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Clinical commentary

Intraoperative rupture in the surgical treatment of patients with intracranial aneurysms

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ABSTRACT

Intraoperative rerupture (IOR) during clipping of cerebral aneurysms is a difficult complication of microneurosurgery. The aim of this study was to evaluate the incidence of IOR and analyze the strategies for controlling profound hemorrhage. A total of 165 patients with unruptured intracranial aneurysms and 46 patients with subarachnoid hemorrhage (SAH) treated surgically between April 2010 and March 2011, were reviewed. The data were collected with regard to age, sex, presence of symptoms, confounding factors and strategy for controlling intraoperative hemorrhage was analyzed in terms of location of aneurysms, timing of rupture and severity of IOR. 211 patients with 228 aneurysms were treated in this series. There were a total of six IORs which represented an IOR rate of 2.84% per patient and 2.63% per aneurysm. The highest ruptures rates occurred in patients with internal carotid artery aneurysms (25%). Surgeries in the group with ruptured aneurysms had a much higher rate of IOR compared with surgeries in the group with unruptured aneurysms. Of the six IOR aneurysms, one occurred during predissection, four during microdissection and one during clipping. One was major IOR, three were moderate and two were minor. Intraoperative rupture of an intracranial aneurysm can be potentially devastating in vascular neurosurgery. Aneurysm location, presence of SAH and surgical experience of the operating surgeon seem to be important factors affecting the incidence of IOR.

1. Introduction

Intraoperative rupture of an intracranial aneurysm during surgery accounts for 3.2–50% of patients, and remains one of the many intraoperative misadventures that can contribute to a poor outcome for patients. With the introduction of the microscope in neurosurgical procedures and the development of microsurgical techniques, surgery for intracranial aneurysms has become safer and outcome has improved significantly [1,2]. However, with the advances of endovascular technique, conventional microneurosurgeons are now facing more complex cerebral aneurysms, which cannot be simply obliterated using the usual microsurgical techniques. The chances of rupture increase with the complexity of the aneurysm and its morphology. During open surgical clipping, rupture can occur during the initial exposure, actual dissection of the aneurysm or during clipping of the aneurysm. Well known methods to control IOR include tamponade, suction, proximal and distal vascular control, temporary clipping, and hypotension [3–5]. We present our clinical experience with management of intraoperative hemorrhage and assess the factors associated with IOR. Such an analysis may help to diminish its frequency and thus improve the patient care.

2. Materials and methods

A total of 211 patients with intracranial aneurysms were treated by surgical clipping at our tertiary care center in Japan between April 2010 and March 2011. Patients with intracranial aneurysms at our institution were evaluated by a multidisciplinary team of neurosurgeons, endovascular and critical care neurologists. All the surgical procedures were performed by two experienced senior neurosurgeons with assistance from four junior colleagues. In 165 patients the aneurysms had not bled before surgery while the other patients presented with SAH or intracerebral hemorrhage. Using the clinical records, we reviewed the 211 patients and data

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Table 1
Locations of surgically treated aneurysms with and without intraoperative rupture (IOR)

Location	IOR rate (%) Unruptured aneurysms	IOR rate (%) Ruptured aneurysms	Total rate (%)
Ophthalmic artery	0 (0/18)	0 (0)	0
Superior hypophyseal artery	0 (0/3)	0 (0/2)	0
Posterior communicating artery	0 (0/36)	9.1 (1/11)	2.1 (1/47)
Internal carotid artery	20 (1/5)	33.3 (1/3)	25 (2/8)
Anterior communicating artery	0 (0/33)	12.5 (2/16)	4.1 (2/49)
Distal anterior cerebral artery	0 (0/10)	50 (1/ 2)	8.3 (1/12)
Middle cerebral artery	0 (0/68)	0 (0/15)	0
Basilar artery	0 (0/2)	0 (0/1)	0
Posteroinferior cerebellar artery	0 (0/1)	0 (0/2)	0
Total	0.57 (1/176)	9.6 (5/52)	2.63 (6/228)

was collected with regard to age, sex, presence of symptoms, location and size of the aneurysm, experience of surgeon, surgical complications and postoperative 1 year outcome. The strategy of controlling intraoperative hemorrhage was analyzed in terms of locations of aneurysms, timing of rupture and severity of IOR.

145 (68.7%) patients were female and 66 were male. Patient ages ranged between 31 and 79 (mean age 56.2 years). Most patients were in their sixth (85, 40.1%) and fifth (53, 25.1%) decades of life. 34 patients (16.1%) were older than 70 years of age. Aneurysm size was assessed by direct interpretation of 3-dimensional computed tomographic angiographic (3D-CTA) or angiographic data. Also, the following measurement characteristics of the cerebral aneurysms were collected by the preoperative imaging: maximal height, maximal width of aneurysmal sac and maximal neck diameter. Murphys tip was also assessed in reconstructed images to predict the potential area of rupture. In this series, micro-Doppler examination was performed after clipping in all patients to assess blood flow in parent and branching vessels. Afterwards if it was necessary, we used endoscopy to verify whether clipping had been performed correctly or not. In most patients we also used microscope-integrated near-infrared indocyanine green videoangiography (ICG-VA). Intraoperative angiography was performed in the patients treated by retrograde suction decompression assisted clipping through the existing catheter to confirm the obliteration of the aneurysm and the patency of the parent vessels. After surgery, all patients underwent either postoperative CTA or digital subtraction angiography (DSA). Clinical outcome was assessed by the use of the Glasgow Outcome Scale (GOS).

Intraoperative rupture was defined as any bleeding from the aneurysm during surgery, regardless of how trivial [2,6–8]. The time of IOR was divided into three main time periods: the initial exposure or predissection; the actual dissection of the aneurysm or microdissection; clipping of the aneurysm [9]. The severity of IOR was categorized according to the description by Thomas and Jennifer as minor bleed, moderate bleed, and major bleed [10]. Minor bleeds from the intraoperative rupture aneurysm were small and easily controlled by 3-French microsuction. Moderate bleeding usually required temporary occlusion of the proximal arterial segment or tamponade of the aneurysm to stop the bleeding. Major IOR resulted in significant hemorrhage that was difficult to control and resulted in serious hemodynamic changes in patient.

3. Results

Altogether, 211 patients with 228 aneurysms were treated in this series. 176 patients had single aneurysm and 35 patients had multiple aneurysms. Of the 35 patients with multiple aneurysms, 12 were treated with clipping of coexistent aneurysms in the same surgery. The distribution of aneurysms and the rates of IOR by aneurysm location and SAH history are summarized in Table 1. There were a total of 6 IORs as listed in Table 2 which represented an IOR rate of 2.84% per patient and 2.63% per aneurysm. Different rupture rates were observed depending on the localization of the aneurysms. The highest ruptures rates occurred in patients with ICA aneurysms (25%).

Surgeries in the group with ruptured aneurysms had a much higher rate of IOR compared with surgeries in the group with unruptured aneurysms (ruptured/unruptured, 9.6%/0.57%). Among the 176 unruptured aneurysms treated surgically in this series, there was only one IOR. In this IOR patient, one blister-like aneurysm was arising from the anterior wall of the internal carotid artery (ICA) without any relationship to an arterial branch. There were five IORs among the 52 ruptured aneurysms treated in this study including two anterior communicating artery (AComA) aneurysms, one ICA aneurysm, one internal carotid-posterior communicating artery (ICPC) aneurysm and one distal anterior cerebral artery (ACA) aneurysm.

Of the six IOR aneurysms, one (16.7%) occurred during predissection, four (66.7%) during microdissection and one during clipping. One was major IOR, three were moderate and two were minor. The minor bleeds could be controlled by a 3-French microsuction and closure of the permanent clip. Among the moderate IORs, two occurred in clipping of ICA blister-like aneurysm and required temporary occlusion of the ICA in the neck in order to control the hemorrhage. The major IOR occurred in an operation for a ruptured AComA aneurysm that had been endovascularly treated 1 week earlier. The patients experiencing minor or moderate IOR recovered without serious deficit. The patient with coiled AComA aneurysm experienced major IOR and sustained a stroke before discharge.

3.1. Illustrative patients

3.1.1. Patient 1

A 77-year-old female, during routine screening was detected to have left ICA aneurysm. Her 3D-DSA imaging demonstrated a blister-like aneurysm arising from the anterolateral wall of the proximal ICA without any relationship to an arterial branch, distal to the ophthalmic artery origin (Fig. 1). Ophthalmological examination was unremarkable, but follow-up DSA demonstrated a gradual increase in the aneurysm size, and thus, surgical clipping was planned. Prior to beginning the intracranial surgery, the left common, internal, and external carotid arteries were exposed at the common carotid artery bifurcation in the neck to secure them for proximal control. A left frontotemporal craniotomy was performed and the anterior clinoid process was removed. The blister-like aneurysm projected superiorly and was adherent to the frontal lobe. The aneurysm ruptured when the surgeon was