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Surgical outcome of primary clipping for anterior circulation aneurysms of size 2 centimeters or larger

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ABSTRACT

Background: Aneurysms of the anterior circulation larger than 2 cm have a complex relationship to the anterior skull base, requiring a multi-modality management approach. This retrospective study of 54 patients with such aneurysms who underwent clipping between 2001 and 2012 analyzes clinical and surgical data, aneurysm characteristics and correlates them with respect to the Glasgow outcome score at follow-up and immediate post-operative clinical status.

Methods: Patients with an outcome score of 5 or 4 were categorized as "good", while those with score 3–1 were "poor". Fisher's exact test and paired *T*-test ($p < 0.5$) were used to test statistical significance for discrete and continuous variables respectively.

Results: 44 (81.4%) patients had a good outcome. Patients with non-ophthalmic/paraclinoid aneurysms had significantly lower incidence of adverse intra-operative events ($p = 0.035$). Patients older than 50 years ($p = 0.045$), with adverse intra-operative events ($p = 0.015$) and post-operative infarction ($p < 0.001$) had a poor outcome compared to those younger than 50 years age and those without adverse intra-operative events or infarctions. The grouped age variable had maximum influence on patient outcome. Location and size of aneurysm did not have an overall impact on surgical outcome. There were 4 mortalities.

Conclusions: Primary clipping of proximal non-cavernous aneurysms on the internal carotid artery is associated with adverse intra-operative events. A multi-modality treatment approach in these aneurysms should be individualized, more so in patients older than 50 years.

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1. Introduction

Surgical approach to proximal large and giant anterior circulation aneurysms is challenged by their relationship to the skull base, cavernous sinus and cranial nerves in close proximity. The 5-year cumulative rupture rate for anterior circulation aneurysms of size 13–24 mm and 25 mm or greater is 14.5% and 40% respectively [1,2]. Two-thirds of giant aneurysms are diagnosed before rupture, mainly due to mass effect on cranial nerves, besides presenting with; seizures, repeated TIAs (transient ischemic attacks) or subarachnoid hemorrhage [3]. Flow-related large and giant aneurysms are usually located at the branching regions on the parent vessel [4].

There have been many advances in the exclusion of large and giant aneurysms from the native circulation since 1885 when Horsley first recorded surgical management (by proximal carotid ligation) of a giant aneurysm located in the pre-cavernous segment of the ICA [3,5,6]. Given the complexity of these aneurysms, there is a high incidence of post-operative morbidity and death associated with surgical exclusion of these aneurysms from the circulation. The risks often exceed the risk of subarachnoid hemorrhage (SAH) from them [1].

This paper addresses the risks associated with primary clipping of aneurysms larger than 2 cm, located in the anterior circulation. The use of microsurgical, endovascular modalities and adjuncts like intra-operative neuromonitoring and blood-flow studies provide a multi-modality approach to treat this complex pathology [7,8].

2. Materials and methods

This retrospective study comprised patients with anterior circulation aneurysms, 2 cm or more in size. These aneurysms are

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categorized as very large and giant aneurysms of the anterior circulation [9]. Over a twelve-year period between January 2001 and June 2012, there were 54 such aneurysms operated and constituted 7.2% of operated aneurysm cases. Of the patients, 26 were male and 28 female, with a mean age of 45.1 years. Other parameters like; patient demographics, symptom at presentation, clinical signs, World federation of neurological societies (WFNS) subarachnoid (SAH) grade at first presentation and functional status at follow-up were mined from the hospital electronic patient database once the subset of aneurysm patients was identified. Radiological images were obtained for review in all cases from the Synapse PACS (Fujifilm Medical Systems, Stamford, CT, USA) system and were used to calculate the size and location of aneurysm and post-surgical aneurysm status. Intra-operative details regarding usage of temporary clip and the duration of temporary clip usage, intra-operative aneurysm rupture, number and configuration of permanent clip used were obtained from the operative notes and video archives.

Data were entered in an Excel spreadsheet (Microsoft Inc.,) and analyzed using SPSS version 17 for Windows (SPSS Inc., Chicago, IL). Patients were divided into two groups; good- Glasgow outcome score (GOS) 5 and 4 and poor (3–1) outcome groups, based on their clinical status at the last follow-up visit. Fisher's exact test two-tailed ($p < 0.05$) was used to check correlation of clinical outcome with demographic, intra-operative surgical maneuvers and adverse events like aneurysm rupture, clinico-radiological factors pre-and post-surgery. Means and standard deviations were computed for continuous variables. The paired *T*-test was used to compare differences in ratios between the good and poor outcome groups.

3. Results

3.1. Presentation

28 patients primarily presented with subarachnoid hemorrhage (SAH), 2 with a temporal parenchymal bleed from middle cerebral artery (MCA) aneurysm, 9 presented with headaches with no recorded sub-arachnoid bleed on radiology, 7 had visual abnormalities, 4 had seizures, 3 had oculomotor nerve palsies and 1 had a subdural hematoma. Out of the patients with SAH, 23 had a single ictus. 4 patients bled twice and 1 patient had 3 icti. In addition, 2 patients with SAH also had post-bleed seizures and 2 patients later developed abducens nerve palsy secondary to hydrocephalus. The patients presented between 1 day and 4 years after ictus (median 30 days). Forty-eight patients were in WFNS SAH grade 1 at presentation, 4 in grade 2 and 1 each in grade 3 and 4.

On computed tomography (CT) or magnetic resonance (MR) evaluation at the hospital at first presentation and applying the Fisher score for SAH; 32 exhibited Fisher grade 1, 7 were in grade 2, 12 had Fisher grade 3 score and 3 had Fisher grade 4 score. Hydrocephalus was seen in 4 patients pre-operatively. A total of 10 patients required an external ventricular drain in the peri-operative period (4 pre-operative and 6 post-operative). A total of 6 patients required a ventriculo-peritoneal shunt post-operatively, which included 3 patients from the pre-operative hydrocephalus group. Infarcts were seen pre-operatively in 3 patients involving the parietal MCA territory in 1 patient and distal anterior cerebral artery (DACA) i.e. A4 territory in 2 patients. Calcification in the vessel wall was documented in 5 patients and an intra-aneurysmal thrombus was noted in 21 patients. 21 patients underwent an angiogram to delineate the aneurysm in relation to the skull base.

3.2. Aneurysm characteristics

The location of aneurysms is provided in Table 1. Ophthalmic segment aneurysms had a higher incidence (20 cases), followed by middle cerebral artery bifurcation (12 cases) and anterior communicating artery aneurysms (11 cases). There was a case of giant A1 segment aneurysm and 2 cases of giant distal anterior cerebral artery aneurysm. Giant aneurysms in the A1 segment and pericallosal region are rare with only a dozen reported cases in each either region [10,11]. These aneurysms are usually associated with arterial anomalies like A1 fenestration, azygos anterior cerebral artery or trauma as in the case of DACA aneurysms, which our patients did not exhibit. The average size of the aneurysms was 2.20 cm (median 2.6; SD 1.10). Two patients with ophthalmic segment aneurysms had small aneurysms in another location (opposite ophthalmic segment and anterior communicating (ACOM) aneurysm). A patient with a posterior communicating segment (PCOM) aneurysm had a Spetzler–Martin grade 1 frontal arterio-venous malformation. Balloon occlusion tests were performed in 49 patients to test the patency of the communicating system and document cross flow.

3.3. Surgery

46 patients with aneurysms underwent a pterional craniotomy and clipping of their anterior circulation aneurysm. 5 patients with ophthalmic segment aneurysms underwent an orbito-zygomatic approach and 2 patients with DACA aneurysms underwent a pericoronal parasagittal craniotomy and 1 patient with a cavernous segment underwent ligation of the cervical internal carotid artery (ICA) under local anesthesia following temporary occlusion of the cervical ICA under hypotensive condition. 52 of the remaining aneurysms were clipped primarily and a giant A1 segment aneurysm was trapped on the A1 segment as the neck was atherosclerotic and the aneurysm could not be clipped with the available clips. Yasargil titanium aneurysm clips (Aesculap Inc., PA) were used in all surgeries. 3 cases (Giant ACOM and 2 ophthalmic segment aneurysms) were operated under total circulatory cardiac arrest under hypothermic conditions. 14 patients with ophthalmic segment aneurysms required drilling of the anterior clinoid process and the roof of optic canal. A temporary clip was used in 32 cases for a mean duration of 5.46 min (median 4 min, range 1–28 min). 37 patients did not have any documented adverse intra-operative events in the operative records which included aneurysm rupture, clip adjustment due to compromise of perforator vessels or communicating vessels of the circle of Willis. Figs. 1–4 show well clipped ACOM, MCA and ophthalmic segment aneurysms in the series.

4. Outcome

4.1. Immediate post-operative

40 (74%) patients were neurologically intact immediately after surgery. 18 (33%) patients had infarcts documented in their post-operative CT or MR images, out of which 10 (18.5%) infarcts involved eloquent areas causing clinical weakness, alteration in sensorium or dysphasia. 3 patients in this group (2 patients with an internal capsular and 1 with a parietal lobar MCA infarct)

Table 1
Location of aneurysm.

Ophthalmic segment aneurysm	20
Middle cerebral artery aneurysm	12
Anterior communicating artery aneurysm	11
Posterior communicating segment aneurysm	5
Anterior choroidal segment aneurysm	2
Distal anterior cerebral artery aneurysm	2
Anterior cerebral artery aneurysm (A1)	1
Cavernous/clinoid segment ICA aneurysm	1

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