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Management strategy of surgical and endovascular treatment of unruptured paraclinoid aneurysms based on the location of aneurysms

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ABSTRACT

Objective: Advances in endovascular treatment (EVT) have greatly improved the treatment outcomes of paraclinoid aneurysms. However, EVT had the shortcoming of durability and thromboembolic complications. As well, surgical treatment of paraclinoid aneurysms is still challenging due to the complexity of adjacent structures. The objective of this study is to report our experience with a combined surgical and endovascular treatment of unruptured paraclinoid aneurysms based on the location of aneurysms.
Methods: A retrospective review was conducted of 185 cases of unruptured paraclinoid aneurysms that underwent surgical or endovascular treatment between September 2008 and August 2012. Thirty-one aneurysms (16.8%) were treated by microsurgery and 154 (83.2%) were treated by EVT. Fifty aneurysms (27.0%) were classified to the dorsal group and 135 (73%) were classified to the non-dorsal group.
Results: Twenty of 50 dorsal group aneurysms (40%) were treated by microsurgery while 124 of 135 non-dorsal group aneurysms (91.9%) underwent an EVT. The rate of complete occlusion was 96.8% in surgical series and 60.4% in EVT ($P < 0.001$). Recanalization occurred in 9 aneurysms (5.8%) of EVT and 1 aneurysm (3.2%) of surgical series ($P = 0.360$). In non-dorsal group, transient complications (10 aneurysms (5.4%), $P = 0.018$) and morbidity at last visiting (6 aneurysms (3.2%), $P = 0.021$) were more present in surgically treated cases rather than in EVT cases. Diplopia and visual field defect occurred in the non-dorsal group only; in 2 of 11 surgical cases (18.2%) and in 1 of 124 EVT series (0.8%) ($P = 0.017$). The overall rate of excellent or good clinical outcomes (Glasgow outcome scale 5 or 4) was 98.9%.
Conclusion: EVT is a safe and effective treatment for the non-dorsal group. Based on angiographic and clinical aspects, microsurgical clipping has prior efficacy with better outcomes in the dorsal group under proper individualized selection.

1. Introduction

Paraclinoid aneurysms have been defined as intracranial aneurysms that arise from the internal carotid artery (ICA) between the site of its exit from the roof of the cavernous sinus and the origin of the posterior communicating artery [1–3]. Because of the close relationship to the complexity of adjacent structures such as skull base including anterior clinoid process (ACP), cavernous sinus and critical cranial nerves, surgical treatment of paraclinoid aneurysms remains a technical challenge to many neurosurgeons [1,2,4–8]. The Unruptured Cerebral Aneurysm study of Japanese investigators reported that the risk for a rupture of ICA aneurysm excluding posterior communicating artery and cavernous portion was statistically low compared with the aneurysms located in the anterior communicating or posterior communicating arteries [9]. Owing to their rare incidence of rupture, the indication for the treatment of unruptured paraclinoid aneurysms would be focused on safety. Since the advent of endovascular techniques, excellent results with coil embolization of paraclinoid aneurysms have been reported especially for those lesions with high surgical risk [6,10–13]. However, endovascular treatment (EVT) of aneurysms

Abbreviations: EVT, endovascular treatment; ICA, internal carotid artery; ACP, anterior clinoid process; 3D, 3-dimensional; CTA, computed tomography angiography; MRA, magnetic resonance angiography; DSA, digital subtraction angiography; GOS, Glasgow outcome scale.

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has been considered as associations with significant problems were faced such as durability of obliteration, thromboembolic complications and hemorrhagic complications related with antithrombotic medications [14–16].

Some reports presented a multidisciplinary approach of microsurgery and EVT for the treatment of paraclinoid aneurysms [6,7,12,17,18]. Considering the procedure related risks of unruptured paraclinoid aneurysms, it is important to identify the proper indication as well as to select safe and effective methods for treatment. We applied a more simplified classification based on anatomic relations for the treatment of paraclinoid aneurysms. The purpose of the present study was to assess the outcomes under the multidisciplinary treatment based on a simplified classification.

2. Materials and methods

2.1. Patient population

Between September 2008 and August 2012, 185 saccular paraclinoid aneurysms in 176 patients were treated at our institute. The medical records and angiographic data of the patients were retrospectively reviewed. This study was approved by the institutional review board at Catholic Medical Center Office of Human Research Protection Program, Seoul, Republic of Korea (Study No. KC14RISI0147). The pre- and postoperative workup included 3-dimensional (3D) computed tomography angiography (CTA) and magnetic resonance angiography (MRA). Digital subtraction angiography (DSA) was performed in all cases for to confirm the diagnosis and classification. Dual reconstruction technique of 3D DSA was also simultaneously performed to evaluate the relation to the adjacent skull base structure including anterior clinoid process, optic strut and dural ring. Blister-like aneurysms were excluded under angiographically suspected or diagnosed under microsurgical field.

2.2. Classification of aneurysms

One hundred eighty-five saccular paraclinoid aneurysms were selected and divided into two groups, according to a simplified modification of previously proposed classifications [19–21]. (1) *Dorsal group* aneurysms are classified as followed: the neck of aneurysms originates from the superior location of the paraclinoid segment of ICA and the dome project to an anterior or superior direction. The aneurysms that arose from the origin of the ophthalmic artery, so called true ophthalmic aneurysms were also included into the dorsal group. (2) *Non-dorsal group* aneurysms are classified as follows: the neck of aneurysms originates from inferior, medial or lateral wall of paraclinoid ICA and the dome projects to any direction except anterior or superior direction. Aneurysm size was categorized by the International Study of Unruptured Intracranial Aneurysms (ISUIA) criteria (small, <10 mm; large, 10 to <25 mm; giant, ≥25 mm). To reduce the selection bias, formal angiograph reading, including determination of aneurysm size and location, were conducted by the same neurointerventional radiologist.

2.3. Therapeutic strategy and follow-up

Our multidisciplinary team applied the indication for paraclinoid aneurysm following considerations. For medial or ventral paraclinoid aneurysms, EVT was firstly indicated because of the surgical difficulties. However, some large or giant aneurysms that presented with mass effect or predicted to incomplete packing due to wide neck or irregular shape were indicated to microsurgery. For dorsally located paraclinoid aneurysms, microsurgery was indicated if an easily surgical access such as less required extensive resection of the ACP was predicted due to pre-operative radiologic studies such as CTA with bone reconstruction and dual reconstruction images of 3D DSA containing bony structures. In addition, if an ophthalmic artery originated from the aneurysmal sac, a microsurgery was preferred to save the branch. In some dorsally located aneurysms, EVT was indicated if the patients were old or clinically deteriorated or a complete packing could be easily achieved.

A standard pterional craniotomy was performed for microsurgery of dorsal group aneurysms. For common or internal carotid artery exposure, a sterile draping on the ipsilateral neck was performed on all indicated patients. Before craniotomy, ICA exposure was routinely performed for the extracranial proximal control using temporary clipping. The ACP, the optic canal and optic strut were removed extradurally or intradurally if the needs were proved on dual reconstruction 3D DSA images.

The patients for EVT received proper antiplatelet medications for 5–7 or more days before the procedures. EVT was performed under general anesthesia. Standard co-axial technique using a 6- or 7-french guiding catheter was performed, and the patients received systemic heparinization during the procedure. When a remodeling technique was needed, a non-detachable balloon or self-expandable stent was applied. Angiographic results were evaluated with the modified Raymond grading system: class 1, complete obliteration; class 2, residual neck; or class 3, residual sac [10,22].

We checked the routine follow-up imaging in all objective patients at 6 months. MRA was performed to evaluate a recanalized aneurysm after EVT and CTA was performed to evaluate the post-clipping status. An early check-up of DSA was indicated if the patients were suspected for recurrence. "Major recanalization" was defined as a contrast filling within the aneurysm dome or significant coil compaction, and "Minor recanalization" was defined as a minimal coil compaction at the aneurysm neck. Clinical outcomes at discharge and last visits on the out-patient status were evaluated with the Glasgow outcome scale (GOS). A "transient complication" was defined if the complication did not affect the clinical status at discharge, or trivial symptoms were only occurred during a brief period.

2.4. Data analysis

All statistical analysis was performed using SPSS Statistics 18th version for Windows (SPSS, Inc., an IBM Company, Chicago, IL, USA). Student's *t*-test was used for continuous variables and the chi-square test or Fisher's exact test was as appropriate used for categorical variables. Statistical significance was defined as a *P*-value <0.05% for a 95% confidence interval.

3. Results

3.1. Patient demographics

The baseline characteristics of study subjects are presented in Table 1. The patients included 148 women (84.1%) and 28 men (15.9%) with a mean age of 53.7 ± 11.0 years (range, 28–81). Multiple aneurysms were found in 49 patients (27.8%). Eight of 176 patients (4.6%) had visual symptoms caused by paraclinoid aneurysms. The other 168 patients (95.4%) were diagnosed due to incidental findings; headache, dizziness, minor head trauma, evaluation for other intracranial lesion and routine medical check etc. Thirty-one aneurysms (16.8%) were treated by microsurgery while 154 (83.2%) were treated by EVT. Based on our proposed classification, 50 aneurysms (27.0%) were included in the dorsal group and 135 (73%) were included in the non-dorsal group. Nine aneurysms (4.9%) were raised from the origin of the ophthalmic artery. In the