New simplified classification of paraclinoid aneurysm according to aneurysm direction

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New simplified classification of paraclinoid aneurysm according to aneurysm direction

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ABSTRACT

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Paraclinoid aneurysm (PA) is classified in several ways according to anatomic locations. However, these classifications could not provide sufficient information for surgical treatment. We retrospectively analyzed findings from 277 consecutive patients (231 females, mean age at surgery: 56.8 years, range: 19-81 years) at our hospital for 14 years. We reviewed aneurysm size, multiplicity, type of treatment, and aneurysm direction. The PAs were classified into four types along the aneurysm direction: Superomedial (SM), superolateral (SL), inferomedial (IM), and inferolateral (IL). As our new classification, SM type occupied 68 (24.5%), SL type was 75 (27.1%), IM type was 118 (42.6%), and IL type was 16 (5.8%). Divided into two treatment modalities, microsurgical treatment and endovascular treatment, Superior group (SM and SL type) was frequently indicated for microsurgery compares to inferior group (IM and IL type). And the endovascular treatment was provided the most for the IM type. Although endovascular treatment is a large part of aneurysm treatment, surgical treatment remains an indispensable option for PA. Grouping the PA according to aneurysm direction can help in the treatment planning and microscopic surgery.

Key words : paraclinoid aneurysm, classification, microscopic surgery, endovascular treatment

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I. INTRODUCTION

Aneurysms arising from the ICA in proximity to the anterior clinoid process (ACP) were defined as paraclinoid aneurysms (PA), which arose between the roof of the cavernous sinus and the origin of the posterior communicating artery.[1] Because of their intimacy with the ACP, cavernous sinus, and cranial nerves, the surgical treatment of PA remains challengeable to many neurosurgeons.[2,3]

In 1993, Al rodhan described the clinoidal region aneurysms according to its anatomic location as superior hypophyseal (Ia), ventral (Ib), ophthalmic (II), carotid cave (III), transitional (IV) and cavernous (V). [4] However, some of these like superior hypophyseal (Ia) seemed misnomer, and its implication to microsurgery is not fascinating. Basically, what we need to know for surgical planning is if the neck of the aneurysm is seen along with the line of microscopic sight or not, and the dome of the aneurysm is hidden under or beyond the optic nerve or not. Krisht et al had once grouped the PAs simply as superior / inferior / medial / lateral concerning the parent ICA.[5] However, this classification is still insufficient for microscopic surgery.

Therefore, we modified the previous classification to be intuitively helpful for surgical treatment and reviewed 277 patients with PAs who were treated by surgical or endovascular treatment on our new classification

II. MATERIALS AND METHODS

1. Patients and aneurysms

After approval of the institutional review board (Gangnam Severance Hospital) for this retrospective study, informed consent was waived.

The prospectively maintained database for the neurovascular center at Severance hospital was searched for patients with PAs who had microsurgical and endovascular treatment (EVT) during the 14 years from January 2000 to December 2014. Patient data were collected from clinical assessments (at admission, during the immediate postoperative period, and at follow-up), radiographic films, operative notes, intraoperative imaging, and postoperative angiography. PAs were defined as mentioned above. Patients treated with bypass or without aneurysm neck clipping (aneurysms treated with wrapping or unclippable) were excluded from this study.

2. Modified Krisht's classification

We modified a Krisht's classification with a combination of superior/ inferior to carotid wall and medial/lateral to optic nerve. Accordingly, with our noble classification, PA can be classified into four types by direction of projection: superomedial (SM), superolateral (SL), inferomedial (IM), and inferolateral (IL). (Figure 1)

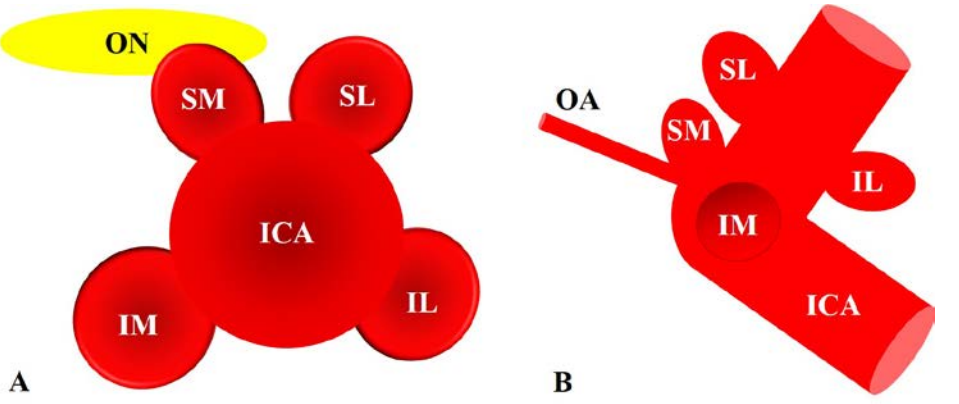

Figure 1 Schematic drawing showing modified Krisht's classification of paraclinoid aneurysms. (A) Anteroposterior view. (B) Lateral view. ICA : internal carotid artery, ON : optic nerve, OA : Ophthalmic artery, SM : superiormedial, SL : superiorlateral, IM : inferiormedial, IL : inferiorlateral,

III. RESULTS

Of the 277 patients, women accounted for 231 (83.4%), and 57 patients (79.4%) had another aneurysm at other locations. Two hundred six patients (74.4%) had aneurysms smaller than 10mm. Fifty-four patients (19.5%) were presented aneurysmal subarachnoid hemorrhage and 223 patients (80.5%) were asymptomatic.

Eighty patients (28.9%) received microsurgical treatment and 197 patients (71.1%) were treated by endovascular tools. Among 277 aneurysms we treated, the most common group was IM type PAs (118/227, 42.6%), followed by SL type (75/277, 27.1%), and SM type (68/277, 27.1%). The IL type (16/277, 5.8%) was the least. (Table 1)

Classified with treatment modality, the sum of the SM type and SL type accounted for 72.5% (58/80) of the total microsurgery. The superior group was frequently indicated for microsurgery than the inferior group (22/80, 27.5%). And the endovascular treatment was provided the most for the IM type PAs (101/197, 85.6%). (Table 2)

Table 1 Characteristics and treatment modality of 277 paraclinoid aneurysms

Characteristic	Value
Sex	
Male	46 (17%)
Female	231 (83%)
Size	
< 10mm	206 (74.4%)
≥ 10mm	69 (25.6%)
Rupture	
Ruptured	54 (20%)
Unruptured	223 (80%)
Multiplicity	
Yes	57 (20.6%)
No	220 (79.4%)
Treatment	
Microsurgical treatment	80 (29%)
Endovascular treatment	197 (71%)
Direction	
Superior group	143 (51.6%)
SuperoMedial type	68 (24.5%)
SuperoLateral type	75 (27.1%)
Inferior group	134 (48.4%)
InferoMedial type	118 (42.6%)
InferoLateral type	16 (5.8%)

Table 2 Aneurysm direction type according to treatment modality

	Microsurgery (n=80)	EVT (n=197)
Superior group	58 (72.5%)	85 (43.1%)
SuperoMedial type	26 (32.5%)	42 (21.3%)
SuperoLateral type	32 (40.0%)	43 (21.8%)
Inferior group	22 (27.5%)	112 (56.9%)
InferoMedial type	17 (21.3%)	101 (51.3%)
InferoLateral type	5 (6.3 %)	11 (4.6%)

EVT : endovascular treatment

IV. DISCUSSION

In this retrospective study, our data verified that PAs had female predominance, multiplicity, which 70% of them were treated by endovascular tools. As for the treatment modality superior group (SL and SM type) was frequently indicated for microsurgery, and endovascular treatment was provided the most for the IM group of PA.

As the endovascular device and technique develop, most of PAs are treated predominantly by endovascular tools.[6] However, as many authors demonstrated how they reform the catheter to access the aneurysm along with the carotid siphon, EVT may not be an easy task in every case.[7-9] Endovascular treatment has a lower complete occlusion rate and more commonly recurrence than direct surgery.[10] Also, endovascular treatment is not effective in a symptom of compression of the optic nerve.[11] Flow diverters showed promising results in PAs, but complication rates of 1.4% -7.6% and mortality rates of 4% -8%. [12]

Under the microscopic surgical view, with our new classification, SM type PA can be found under the optic nerve (Figure 2), and SL type PAs can be seen fully exposed in the ipsilateral approach. (Figure 3) IM type PAs are being hidden opposite wall to the carotid artery (Figure 4), and IL type PA is seen away lateral to the carotid A. (Figure 5) Several authors advocated that the superiorly projecting PAs could be more intuitive for microsurgery.[3,5,11,13] In these aneurysms, coil embolization is difficult for accessing the aneurysm sac and maintaining micro-catheter stably due to superior projections situated at the sharp curvature of the carotid siphon[8,14] In addition, endovascular treatment has the risk of visual field deficits due to unexpected thromboembolic event or post-procedural occlusion of the ophthalmic artery.[13,15] Whereas the inferiorly projecting PAs are the best for endovascular treatment.[3,13,16]

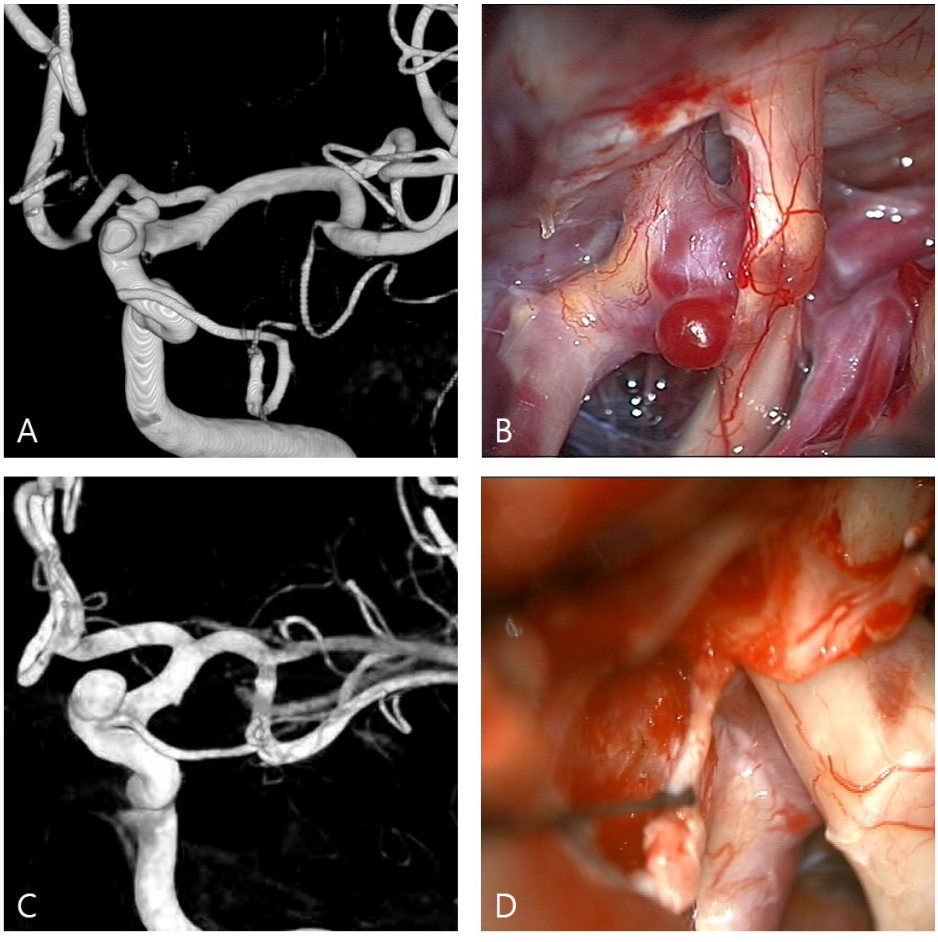

Figure 2 Two cases of SM type PA. A: AP view of preoperative DSA. (So-called Dorsal wall aneurysm). B: Intraoperative microscopic view. The aneurysm' dome is impacting strongly to the optic nerve. C: DSA AP view. (So-called Ophthalmic artery aneurysm). D: Intraoperative microscopic view. Aneurysm's dome is buried under the optic nerve. AP: anteroposterior

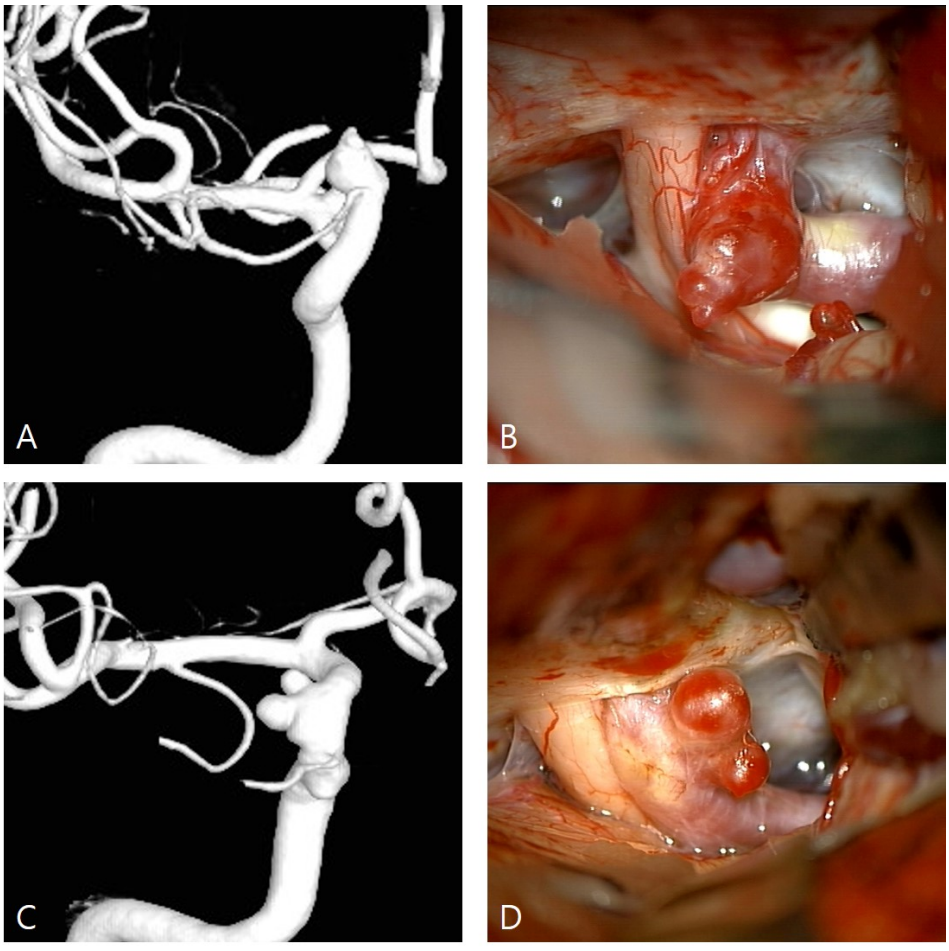

Figure 3 Two cases of SL type PA. A: AP view of preoperative DSA (So-called Ophthalmic artery aneurysm) B: Intraoperative microscopic view. The aneurysm is fully seen beside the latral border of the optic nerve. C: AP view of preoperative DSA (So-called dorsal wall aneurysm) D: Intraoperative microscopic view. The aneurysm projected lateral to the optic nerve

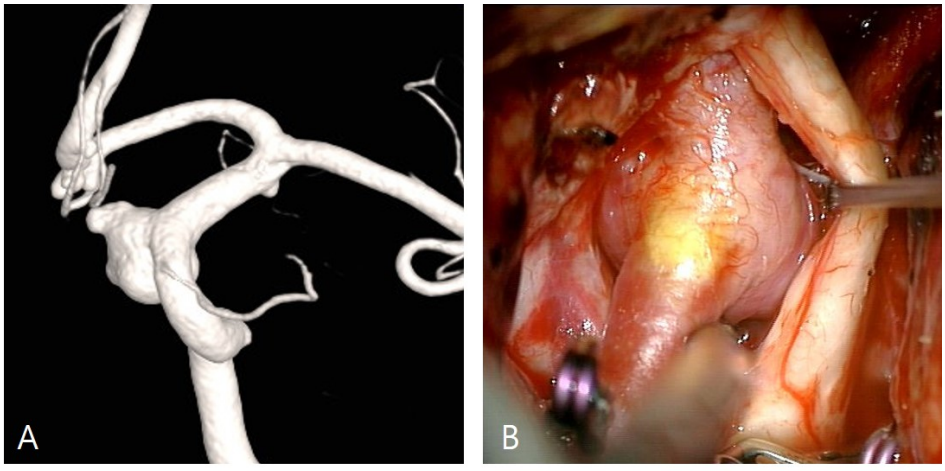

Figure 4 A case of IM type PA. A: AP view of preoperative DSA (So-called superior hypophyseal artery aneurysm) B: Intraoperative microscopic view

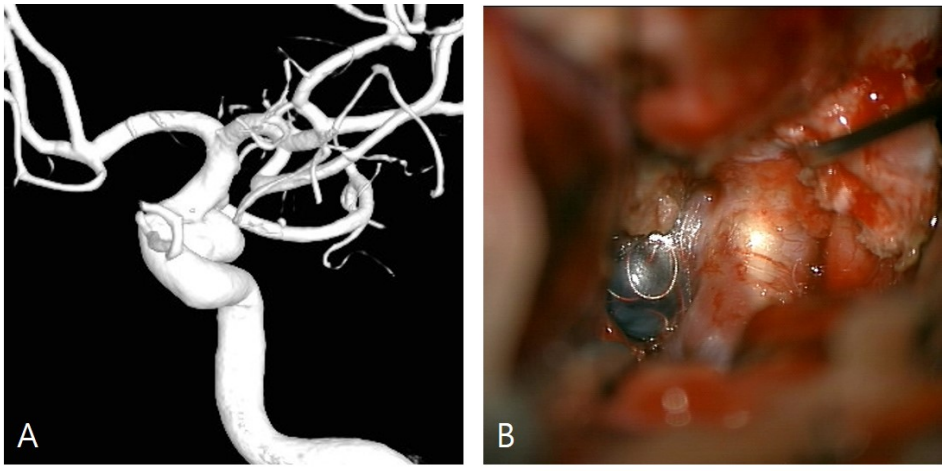

Figure 5 A case of IL type PA. A: AP view of preoperative DSA (So-called ventral ICA aneurysm) B: Intraoperative microscopic view. Partially coiled previously

PAs are often challenging to clip ligation because of its proximity to the skull base, cavernous sinus and cranial nerves.[17] And the most complicated part of surgery depends on how the aneurysm is related to the distal dural ring[11]. Thus, anterior clinoidectomy, opening of the optic sheath and release of the dural ring are almost always essential. Additionally, preoperative computed tomography scan should be carefully reviewed before surgery to observe anatomic variations of the ACP.[18]

For identifying the relation to the DDR, the proton density weighted magnetic resonance imaging is very informative.[19] It showed quite well the dural boundary of cavernous sinus and its relation to the black vessel. So we can assume preoperatively how the aneurysm resides around the DDR. In some of PAs, only the opening of the optic sheath is enough to put the clip. However in some others, the neck of the aneurysm blends with the DDR. Therefore, the careful release of the DDR is essential for the clipping and preoperative tactical planning according to the aneurysm direction may be helpful.

Using our new classification, we may prefer to use different clips for each direction. The angled clip is likely placed to the SM type PAs, across the ICA, with blades pointing inferomedially. For SL type of PAs, L-shaped clips are frequently utilized parallel to the ICA curvature. And especially for the IM type of PAs, the utilization of a fenestrated clip passing ICA through the fenestration is almost always needed. Simply, SL type and IM type of PAs are likely to accept the parallel clipping to the ICA curvature, whereas the SM type and IL type PAs are frequently clipped across the ICA perpendicularly. Fenestrated clips are valuable for aneurysms projecting away from the opposite wall of the ICA.[20] (Figure 6)

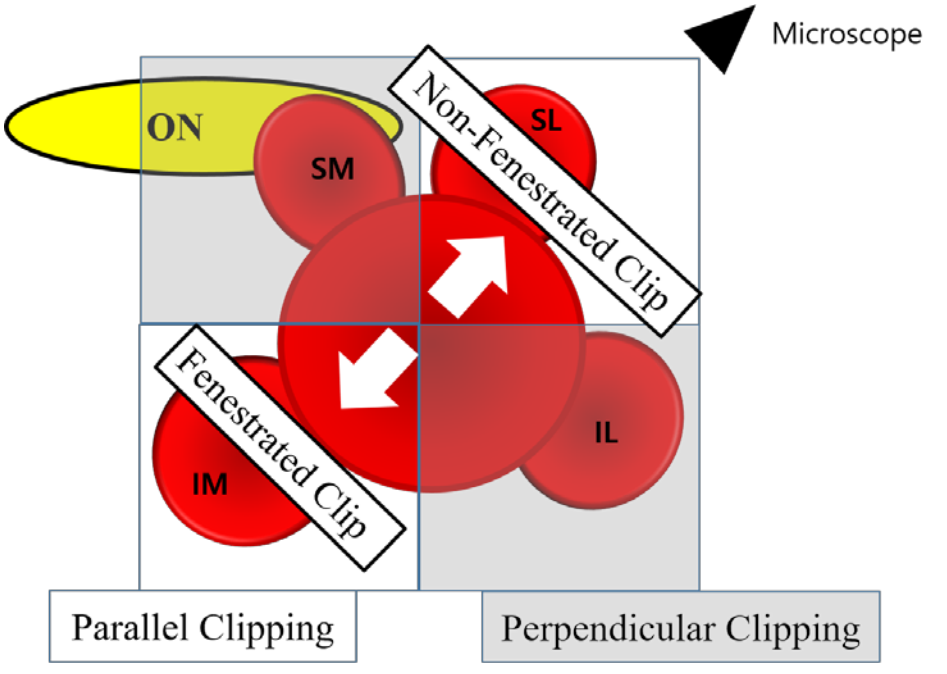

Figure 6 Clip selection according to aneurysm direction under microscopic view
ON : optic nerve, SM : superiormedial, SL : superiorlateral, IM : inferiormedial, IL : inferiorlateral,

V. CONCLUSION

The superior group PA was more suitable for microsurgery than the inferior group, and EVT was most frequently done in IM type PA. Although endovascular treatment is a large part of aneurysm treatment, surgical treatment remains an indispensable option for PA. Grouping the PA according to aneurysm direction can help in the treatment planning and microscopic surgery.

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ABSTRACT(IN KOREAN)

상상돌기주변 동맥류의 방향에 따른 새로운 분류법

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김 재 호

상상돌기주변 동맥류(PA)는 해부학적 위치에 따라 여러 가지 방법으로 분류된다. 그러나 이러한 분류는 수술적 치료에 충분한 정보를 제공 해 주지 않는다. 본원에서 14 년 동안 상상돌기주변 동맥류로 치료받은 277명 (여성 231명, 평균 연령 : 56.8 세, 19-81 세)의 결과를 후향적으로 분석하였고, 동맥류 크기, 다양성(multiplicity), 치료 유형 및 동맥류 방향을 검토하였다. PA는 동맥류의 방향에 따라 Superomedial (SM), superolateral (SL), inferomedial (IM), inferolateral (IL)의 4 가지 유형으로 분류되었다. 새로운 분류로 SM형은 68(24.5%), SL형은 75(27.1%), IM형은 118(42.6%), IL형은 16(5.8%)이었다. 미세현미경 수술과 혈관내 치료의 두 가지 치료 방식으로 나누었을 때, superior 그룹 (SM 및 SL유형)이 inferior 그룹 (IM 및 IL유형)에 비해 미세 수술의 대상이 되었다. 그리고 혈관내 치료는 IM 유형에서 가장 많이 시행되었다. 혈관 내 치료는 동맥류 치료의 큰 부분이지만 수술적 치료는 PA에 없어서는 안될 옵션으로 남아 있다. 동맥류 방향에 따라 PA를 나누었을 때, 치료 계획 및 현미경 수술에 도움이 될 수 있다.

핵심되는 말 : 상상돌기주변 동맥류, 미세현미경 수술, 혈관내 치료