Microneurosurgical Management of Posterior Communicating Artery Aneurysm: A Contemporary Series from Helsinki

Peeraphong Thiarawat[1,2], Behnam Rezai Jahromi[1], Danil A. Kozyrev[1,4], Patcharin Intarakhao[1,3], Mario K. Teo[5], Joham Choque-Velasquez[1], Juha Hernesniemi[1]

■ OBJECTIVE: **The objectives of this study were to analyze microsurgical techniques and to determine correlations between microsurgical techniques and the radiographic findings in the microneurosurgical treatment of posterior communicating artery aneurysms (PCoAAs).**

■ METHODS: **We retrospectively analyzed radiographic findings and videos of surgeries in 64 patients with PCoAAs who underwent microsurgical clipping by the senior author from August 2010 to 2014.**

■ RESULTS: **From 64 aneurysms, 30 (47%) had acute subarachnoid hemorrhage (SAH) that necessitated lamina terminalis fenestration (odds ratio [OR], 67.67; $P < 0.001$) and Liliequist membrane fenestration (OR, 19.62; $P < 0.001$). The low-lying aneurysms significantly necessitated the coagulation of the dura covering the anterior clinoid process (ACP) (OR, 7.43; $P = 0.003$) or anterior clinoidectomy (OR, 91.0; $P < 0.001$). We preferred straight clips in 45 (83%) of 54 posterolateral projecting aneurysms (OR, 45.0; $P < 0.001$), but preferred curved clips for posteromedial projecting aneurysms (OR, 6.39; $P = 0.008$). The mean operative time from the brain retraction to the final clipping was 17 minutes and 43 seconds. Postoperative computed tomography angiography revealed complete occlusion of 60 (94%) aneurysms. Three (4.6%) patients with acute SAH suffered postoperative lacunar infarction.**

■ CONCLUSIONS: **For ruptured aneurysms, lamina terminalis and Liliequist membrane fenestration are useful for additional cerebrospinal fluid drainage. For low-lying aneurysms, coagulation of the dura covering the ACP or tailored anterior clinoidectomy might be necessary for exposing the proximal aneurysm neck. Type of clips depends on the direction of projection. The microsurgical clipping of the PCoAAs can achieve good immediate complete occlusion rate with low postoperative stroke rate.**

INTRODUCTION

Internal carotid artery (ICA) posterior communicating artery aneurysms (PCoAAs) are among the most common intracranial aneurysms. Three randomized controlled trials comparing clipping and coiling for securing ruptured cerebral aneurysms have been conducted,[1-3] and 2 showed that coiling resulted in better clinical outcomes in the short term.[2,3] Furthermore, the outcome differences become more statistically significant in favor of endovascular treatment for posterior circulation aneurysms because of the complex cerebrovascular anatomy, depth of lesion, presence of multiple perforators, which are not well visualized, and therefore higher risk associated with open surgery.[3] Some studies classified PCoAAs as posterior circulation

Key words
- Microneurosurgical treatment
- Operative technique
- Posterior communicating artery aneurysm
- Radiographic finding

Abbreviations and Acronyms
ACP: Anterior clinoid process
aSAH: Aneurysmal subarachnoid hemorrhage
CA: Contralateral approach
CI: Confidence interval
CSF: Cerebrospinal fluid
ICA: Internal carotid artery
ICG: Indocyanine green
ICH: Intracerebral hematoma
OR: Odds ratio
PCoA: Posterior communicating artery
PCoAA: Posterior communicating artery aneurysm
TC: Temporary artery clipping

From the [1]Department of Neurosurgery, Helsinki University Hospital, Helsinki, Finland; Departments of [2]Surgery and [3]Anesthesiology, Naresuan University, Phitsanulok, Thailand; [4]Department of Neurosurgery, North-Western State Medical University, Saint Petersburg, Russia; and [5]Department of Neurosurgery, Bristol Institute of Clinical Neuroscience, North Bristol University Hospital, Bristol, United Kingdom.

To whom correspondence should be addressed: Peeraphong Thiarawat, M.D. [E-mail: peeraphongt@gmail.com]

Supplementary digital content available online.

Citation: World Neurosurg. (2017) 101:379-388.
http://dx.doi.org/10.1016/j.wneu.2017.02.033

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

aneurysms,[4] and the subgroup analysis of the International Subarachnoid Aneurysm Trial showed that endovascularly treated patients with PCoAAs have a lower risk ratio of death or dependency at 1 year (relative risk, 0.56; 95% confidence interval [CI], 0.43–0.72).[5] However, in the Barrow Ruptured Aneurysm Trial study, where PCoAAs were categorized in anterior circulation aneurysms, there was no significant difference in the outcomes of anterior circulation aneurysms between the 2 assigned groups across various time points (at discharge and 6 months, 1 year, or 3 years after treatment). A subsequent follow-up study of the International Subarachnoid Aneurysm Trial also showed that PCoAAs that were treated endovascularly were associated with more retreatments compared with aneurysms at other locations, and also compared with PCoAAs treated by open surgery.[6] Therefore, there is ongoing controversy about the best management for PCoAAs.

In addition, outcomes of microsurgical clipping have improved in the last decade because of centralization of the open vascular cases to specialist centers and the development of electrophysiologic monitoring and indocyanine green (ICG) videoangiography. Furthermore, endovascular treatment might not be feasible in some situations, such as very small aneurysms, giant aneurysms, and complex aneurysms.

In the modern era of open surgery, we believe in the "clean, fast, and preserving normal anatomy" philosophy.[7] Therefore, microneurosurgeons should be well-trained, efficient, and only perform the inevitable steps to achieve surgical aims.

The objectives of this study are 1) to present the microneurosurgical techniques of a contemporary series of open surgery for PCoAAs; 2) to analyze the operative techniques, anatomy of PCoAAs, and parent vessels from computed tomography angiography and intraoperative findings; and 3) to determine the correlations between operative techniques and preoperative radiographic findings.

METHODS

Patients

With local ethics committee approval, this study was limited from 2010 onward because of the presence of full-length microsurgery videos for the purpose of review. After excluding 3 reoperative cases, all the remained 58 patients (harboring 64 PCoAAs) who underwent primary microsurgical clipping by a single surgeon at Helsinki University Hospital from August 2010 to 2014 were included.

Radiographic Study

All radiographic studies were available for review from the hospital's digital archiving system (IMPAX, version 6.5.5.1608 [Agfa, Mortsel, Belgium]). We recorded aneurysm characteristics, the diameter of the ICA and the posterior communicating artery (PCoA), and its anatomic variations. Low-lying PCoAAs were defined as aneurysms with their proximal neck located below the level of the tip of the anterior clinoid process (ACP). In ruptured aneurysms, we recorded the Fisher grade, size, and location of the hematoma. The volume of the intracerebral hematoma (ICH) was calculated using the following equation: $abc/2$, where a, b, and c are the 3 major diameters of the hematoma. Postoperative infarction was determined by review of immediate and delayed computed tomography scans, whereby persistent white matter hypodensity was recorded as postoperative territory or lacunar infarct.

Microsurgery Video Study

All 64 videos with recordings from dural opening to dural closure were reviewed. Key surgical steps deemed necessary for PCoAA clipping were carefully analyzed, including detailed description of clip occlusion techniques. The operative time was recorded from the start of brain retraction until final clip deployment after securing the aneurysms, and confirmed on ICG.

Statistical Analyses

We used SPSS version 22.0.0 (IBM SPSS Statistics for Macintoch, Version 22.0. Armonk, New York: IBM corp) for statistical analyses. For univariate analysis, Student t test was used for comparison of means in parametric continuous variables. For categorical variables, χ^2 test was used. We used Mann-Whitney U test for nonparametric variables. A probability value <0.05 was considered statistically significant.

RESULTS

Patients

Our study population was comprised of 64 PCoAAs in 58 patients, with a median age of 60.5 years (range, 21–81 years). Of these, 8 patients were men, and 50 patients were women. Aneurysms were located on the left side in 19 cases, located on the right side in 33 cases, and bilateral in 6 cases.

Radiographic Study

Aneurysmal Subarachnoid Hemorrhage and ICH. Thirty of the 64 aneurysms (47%) in our study group presented with aneurysmal

Table 1. Anatomic and Radiologic Parameters of 64 Aneurysms

Parameter	Ruptured Aneurysms (n = 31)	Unruptured Aneurysms (n = 33)	Total (N = 64)	*P* Value
Aneurysm neck (mm)	3.4 (1.7–7.7)	3.0 (1.4–8.3)	3.1 (1.4–8.3)	0.152
Aneurysm dome (mm)	6.1 (2.3–16.8)	4 (2.0–14.10)	5.3 (2.0–16.8)	0.006
Dome-to-neck ratio	1.9 (0.9–3.8)	1.4 (0.3–6.0)	1.6 (0.3–6.0)	0.055
Diameter of the ICA (mm)	3.2 (2.0–4.2)	3.2 (2.0–5.8)	3.2 (2.0–5.8)	0.731
Diameter of the PCoA (mm)	1.4 (0–2.0)	1.1 (0–2.3)	1.3 (0–2.3)	0.123
Distance from ICA origin to proximal aneurysm neck (mm)	3.3 (1.1–8.3)	3.6 (1.2–6.9)	3.4 (1.1–8.3)	0.464
Distance from distal aneurysm neck to ICA-M1 junction (mm)	4.4 (1.2–7.5)	5 (0.5–8.2)	4.9 (0.5–8.2)	0.506

Values are presented as median (range) or as otherwise indicated.
ICA, internal carotid artery; PCoA, posterior communicating artery; M1, sphenoidal segment of middle cerebral artery.