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Original research

Comparison of surgical and endovascular approaches in the management of multiple intracranial aneurysms

Qing-Lin Dong [a, *, 1], Bu-Lang Gao [b, **, 1], Zhong-Rong Cheng [a], Yan-Yan He [a], Xue-Jing Zhang [b], Qiong-Ying Fan [b], Cong-Hui Li [b], Song-Tao Yang [b], Cheng Xiang [b]

[a] *Emergency Department, People's Hospital of Rizhao, Rizhao, Shandong, PR China*
[b] *Departments of Medical Research and Neurosurgery, Shijiazhuang First Hospital, Hebei Medical University, Shijiazhuang, Hebei, PR China*

HIGHLIGHTS

- Endovascular group: total complication rate 12%, no permanent deficit.
- Surgical clipping group: total complication rate 10.9%, 1 permanent deficit.
- Combination group: complication rate of 15.8%, no permanent deficit.
- Endovascular is a better approach for multiple aneurysms than surgical clipping.

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ABSTRACT

Objective: To investigate the outcomes and safety of endovascular compared with surgical clipping for multiple intracranial aneurysms.
Material and methods: 98 patients with 260 multiple intracranial aneurysms were treated with endovascular, surgical clipping, combined treatment, and observation. Data were retrospectively studied following treatment and at follow-up.
Results: In the endovascular group, 44 aneurysms were treated with coils only and 29 aneurysms were treated with stent deployment. The complete occlusion rate was 65%, and the total complication rate was 12% with no permanent deficit. After angiographic follow-up for 1–90 (mean 62) months, the total recurrence rate was 18.3%. In the clipping group, 65 aneurysms were clipped. The complete occlusion rate was 90.8%, and the complication rate was 10.9% with 1 permanent deficit. After follow-up for 11–71 (mean 49) months, the angiographic recurrence rate was 1.5%. In the combination group, 20 aneurysms were treated endovascularly. The complete occlusion rate was 78.9%, and the complication rate was 15.8% with no permanent deficit. Twenty-eight aneurysms were treated surgically with the complete occlusion rate of 89.3%, the complication rate of 20% and 3 permanent deficits. After follow-up for 1–93 (mean 58) months, the angiographic recurrence rate was 33.3% for embolization and 3.6% for clipping. Seventy-four aneurysms for observation had 2.7% regrowth rate within 1–3 years.
Conclusion: Endovascular embolization has an accepted complication rate but no neurological deficits compared with surgical clipping and may be a better approach for multiple intracranial aneurysms than surgical clipping.

1. Introduction

Multiple intracranial aneurysms (MIA) have been increasingly found with utilization of carotid and vertebral angiographies. The reported incidence of MIA differs widely, with a broad range of 7% to nearly 45% [1–3]. Angiographic quality, number of vessels examined, referral patterns, and experience of the angiographer influence the detection of multiple lesions. Although the causes of

* Corresponding author. Emergency Department, People's Hospital of Rizhao, 126 Tai'an Road, Rizhao, 276826, Shandong, PR China.
** Corresponding author. Department of Medical Research, Shijiazhuang First Hospital, Hebei Medical University, 36 Fanxi Road, Shijiazhuang, 050011, Hebei, PR China.
E-mail addresses: dqlrz@163.com (Q.-L. Dong), browngao@163.com (B.-L. Gao).
[1] These two authors contributed equally to this work.

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intracranial aneurysms (IA) are still unclear, congenital and/or acquired degeneration of arterial wall have been implicated in previous studies [1,2]. The presence of MIA represents a greater risk than a single aneurysm due to the higher associated complication rate resulting from both the aneurysm rupture and treatment, which may involve complex management issues. The strategy for managing MIA has remained one of the most difficult challenges to date. A previous silent, untreated aneurysm carries a greater risk of bleeding in perioperation when surgical management is performed for a ruptured one [4,5]. The chance of fatal bleeding from some untreated aneurysms may be greatly decreased by clipping all aneurysms during one single surgical procedure with bilateral or contralateral approaches. When all the aneurysms had been treated and protected from rupture, it would be easier to manage vasospasm due to aneurysmal subarachnoid hemorrhage (SAH). Otherwise, unprotected or untreated aneurysms may be at risk for rupture when hypertensive therapy is administered. However, not all aneurysms can be safely clipped in one single session due to the poor clinical conditions of some patients with SAH or inaccessibility of some aneurysms.

In recent years, significant progress has taken place in endovascular management of IA, including stent-assisted coiling, balloon remodelling technique, three dimensional coils for the management of wide-necked and morphologically unfavourable aneurysms, and flow diverters [6–9]. The endovascular approach for IA has been accepted for poor surgical candidates or inoperable aneurysms. Besides, the endovascular approach has become an alternative to surgical intervention as the International Subarachnoid Aneurysm Trial (ISAT) has revealed an absolute risk reduction of dependence (7.4%) favouring endovascular therapy [10]. As a result, an increasing number of patients with MIA have been treated endovascularly [5,11–13]. In this paper, the safety and outcomes of endovascular and surgical clipping (SC) in the management of MIA were investigated.

2. Materials and methods

2.1. Patient population

This study was approved by the Ethics Committee of our hospital for scientific research. Informed consent was obtained from all patients. Ninety-eight consecutive patients with MIA presented to our institution from January 2005 to July 2014. Table 1 shows the demographic data and characteristics of patients. Sixty-one (62.2%) patients had 2 aneurysms, 19 (19.4%) patients had 3 aneurysms, 11 (11.2%) patients had 4 aneurysms, 6 (6.1%) patients had 5 aneurysms, and 1 (1%) patient had 7 aneurysms. Seventy-eight (30%) aneurysms were on the middle cerebral artery (MCA, 63 aneurysms on the MCA bifurcation or trifurcation, 8 on M1 segment, and 7 on M2), 79 on the internal carotid artery (ICA, 28 on the paraclinoid segment, 23 on the cavernous segment, 21 on the ophthalmic segment, and 7 on ICA bifurcation), 38 on the posterior communicating artery (PCom), 28 on the anterior communicating artery (ACom), 13 on the anterior cerebral artery, 11 on the basilar tip, 5 on vertebral artery, 3 on posterior cerebral artery (PCA), 3 on superior cerebellar artery, 1 on posterior inferior cerebellar artery and 1 at the vertebral-basilar artery junction. Angiographically, the size of the 260 aneurysms were <5 mm in 151 cases (58.1%), 5–10 mm in 90 cases (34.6%) and 11–20 mm in 19 cases (7.3%).

2.2. Treatment modalities

Endovascular embolization was the primary treatment modality for IA. SC was proposed only if complete coil embolization seemed impossible or when endovascular treatment failed. In case of SAH associated with an intracranial hematoma, the patient would be treated by SC for the ruptured aneurysm. Surgical evacuation of the hematoma would also be performed during the same session when a mass effect was clinically significant or when a shift of the median cerebral structures was observed on the computed tomographic scan. If the hematoma was well-tolerated on clinical and imaging examinations, the patient would be treated by EE. Inclusion criteria for surgical or endovascular therapy included aneurysm location, size and configuration, presence of intracranial vasospasm or hematoma, patient's age and demands, and other medical commodities. The criteria for selection of cerebral aneurysms for coil embolization are: Dome-to-neck ratio $\geq 2:1$, neck diameter <5 mm, and no incorporation of adjacent arterial branches into the aneurysm base in the cerebral angiograms. Patients with small aneurysms (2–3 mm), severe clinical conditions or severe comorbidities might be observed if the aneurysms had a lower risk of rupture or severe clinical conditions precluded further manoeuvre.

General anaesthesia and systemic heparinization were applied for EE. Systemic anticoagulation was monitored for adequacy by frequent measuring of the activated clotting time. A baseline activated clotting time was reached before bolus heparin infusion (70 U/kg) followed by a continuous drip (30 U/kg/hour body weight) to double the baseline activated clotting time. Patients were treated with selective embolization with coils only. In case of wide-necked aneurysms, the stent-assisted technique would be used. The patient would receive an antiplatelet regimen consisting of clopidogrel 75 mg/d and aspirin 325 mg/d at least 3 days prior to intervention. After embolization, clopidogrel and aspirin were maintained for 1 month and 1 year, respectively.

2.3. Angiographic results and follow-up

Three types of aneurysm occlusion were considered following endovascular or surgical treatment and during follow-up: Complete (the aneurysm cavity and neck were packed without filling by contrast agent); near complete (the aneurysm sac was blocked but a neck remnant remained); and incomplete (persistent opacification of the aneurysm sac existed). For patients experiencing SC, angiography was performed during or shortly after the surgical procedure to confirm the initial occlusive extent of the aneurysms. For patients with EE, angiographic follow-up was usually performed at 3–6 months. Based on the angiographic findings, the second angiographic follow-up would be performed from 6 months to one year.

Comparison of the follow-up and immediate post-embolization angiograms was performed. The degree of aneurysm occlusion was assigned to one of three classifications: Progressive thrombosis (the contrast material within the aneurysm sac decreased); unchanged (a similar extent of aneurysm occlusion was detected in multiple projections); and recanalization (an increase of contrast filling in the aneurysm was observed). Aneurysm recurrence was determined when a completely-occluded aneurysm had a recanalization of the neck or when a near-completely occluded aneurysm had an increase in size of the neck remnant at follow-up angiograms.

2.4. Statistics

Paired *t*-tests were performed to analyse the differences among different groups using the JMP software package, Version 5.0 (SAS Institute, Cary, NC, USA). The statistical significance was reached when the P value was less than 0.05.