[UCI]I804:11046-000000516441

Radiographic and microsurgical characteristics of Proximal (A1) Segment Aneurysms of the Anterior Cerebral Artery

Chang KI Jang

Department of Medicine
The Graduate School, Yonsei University

Radiographic and microsurgical characteristics of Proximal (A1) Segment Aneurysms of the Anterior Cerebral Artery

Chang KI Jang

Department of Medicine
The Graduate School, Yonsei University

Radiographic and microsurgical characteristics of Proximal (A1) Segment Aneurysms of the Anterior Cerebral Artery

Directed by Professor Yong Bae Kim

The Master's Thesis
submitted to the Department of Medicine,
the Graduate School of Yonsei University
in partial fulfillment of the requirements for the degree
of Doctor of Philosophy

Chang Ki Jang

June 2018

This certifies that the Master's Thesis of Chang Ki Jang is approved.

Thesis Supervisor : Joonho Chung

Thesis Committee Member#1 : Yong Bae Kim

Thesis Committee Member#2 : Sang Hyun Suh

The Graduate School
Yonsei University

June 2018

ACKNOWLEDGEMENTS

I think it is my parents and Master who gave birth in the world and let me do my role. I would like to say that I always thank to my parents who taught me to live with a warm heart between people. This work will be a small gift to my parents who are worring about my every moment, and also gratefully thanks to my neurosurgeon professors and interventional radiology professors who have made me work as a lifelong physician and taught me under the great reputation of Severance.

In particular, I would like to express my sincere gratitude to Professor Yong Bae Kim, who is the supervisor of this thesis and master 's degree course, and Sang Hyun Suh and Joonho Chung, who directed the thesis.

It was really a great honor to me with severance and great teachers in the process of my graduating dissetation.

I think this dissertation will be a great opportunity to make another leap forward in the next steps, and I would like to once again thank everyone around me.

<TABLE OF CONTENTS>

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Radiographic and microsurgical characteristics of Proximal (A1) Segment Aneurysms of the Anterior Cerebral Artery

Chang ki Jang

Department of Medicine
The Graduate School, Yonsei University

(Directed by Professor Yong Bae Kim)

Background: Proximal A1 segment aneurysms of the anterior cerebral artery (ACA) radiologically resemble internal carotid artery bifurcation (ICBIF) aneurysms because of their anatomical proximity. However, proximal A1 aneurysms exhibit distinguishing features, relative to ICBIF aneurysms. We report our experience of managing proximal A1 aneurysms, then compare them to ICBIF aneurysms.

Methods: Among 2191 aneurysms treated between 2000 and 2016 in a single institution, we retrospectively reviewed 100 cases categorized as ICBIF or A1 aneurysms.We included aneurysms originating from the ICBIF and ACA, proximal to the anterior communicating artery (A1 segment) and divided them into two groups: proximal A1 ($n = 32$) and ICBIF ($n = 50$). If any portion of the aneurysm involved the ICBIF, it was classified as ICBIF. Aneurysms wholly located in the A1 segment were classified as proximal A1. Patient factors and angiographic factors were evaluated and compared.

Results: The proximal A1 group exhibited differences in aneurysm size ($p = 0.013$), posterior aneurysm direction ($p = 0.001$), and A1 perforators as incorporating vessels ($p = 0.001$). The proximal A1 group tended to rupture more frequently when the aneurysm was smaller (p = 0.046). One case of morbidity occurred in the proximal A1 group.

Conclusion: Compared to ICBIF aneurysms, proximal A1 aneurysms were smaller and directed posteriorly, with incorporating perforators. Because of these characteristics, it may be difficult to perform clipping with 360° view in microsurgical field. Therefore, when planning to treat proximal A1 aneurysms, different treatment strategies may be necessary, relative to those used for ICBIF aneurysms.

Key words : Aneurysm, Anterior Cerebral Artery; Intracranial Aneurysm; Carotid Artery, Internal;

Radiographic and microsurgical characteristics of Proximal (A1) Segment Aneurysms of the Anterior Cerebral Artery

Chang ki Jang

Department of Medicine
The Graduate School, Yonsei University

(Directed by Professor Yong Bae Kim)

I. INTRODUCTION

The A1 segment is defined as the segment of the anterior cerebral artery (ACA) between the internal carotid bifurcation artery (ICBIF, proximally) and the anterior communicating artery (distally). The A1 segment is further subdivided by location into proximal, middle, and distal sections;[1] the portion (one-third) of the A1 segment that is closest to the ICBIF is defined as the proximal A1 segment. Critically, proximal A1 segment aneurysms radiologically resemble ICBIF aneurysms; thus, before the introduction of 3D digital subtraction cerebral angiography (DSA), it was difficult to distinguish proximal A1 aneurysms from ICBIF aneurysms. Further, proximal A1 aneurysms are rare, comprising approximately 1–4% of all aneurysms,[2-4] and are anatomically located within a few millimeters of ICBIF aneurysms. (Figure 1) In a previous report, a proximal A1 was erroneously classified as an ICBIF aneurysm subtype.[5] However, these two aneurysms demonstrate markedly different features and surgical findings.[1]

Here, by reporting our experience in managing proximal A1 aneurysms, as well as comparing them to ICBIF aneurysms, we describe detailed characteristics of proximal A1 aneurysms.

II. MATERIALS AND METHODS

Patients

If a small segment of the aneurysm wall was involved with the ICBIF segment,it was defined as an ICBIF aneurysm, whereas if only the A1 segment was involved with the aneurysm, it was defined as an A1 aneurysm. Further, the proximal 1/3 of the A1 segment was defined as the proximal A1. (Figure 1)

From among 2191 aneurysms treated between 2000 and 2016, 100 aneurysms were enrolled that were either proximal A1 or ICBIF aneurysms. Among these, 82 aneurysms (Proximal A1 aneurysm, n=32; ICBIF aneurysm, n=50) were ultimately included in this study. The two group were clearly distinguishable by DSA. Eighteen aneurysms were excluded because of a lack of DSA images. Patient medical records and radiolographic data were retrospectively reviewed.

Treatment

Treatment criteria for unruptured intracranial aneurysms included (1) patients with symptoms, (2) patients whose age was <50 years old, (3) patients with aneurysms >5 mm, (4) patients with aneurysms exhibiting a daughter sac, (5) patients with prior subarachnoid haemorrhage, (6) patients with changes in aneurysm shape during the follow-up period, (7) patients with aneurysms <5 mm when an accompanying aneurysm at the ipsilateral surgical site also met treatment criteria. Treatment modality was selected based on characteristics of individual patients and aneurysms via interdisciplinary decision-making. Patient preferences for treatment were also considered. Various patient factors were evaluated, including age, sex, size, aneurysm direction, multiplicity, contralateral A1 hypoplasia, and clinical outcome. Morbidity was defined as a procedure-related and permanent disability that resulted in a modified Rankin Scale (mRS) score of >1.[6]

Statistical Analysis

Statistical analysis was performed using SPSS 18.0 (SPSS Inc., Chicago, IL, USA). Variables were expressed as mean ± SD or, number of patients (%), as appropriate. For univariate analysis, we used Student's t-test for continuous variables, and the χ^2 test for categorical variables. $P < 0.05$ was considered to be statistically significant.

III. RESULTS

Demographic and anatomical data comparing the proximal A1 group (males, seven; females, 25; mean age, 55 ± 11 years) with the ICBIF group (males, 17; females, 33; mean age, 51 ± 13 years) are summarized in Table 1.

Table 1. Comparison of the proximal A1 group with the ICBIF group

		Proximal A1(N=32)	**ICBIF(N=50)**	**P-value**
Age(yr,mean±SD)		55±11	51±13	
Rupture (%)		11(34.3%)	12(24%)	0.255
Female (%)		25(78.1%)	33(66%)	0.239
Multiplicity(%)		17(53.1%)	25(50%)	0.782
Aneurysm with dominant A1 (%)		14(43.7%)	19(38.7%)	0.604
Fetal type PCA(%)		11(34.3%)	9(19.3%)	0.092
Size(mm,mean±SD)		2.9±1.3	5.0±3.4	0.013
Location				0.001
	Superior	4(12.5%)	39(78 %)	
	Antero-Superior	3(9.3%)	5(10%)	
	Postero-Superior	8(25%)	4(8%)	
	Posterior	17(53.1%)	2(4%)	
Incorporationof Perforator		22(68.7%)	10(32.2%)	0.001
Morbidity*(procedure related)		1 (4)	0 (0)	

*: Infarction of caudate nucleus in one ruptured case

In the proximal A1 group, there were 11 ruptured and 21 unruptured aneurysms, whereas in the ICBIF group, there were 14 ruptured aneurysms and 36 unruptured aneurysms. Microsurgery was offered as a primary treatment in 89.0% of patients (73 of 82). The proximal A1 group showed a trend towards posterior aneurysm direction ($p = 0.001$), A1 perforators as incorporating vessels ($p = 0.001$), and differences in aneurysm size ($p = 0.013$), compared with the ICBIF group. The direction of proximal A1 aneurysms seemed to follow the direction of the perforating arteries in the surgical view. (Figure 1)

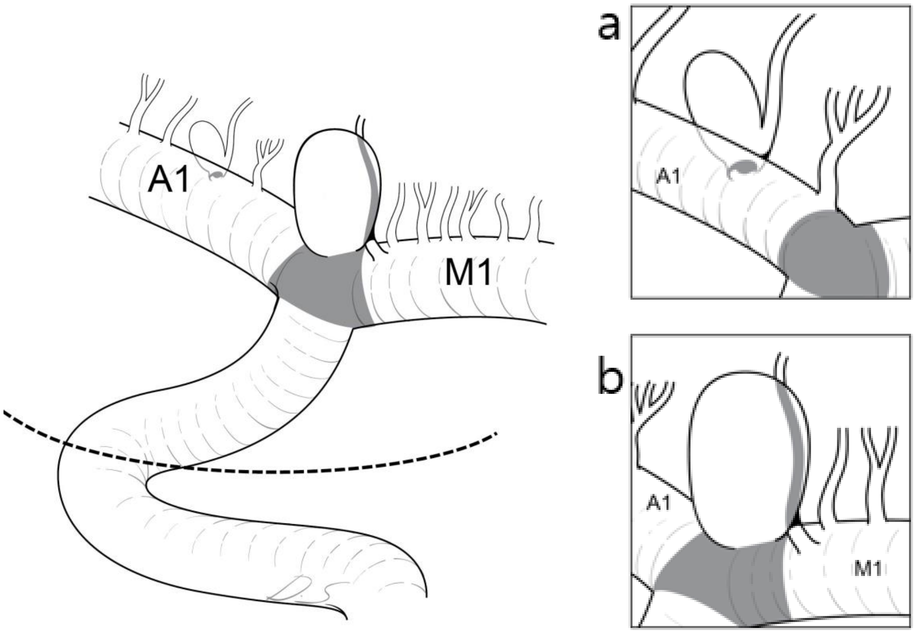

Figure 1. Schematic diagram of (a) a proximal A1 aneurysm and (b) an ICBIF aneurysm
ICBIF : internal carotid bifurcation

: Proximal A1 aneurysms originate from the ICBIF and ACA proximal to the anterior communicating artery. They are defined as such because their necks do not involve the ICBIF lesion (gray-coloured area). Incorporated perforating arteries in proximal A1 aneurysms mostly originated from the posterior aspect of the ACA trunk (a). However, perforating vessels in the ICBIF group adhered to the posterior aspect of the dome (b).

There was no significant difference in hypoplasia of the contralateral A1 or in multiplicity between proximal A1 aneurysms and ICBIF aneurysms ($p = 0.604$ and $p = 0.782$, respectively). In cases with ruptured aneurysms, proximal A1 aneurysms (mean size, 3.3 ± 0.9 mm) were smaller than ICBIF aneurysms (mean size, 10.4 ± 4.8 mm) ($p = 0.046$, Table 2).

Table 2. Comparison of ruptured cases in the proximal A1 group and the ICBIF group

	A1 an. (n = 11)	**ICBIF an. (n = 12)**	**P-value**
Age (yrs, mean ± SD)	43 ± 12	52 ± 9	0.455
Female (%)	4 (42)	9 (75)	0.203
Size (mm, mean ± SD)	3.3 ± 0.9	10.4 ± 4.8	0.046
Aneurysm with dominant A1 (%)	7 (64)	6 (50)	0.660
Incorporating vessel (%)	8 (72)	3 (25)	0.030
Multiplicity (%)	3 (27)	7 (58)	0.387
Direction of dome (%)			0.002
posterior	9 (82)	1 (8)	
superior	2 (18)	8 (67)	
others	0 (0)	3 (25)	

Ruptured proximal A1 aneurysms were more frequently associated with perforating vessels than ruptured ICBIF aneurysms (72% in the proximal A1 group, 25% in the ICBIF group, p = 0.030). We encountered one case of morbidity in the proximal A1 group, which consisted of post-operative basal ganglia infarction that resulted in hemiparesis.

During endovascular treatment, nine patients with ICBIF aneurysms were treated by coil embolization (five cases of ICBIF, four cases of proximal A1). Balloon-assisted coil embolization was performed in two cases (one ICBIF, one Proximal A1). Other cases were treated with simple coil embolization. We did not encounter complications.

Illustrated Case

A 59-year-old woman was examined for headache. Computed tomography imaging showed no subarachnoid hemorrhage. Cerebral angiography revealed an unruptured left proximal A1 aneurysm. (Figure 2) The aneurysm projected posteriorly and had many perforators, including the anterior choroidal artery (AchA). (Figure 2 A,B)

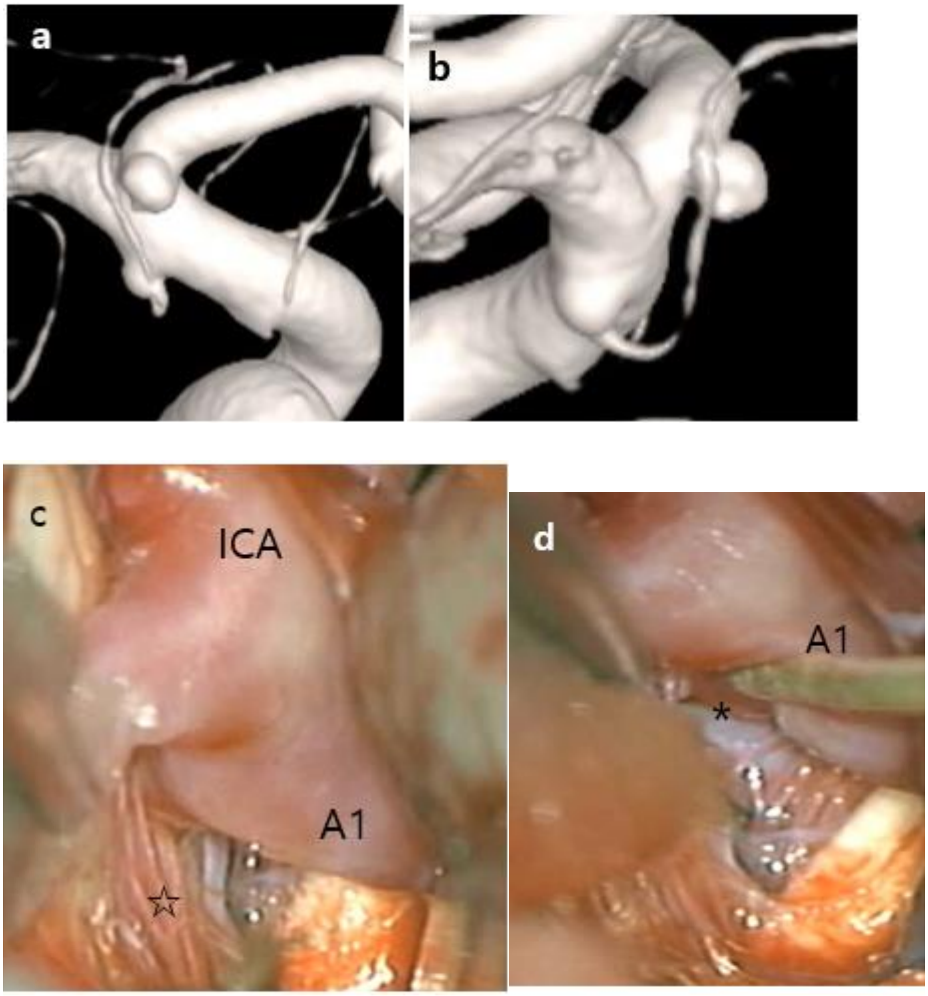

Figure 2. Illustrative patient

Posterior view(a) and Lt lateral view(b) of Cerebral angiography 3D rotation showed aneurysm directed posterior projection.Intra operative view,Many perforators(☆) were detected near Proximal A1.Aneurysm was coverd by A1 totally(c). A1 was retracted by using dissector.But only small portion of aneurysm could be seen.(d)

The patient was placed in a supine position with her head turned to the right side, approximately 45 degrees; then, we performed pterional craniotomy. In the operative view, there were many perforators, including the AchA and A1 perforator, which were covered by the arachnoid membrane.We gently dissected the arachnoid membrane and all perforators until the aneurysm tip was seen in the operative field. However, the aneurysm was obscured by the parent A1 artery. To clearly see the aneurysm, the proximal A1 was retracted using a micro dissector, but only a small portion of aneurysm could be seen. Following careful dissection around the aneurysm, a Yasargil right-angle 5-mm clip was applied during aneurysm retraction, using the micro dissector. Perforators remained intact without kinking, as checked by mirror. Indocyanine green (ICG) was used to check for flow restriction; no restriction was found. In the postoperative period, the patient exhibited no neurological deficit.

IV. DISCUSSION

In our study, distinguishing characteristics of proximal A1 aneurysms were smaller aneurysm size at time of rupture, posterior aneurysm direction, and aneurysmal neck incorporation of perforating vessels; these differences require treatment using a variety of surgical and endovascular strategies.

Proximal A1 aneurysm is likely to be confused with an ICBIF aneurysm, as they are almost identical in position, a few millimeters apart. We attempted to identify these differences and charcateristics through a comparision of the two groups. Notably, the proximal A1 aneurysm is rare, and exhibits several unique characteristics, including presence in patients of relatively young age, associated with vascular abnormality, and multiplicity [7-10].

Proximal A1 aneurysms tended to rupture frequently at smaller sizes ($p = 0.046$, Figure 2). Previous studies have stated that small aneurysms (<5 mm in diameter) should be managed conservatively [11-13]; however, we found that proximal A1 aneurysms ruptured even at these small sizes. Further, the mean size of proximal A1 artery aneurysms is smaller than aneurysms in other locations [4,10,14,15]. The cause of increased risk for rupture of small proximal A1 aneurysms is not clearly understood. We suspect that the necks of many proximal A1 aneurysms may incorporate small perforating arteries [8,10] (Figure 1), and that the relatively large size of the aneurysm, compared to the thin perforating vessels, could induce increased hemodynamic forces and vessel wall changes,[16] as intracranial arteries exhibit thinner adventitia and fewer elastic fibers in the tunica media, compared with extracranial arteries.[17] Therefore, we speculated that the association between aneurysm neck and incorporation of small perforating arteries may explain why small proximal A1 aneurysms tend to rupture more frequently.

Aneurysms with familial background have been reported to rupture at a younger patient age and a smaller aneurysm size.[18-20] The overall percentage of aneurysm patients with relatives who had experienced subarachnoid haemorrhage was reported as 9–20%.[21,22] Relatively young age in the patients with ruptured proximal A1 aneurysms (43.5 ± 11.5 years) suggests a genetic component to the rupture risk,[21,23] and indicates that congenital factors may be associated with the onset of aneurysms.[23] Moreover, Lazzaro reported that patients who have congenital anomalies of the circle of Willis may be higher risk for aneurysm rupture[24]. In our study, there were 14 patients with contralateral hypoplasia of A1 (43.7%) in the proximal A1 group, compared with 12 (24%) in the ICBIF group, which agrees with other reports that proximal A1 aneurysms tend to be associated with other vascular anomalies.[25-28] Dome projecting direction was significantly different between the two groups ($P < 0.001$). Superior direction was dominant in the ICBIF group, whereas posterior direction was dominant in the proximal A1 group. In the operative view, ICBIF aneurysms were clipped easily, because main artery trunk and branch could be easily identified. In contrast, proximal A1 aneurysms were covered by the A1 main trunk, particularly around the neck portion (Figure 1A), which posed a challenge during complete clipping.

The overall rate of procedure-related complications in proximal A1 and ICBIF aneurysms was low, with only one complication. That particular patient exhibited a drowsy mentality and showed Fisher grade III subarachnoid hemorrhage, due to the ruptured proximal A1 aneurysm. During the operation, a perforator was seen immediately adjacent to the aneurysm neck; the perforator was dissected carefully and clipped without injury. However, cerebral infarction of the caudate nucleus and basal ganglia area occurred, resulting in hemiparesis, perhaps because of the perforating vessel kinking. We did not encounter any cases of mortality.

As seen in the complicated case, proximal A1 aneurysm demonstrates many perforators, including the medial lenticulostriatal artery and the recurrent artery of Heubner, because of its posterior projection. Most perforating arteries are not visible on DSA;[15] however, in the operative view, perforating arteries were identified that mostly originated from the posterior aspect of the ACA trunk, as seen in other studies.[2,3,7,10,14,29] Kedia et al. reported that all A1 segment perforators arose mostly from the posterosuperior surface and rarely from the inferior surface; further, the number of perforators ranged from 3–7 (mean, 4.5) and the sizes of these perforators ranged from 1.5–3 mm (mean diameter, 2.3 mm).[30] Thus, many proximal A1 aneurysms incorporated perforators and were surrounded by perforators. As these perforators supply the thalalamus, the anterior limb of the internal capsule, and the anteroinferior part of the striatum, a neurosurgeon should carefully preserve them during clipping to avoid perforator infarction.

Surgery

Because of its posterior direction, proximal A1 aneurysms are obscured by the parent artery (A1) in the operating view. Typically, the aneurysm dome was invisible, but could be visualized by retracting the parent A1 vessel (Figure 2). In some cases, we performed clipping without full visualization of the neck. In those cases, we determined preservation of the perforating artery by transcranial doppler ultrasonography, intraoperative neurophysiological monitoring (MEP,SSEP), fluorescent-like ICG angiography with microscopy, and intraoperative endoscopy. The intraoperative endoscope is a very promising modality to detect kinking or sacrifice of the perforator, using the highly magnified field view. Particularly when used with angled endoscopy of 30 or 60 degree view, we were able to visualize neck and perforator status after clipping. Moreover, blind points could be clearly seen with endoscopy. Thus, this modality was essential and effective for checking the complete clipping of proximal A1 aneurysms. Additionally, it is not good to have excessively long clip blade due to narrow space and limited visibility. Preparing for surgery, 3D DSA was also very helpful. In the operating view on 3D DSA, the degree of head rotation to the opposite side could be measured. Chaddad et al. reported better visualization of the ICA bifurcation site following a mean rotation of 8 degrees (range, 6–10) and a mean extension of 15 degrees (range, 9–20).[31] However, in proximal A1 aneurysms, patient heads were rotated to a greater extent, similar to preparation for posterior communicating artery aneurysms, because of the posterior direction of the proximal A1 aneurysm.

An A1 temporal clip could be used when the patency of the anterior communicating artery was good. The proximal half of the A1 was a richer in perforating arteries than the distal half,[32] which allowed clear identification of the A1 distal portion and dissection for temporal clipping. Without these procedures, temporally clipping the proximal A1 can cause perforator injury.

There are several limitations to this study. First, it is retrospective and cannot overcome possible selection bias, compared with an equally matched control group. Two neurosurgeons and two interventionists made surgical decisions on a case-by-case basis, following our own management protocols; notably, no randomization was performed. Second, the study included only a small number of patients, which may limit its power because of the rarity of proximal A1 aneurysms. If a larger group of patients were studied, a different array of distinctive characteristics of proximal A1 aneurysms may have been determined.

V. CONCLUSION

Compared to ICBIF aneurysms, proximal A1 aneurysms were small in size and were directed posteriorly, with incorporating perforators. Because of the posterior direction and A1 perforators, it may be difficult to perform clipping with 360° view in the microsurgical field. Therefore, when planning to treat proximal A1 aneurysms, it might be beneficial to apply different treatment strategy, rather than simply employing those used for ICBIF aneurysms. Despite their anatomical proximity, therefore, it might be beneficial to utilize different approaches to treat proximal A1 aneurysms and ICBIF aneurysms.

REFERENCES

1. Bhaisora KS, Behari S, Prasadh G, Srivastava AK, Mehrotra A, Sahu RN, et al. A I-segment aneurysms: management protocol based on a new classification. Neurol India 2014;62:410-6.
2. Handa J, Nakasu Y, Matsuda M, Kyoshima K. Aneurysms of the proximal anterior cerebral artery. Surg Neurol 1984;22:486-90.
3. Suzuki M, Onuma T, Sakurai Y, Mizoi K, Ogawa A, Yoshimoto T. Aneurysms arising from the proximal (A1) segment of the anterior cerebral artery. A study of 38 cases. J Neurosurg 1992;76:455-8.
4. Wakabayashi T, Tamaki N, Yamashita H, Saya H, Suyama T, Matsumoto S. Angiographic classification of aneurysms of the horizontal segment of the anterior cerebral artery. Surg Neurol 1985;24:31-4.
5. Sakamoto S, Ohba S, Shibukawa M, Kiura Y, Okazaki T, Arita K, et al. Characteristics of aneurysms of the internal carotid artery bifurcation. Acta Neurochir (Wien) 2006;148:139-43; discussion 43.
6. van Swieten JC, Koudstaal PJ, Visser MC, Schouten HJ, van Gijn J. Interobserver agreement for the assessment of handicap in stroke patients. Stroke 1988;19:604-7.
7. Hino A, Fujimoto M, Iwamoto Y, Oka H, Echigo T. Surgery of proximal anterior cerebral artery aneurysms. Acta Neurochir (Wien) 2002;144:1291-6; discussion 6.
8. Wanibuchi M, Kurokawa Y, Ishiguro M, Fujishige M, Inaba K. Characteristics of aneurysms arising from the horizontal portion of the anterior cerebral artery. Surg Neurol 2001;55:148-54; discussion 54-5.
9. Park HS, Choi JH, Kang M, Huh JT. Management of aneurysms of the proximal (A1) segment of the anterior cerebral artery. J Cerebrovasc Endovasc Neurosurg 2013;15:13-9.
10. Lee JM, Joo SP, Kim TS, Go EJ, Choi HY, Seo BR. Surgical management of anterior cerebral artery aneurysms of the proximal (A1) segment. World Neurosurg 2010;74:478-82.
11. Juvela S, Porras M, Poussa K. Natural history of unruptured intracranial aneurysms: probability of and risk factors for aneurysm rupture. J Neurosurg 2008;108:1052-60.
12. Wiebers DO, Whisnant JP, Huston J, 3rd, Meissner I, Brown RD, Jr., Piepgras DG, et al. Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment. Lancet 2003;362:103-10.
13. Morita A, Kirino T, Hashi K, Aoki N, Fukuhara S, Hashimoto N, et al. The natural course of unruptured cerebral aneurysms in a Japanese cohort. N Engl J Med 2012;366:2474-82.
14. Dashti R, Hernesniemi J, Lehto H, Niemela M, Lehecka M, Rinne J, et al. Microneurosurgical management of proximal anterior cerebral artery

aneurysms. Surg Neurol 2007;68:366-77.
15. Cho YD, Ahn JH, Jung SC, Kim CH, Kang HS, Kim JE, et al. Coil embolization in precommunicating (A1) segment aneurysms of anterior cerebral artery. Neuroradiology 2014;56:219-25.
16. Kataoka K, Taneda M, Asai T, Kinoshita A, Ito M, Kuroda R. Structural fragility and inflammatory response of ruptured cerebral aneurysms. A comparative study between ruptured and unruptured cerebral aneurysms. Stroke 1999;30:1396-401.
17. Wilkinson IM. The vertebral artery. Extracranial and intracranial structure. Arch Neurol 1972;27:392-6.
18. Leblanc R, Melanson D, Tampieri D, Guttmann RD. Familial cerebral aneurysms: a study of 13 families. Neurosurgery 1995;37:633-8; discussion 8-9.
19. Schievink WI, Schaid DJ, Michels VV, Piepgras DG. Familial aneurysmal subarachnoid hemorrhage: a community-based study. J Neurosurg 1995;83:426-9.
20. Ronkainen A, Hernesniemi J, Tromp G. Special features of familial intracranial aneurysms: report of 215 familial aneurysms. Neurosurgery 1995;37:43-6; discussion 6-7.
21. Brown RD, Jr., Broderick JP. Unruptured intracranial aneurysms: epidemiology, natural history, management options, and familial screening. Lancet Neurol 2014;13:393-404.
22. Bor AS, Rinkel GJ, van Norden J, Wermer MJ. Long-term, serial screening for intracranial aneurysms in individuals with a family history of aneurysmal subarachnoid haemorrhage: a cohort study. Lancet Neurol 2014;13:385-92.
23. Broderick JP, Brown RD, Jr., Sauerbeck L, Hornung R, Huston J, 3rd, Woo D, et al. Greater rupture risk for familial as compared to sporadic unruptured intracranial aneurysms. Stroke 2009;40:1952-7.
24. Lazzaro MA, Ouyang B, Chen M. The role of circle of Willis anomalies in cerebral aneurysm rupture. J Neurointerv Surg 2012;4:22-6.
25. Maurer J, Maurer E, Perneczky A. Surgically verified variations in the A1 segment of the anterior cerebral artery. Report of two cases. J Neurosurg 1991;75:950-3.
26. Friedlander RM, Oglivy CS. Aneurysmal subarachnoid hemorrhage in a patient with bilateral A1 fenestrations associated with an azygos anterior cerebral artery. Case report and literature review. J Neurosurg 1996;84:681-4.
27. Taylor R, Connolly ES, Jr., Duong H. Radiographic evidence and surgical confirmation of a saccular aneurysm on a hypoplastic duplicated A1 segment of the anterior cerebral artery: case report. Neurosurgery 2000;46:482-4.
28. Kwon WK, Park KJ, Park DH, Kang SH. Ruptured saccular aneurysm

arising from fenestrated proximal anterior cerebral artery : case report and literature review. J Korean Neurosurg Soc 2013;53:293-6.

29. Czepko R, Libionka W, Lopatka P. Characteristics and surgery of aneurysms of the proximal (A1) segment of the anterior cerebral artery. J Neurosurg Sci 2005;49:85-95.
30. Kedia S, Daisy S, Mukherjee KK, Salunke P, Srinivasa R, Narain MS. Microsurgical anatomy of the anterior cerebral artery in Indian cadavers. Neurol India 2013;61:117-21.
31. Chaddad-Neto F, Doria-Netto HL, Campos-Filho JM, Ribas ES, Ribas GC, Oliveira E. Head positioning for anterior circulation aneurysms microsurgery. Arq Neuropsiquiatr 2014;72:832-40.
32. Perlmutter D, Rhoton AL, Jr. Microsurgical anatomy of the anterior cerebral-anterior communicating-recurrent artery complex. J Neurosurg 1976;45:259-72.

ABSTRACT(IN KOREAN)

근위부 전방 대뇌 혈관의 방사선학적 수술적 특성

<지도교수 김 용 배>

연세대학교 대학원 의학과

장 창 기

배경:전방 대뇌 혈관의 근위부 A1 부위의 동맥류는 그들의 해부학적 인접성으로 인해 영상학적으로 내경동맥분지부 동맥류와 유사성을 갖는다.그러나 근위부 A1의 동맥류는 내경동맥 분지부의 동맥류와는 특징적인 다른 특성을 가지고 있다.우리는 근위부 A1 동맥류의 치료에 대한 경험을 발표하고 이를 내경동맥 분지부의 동맥류와 비교하였다.

방법:2000년부터 2016년까지 단일 기관에서 치료 받은 2191 명의 동맥류에서 100명의 내경동맥분지부 동맥류 및 A1 동맥류를 분류 하였다.우리는 내경동맥 분지부와 전방교통 동맥의 근위부 까지의 기원을 갖는 동맥류를 포함 시켜 이를 두개의 그룹으로 나누었다.:근위부 A1(n=32) 와 내경동맥분지부(n=50).아주 일부의 내경동맥 분지부를 포함하면 이를 내경동맥분지부 동맥류로 분류하였다.완전히 A1만 포함한다면 근위부 A1 동맥류에 포함하였다.환자요인과 혈관조영술적 요인이 평가되고 비교되었다.

결과:근위부 A1 그룹이 크기의 차이(p=0.013),뒤쪽 방향성(p=0.001) 그리고 A1 관통동맥의 연관 여부(p=0.001)의 차별점을 보여주었다.근위부 A1 그룹이 좀 더 작을 때 터지는 경향성을 보여주었다.(p=0.046) 근위부 A1 그룹에서 한 케이스의 합병증이 발생하였다.

결론:내경동맥분지부 동맥류와 비교하여 근위부 A1 동맥류는 작고 뒤쪽을 향하는 경향성을 보이고 연관된 관통동맥을 갖는 경우가 있습니다.이런 특성으로 인해 수술장에서 전장의 동맥류를 확인하는 것은 어렵다.그래서 근위부 A1 동맥류의 치료를 결정할때는 내경동맥 분지부의 동맥류 치료의 방식과는 다른 치료 접근 방식이 필요하다.

핵심되는 말 :뇌동맥류,전대뇌동맥,두개내 동맥류0