms is technically feasible and an efficacious means of treatment, it is associated with an increased rate of intra-procedural complications. This should be taken into account when embarking upon treatment of patients with ruptured small cerebral aneurysms.

1. Introduction

The results of The International Subarachnoid Aneurysm Trial (ISAT) were encouraging as it presented an additional therapeutic option in the armoury against aneurysmal subarachnoid haemorrhage (SAH). This multicentre randomised controlled trial indicated that for those patients with ruptured cerebral aneurysms where there is clinical equipoise as to the optimal mode of treatment, endovascular treatment fared better when compared with microneurosurgery [1]. Consequently many centres have employed endovascular treatment as the first line and mainstay of treatment in aneurysmal SAH [2].

Despite the affirmative results from ISAT, this trial addressed only a very specific subpopulation of patients with aneurysmal SAH with regards to its safety and efficacy of endovasculartreatment. There remain certain subgroups of patients with aneurysmal SAH where the efficacy of endovascular treatment remains uncertain and one such subgroup are the patients with ruptured small aneurysms. These have been traditionally and arbitrarily defined as 3 mm or less. A number of reports have demonstrated an increased risk of intra-procedural complications such as rupture and thromboembolism owing to aneurysmal and technical aspects associated in the endovascular treatment of small cerebral aneurysms [3]. It has been proposed that small aneurysms may possess weaker walls which in combination with technical limitations associated with microcatheters, coil design and size increase the vulnerability for intra-procedural complication [4].

The purposes of this study are to assess the intra-procedural risk, as well as the clinical and radiological outcome for patients with ruptured small cerebral aneurysms.

2. Materials and methods

2.1. Study design

A retrospective study was conducted on patients with aneurysmal SAH identified from a prospective database over a 3 year period

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from 01 January 2008 to 31 December 2010 managed at Salford Royal Foundation Trust, Salford, United Kingdom, a tertiary neurosurgical referral hospital servicing an estimated population of 3.2 million. One hundred and eight patients with confirmed SAH from a cerebral aneurysm 3 mm or less were identified and included in this study.

2.2. Diagnosis of subarachnoid haemorrhage

The diagnosis of SAH was based on clinical history and confirmed by the detection of SAH on CT or MRI, or xanthochromia in cerebrospinal fluid (CSF). Data with regards to the size and location of cerebral aneurysms were obtained from CT or digital subtraction angiography.

2.3. Patient characteristics and clinical data

Clinical and radiological characteristics were recorded including age, sex, clinical condition according to World Federation of Neurological Surgeons (WFNS) grade, time to treatment from admission to hospital, modality of treatment, location of aneurysm, complications (intra-procedural complications including rupture and thromboembolism, rebleeding, vasospasm and hydrocephalus requiring permanent CSF diversion), length of stay and follow up.

The decisions to treat and the mode of treatment were made after multidisciplinary evaluation comprising of interventional neuroradiologists and vascular neurosurgeons. The subsequent management of patients with aneurysmal SAH follows established routine protocols [5].

2.4. Outcome analysis

Neurological outcome was assessed at clinical follow up using the Glasgow outcome scale (GOS). Using this scale, GOS 5 (good recovery) and GOS 4 (independent living but with disability) were considered as good outcome. GOS 3 (dependent with severe disability), GOS 2 (vegetative state) and GOS 1 (dead) were considered poor outcome. Radiological follow up was conducted routinely using MR time of flight (TOF) angiography at 6 months and at 2 years.

Control catheter angiograms at the end of embolisation procedure were assessed for degree of aneurysmal exclusion similarly to that set out by Roy et al. [6]. Complete occlusion was asserted when there the aneurysm is totally obliterated. Near complete occlusion is considered when there is residual neck and an aneurysm is deemed partially occluded when contrast filling in the body of aneurysm is seen.

During follow up angiography, rates of complete occlusion, stable occlusion, minor recurrence, major recurrence, retreatment and rebleeding were recorded and analysed. Stable occlusion was defined as no interval change from follow up angiography compared to control angiography obtained at end of coiling procedure. Minor recurrence is defined as new or increase in neck remnant less than 1.5 mm and major recurrence as growth or recanalisation in the body of the aneurysm, or an increase in size of neck remnant of more than 1.5 mm.

2.5. Statistical analysis

Complication rates were calculated by dividing the number of observed events by the total number of cases performed. Comparison of complication rates were performed using Fisher's test and p values <0.05 were considered statistically significant.

Fig. 1. Intra-procedural rupture of small basilar artery apex aneurysm (dashed arrow) with extravasation of contrast (solid arrow).

3. Results

Of the 108 patients identified in this study, 72 (66.7%) underwent coil embolisation, 28 (25.9%) microsurgical clipping and 8 (7.4%) were not treated. The majority of patients in this study presented in a good neurological state (86 patients, 79.6% in WFNS 1 or 2) and underwent treatment to secure the ruptured aneurysm promptly (median time to treatment from admission to hospital 1 day). Overall, a good outcome was achieved in 90 patients (83.3%) at clinical follow up at a median of 72 days after discharge with 4 patients lost to follow up. In the endovascular cohort specifically, 63 patients (87.5%) had a good outcome (Table 1A) (Table 1B).

Endovascular coil embolisation of small ruptured cerebral aneurysms carried an 11.1% (±7.3% 95% CI) rate of intra-procedural complications and a 6.9% (±5.9% 95% CI) of procedural-related morbidity and mortality. Intra-procedural rupture occurred in 6 patients (8.3 ± 6.4% 95% CI) and accounted for a procedural-related mortality of 4.2 ± 4.6% 95% CI. Intra-procedural thromboembolic events occurred in 2 patients (2.8 ± 3.8% 95% CI) and accounted for a procedural-related morbidity and mortality of 1.4 ± 2.7% 95% CI respectively (Tables 2 and 3).

The observed rate of intra-procedural complications and in particular the intra-procedural rupture rate for small ruptured cerebral aneurysms were statistically significantly higher than their respective complication rates during embolisation of ruptured aneurysms over 3 mm in the same study period. The rate of total intra-procedural complications for small ruptured cerebral aneurysms was 11.1% compared to that of 4.3% for larger aneurysms ($p = 0.049$) and the rate of intra-procedural rupture was significantly higher at 8.3% compared to 2% ($p = 0.029$) (Table 3 and Fig. 1).

A total of 65.5 patient years of radiological follow up of coiled aneurysms was obtained. During this period, 18 (25.0%) patients were lost to radiological follow up, 7 (9.7%) of which due to inpatient mortality. In the cohort where radiological follow up was available, a satisfactory radiological result (complete obliteration or stable occlusion) was achieved in 89.2 ± 7.6% 95% CI of patients. Twenty-two patients (33.8 ± 11.5% 95% CI) showed progressive complete occlusion of coiled aneurysm, and only 1 patient (1.5 ± 3.0% 95% CI) with major recurrence. In addition, there were no incidences of retreatment or rebleeding (Table 4).