Microsurgical Treatment of Posterior Cerebral Circulation Aneurysms Via Keyhole Approaches

Qing Lan, Qing Zhu, Guowei Li

■ OBJECTIVE: **To explore the techniques of microsurgical treatment for posterior cerebral circulation aneurysms via keyhole approaches and assess its feasibility.**

■ METHODS: **A total of 27 patients with 28 posterior cerebral circulation aneurysms were treated surgically by keyhole approaches; 24 patients presented with subarachnoid hemorrhage and 3 with headache. Of these 27 patients, 15 patients were treated via the supraorbital keyhole approach, 6 via the retrosigmoid keyhole approach, 3 via the subtemporal keyhole approach, 2 via median suboccipital approach, and 1 via the pterional keyhole approach.**

■ RESULTS: **Of the 28 posterior cerebral circulation aneurysms, 24 aneurysms were clipped and 4 trapped; 23 aneurysms clipped completely, and 1 had residual aneurysm. Glasgow Outcome Scores at discharge revealed 25 patients had a good recovery; 1 patient was slightly disabled, and 1 patient was severely disabled. Of 15 patients treated via the supraorbital keyhole approach, to make a wider operative space, drilling of anterior clinoid process (2 patients) and posterior clinoid process (3 patients) was performed; posterior communicating artery was cut off (1 patient). For 3 patients with multiple aneurysms, complete occlusion was achieved via the same approach at one-stage.**

■ CONCLUSIONS: **Individualized keyhole approaches for posterior cerebral circulation artery aneurysms are safe and effective. The anterior clinoid process or posterior clinoid process could be drilled to offer a wide operative space for clipping. The use of multiple working windows is very helpful for controlling the parent artery and clipping the aneurysm.**

INTRODUCTION

The management of posterior circulation aneurysm remains challenging to neurosurgeons because of its deep location, difficult exposure, numerous surrounding cranial nerves and perforators, narrowness of surgical field, and limited space to operate. Great advances have been gained in surgery for posterior circulation aneurysms as the result of the skull base approach, which could reduce brain retraction, shorten distance, and enlarge the working space. The keyhole approach is one kind of skull base approach that avoids unnecessary destruction and exposure of the brain and preserves the required manipulating space, or the "key hole" part. Because of its narrow space, the internal structure feature is an unchangeable aspect regardless of the size of the bone window outside. The bone window for posterior circulation aneurysms could reach the size of the keyhole space via effective preoperative approach design.

Reisch and Perneczky (12) first reported the supraorbital keyhole approach for posterior circulation aneurysm clipping in 2005. We also demonstrated its feasibility through related anatomic studies (10). The classic example of a keyhole approach is supraorbital, which is used widely in sellar tumor resection and anterior circulation aneurysm clipping (1, 3, 6, 8, 11, 13). At that time, we fully opened cisterns to clean off subarachnoid hematocele and to observe posterior circulation by opening the interpeduncular cistern. Here, we report the results of our use of the

Key words
- Intracranial aneurysm
- Keyhole approach
- Posterior circulation

Abbreviations and Acronyms
BA: Basilar artery
DSA: Digital subtraction angiography
MCA: Middle cerebral artery
PCA: Posterior cerebral artery
PICA: Posterior inferior cerebellar artery
SAH: Subarachnoid hemorrhage
VA-PICA: Vertebral artery-posterior inferior cerebellar artery

Department of Neurosurgery, Second Affiliated Hospital of Soochow University, Suzhou, Jiangsu Province, P. R. China

To whom correspondence should be addressed: Prof. Qing Lan, M.D., Ph.D. [E-mail: szlq006@163.com]

Citation: World Neurosurg. (2015) 84, 6:1758-1764.
http://dx.doi.org/10.1016/j.wneu.2015.07.046

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

keyhole approach in 27 patients with posterior circulation aneurysms after sufficient preoperative preparation.

PATIENTS AND METHODS

A total of 27 patients with 28 posterior circulation aneurysms (14 male, 13 female), ranging in age from 16 to 78 years (mean, 50.9 years) were treated surgically via the keyhole approach. Twenty-four patients presented with subarachnoid hemorrhage (SAH) and 3 with headache; 2 were Hunt and Hess grade I, 9 were grade II, 10 were grade III, and 3 were grade IV. Of these 28 aneurysms, 25 were small aneurysms (<1.0 cm), 1 was a macroaneurysm (>1.5 cm to <2.5 cm), and 2 were giant thrombotic aneurysms (>2.5 cm).

A total of 15 patients were treated via the supraorbital keyhole approach (6, 10), including 9 basilar artery (BA) aneurysms (8 patients harboring 9 aneurysms), 4 BA—superior cerebellar artery aneurysms, 2 posterior cerebral artery (PCA) aneurysms (1—2 segments), and 1 PCA—BA—superior cerebellar artery aneurysm. Of these 15 patients, 2 patients underwent early-phase surgery (within 3 days after SAH), 8 patients underwent mid-phase surgery (4—14 days after SAH), 4 patients underwent surgery 2 weeks later, and 1 patient with an unruptured aneurysm underwent surgery at the same stage, whereas the ruptured middle cerebral artery (MCA) aneurysm was clipped 5 days after SAH.

Six patients were treated via the retrosigmoid keyhole approach (6, 9); all were posterior inferior cerebellar arteries (vertebral artery [VA]-PICA) aneurysms. Of these 6 patients, 4 underwent early-phase surgery after SAH, 1 underwent mid-phase surgery, and 1 patient had an unruptured aneurysm.

3 patients with PCA 2—3 segment aneurysms were treated via a subtemporal keyhole approach (6, 7). One patient underwent surgery 8 days after SAH, and 2 patients who presented headache were diagnosed as giant thrombotic aneurysms and were treated successfully.

Two patients with PICA aneurysms were managed via the median suboccipital keyhole approach (6); surgery was performed the day after SAH and 11 days later, respectively.

One patient was managed via the pterional keyhole approach (16). The patient had a PCA aneurysm rupture combined with anterior choroidal artery aneurysm 1 year after a clipping was performed for a posterior communicating artery aneurysm. We chose the pterional keyhole approach to explore the clipped posterior communicating artery aneurysm (pointing backward).

Digital subtraction angiography or computed tomography angiography was performed within 1 month after operation to investigate clinical effects.

RESULTS

Of 27 patients with 28 posterior cerebral circulation aneurysms, aneurysm clipping was used in 24 patients, and trapping was applied in 4 patients. Postoperative angiographs showed complete clipping was achieved in 23 patients, and 1 patient had residual aneurysm. Glasgow Outcome Score at discharge showed 25 patients had good recovery; 1 patient had slight disability, and 1 patient had severe disability.

Of 15 patients treated via the supraorbital keyhole approach, to create a wider operative space, we drilled the anterior clinoid process in 2 patients (Figure 1) and the posterior clinoid process in 3 patients (Figure 2); the posterior communicating artery was cut off in 1 patient. Aneurysms were clipped in 14 patients (15 aneurysms); 1 patient (Hunt and Hess grade IV) regained consciousness and had mild disability postoperatively; trapping was applied in 1 patient (PCA aneurysm) for a giant intraluminal thrombus and good collateral circulation. This patient (Hunt and Hess grade IV) regained consciousness and had severe disability postoperatively; ventricular drainage was applied in 1 patient for coagulation disorder and intraventricular hemorrhage. Complete occlusion was achieved in 3 patients with multiple aneurysms (anterior cerebral artery-A1segment aneurysm, middle cerebral artery aneurysm, ophthalmic artery aneurysm) via the same approach. One patient (with a BA aneurysm) was treated via 1-stage clipping after MCA rupture; the aneurysm was barely exposed because it deviated to contralateral side and was blocked by ipsilateral optic nerve (Figure 3).

Six patients were managed by the retrosigmoid keyhole approach (VA-PICA). Clipping was achieved in 5 patients and trapping in 1 patient with good collateral circulation. One macroaneurysm was clipped with 2 clips after an intraluminal thrombus was removed; 1 patient (Hunt and Hess grade IV) was in a moderate coma and had hydrocephalus preoperatively; aneurysm clipping was performed as well as bilateral ventricle drainage. The patient regained consciousness 2 days later and recovered eventually. One patient experienced mild posterior cranial nerve paralysis in the early stages after operation, and another patient had some residual aneurysm.

Three patients with PCA 2—3 segment aneurysms were managed via the subtemporal approach; 1 aneurysm was clipped (Figure 4), 2 giant thrombotic aneurysms were trapped before thrombectomy, and the collateral circulation of distal artery was good.

Two patients with distal PICA aneurysms (via the median suboccipital keyhole approach) and 1 patient with PCA aneurysm rupture combined with anterior choroidal artery aneurysm (via the pterional approach) were treated uneventfully and had a good recovery.

DISCUSSION

Minimally invasive intervention is used widely in the treatment of posterior cerebral circulation aneurysms because of the risks associated with an open surgical procedure; however, surgical clipping is still needed for the following reasons: 1) intracranial hematomas should be removed in the acute stages; 2) decompressive craniotomy should be performed in case of intracranial hypertension; 3) lesions should be resected in giant thrombotic aneurysms; 4) multiple aneurysms should be managed in a 1-stage operation; and 5) if an aneurysm ruptures during intervention, the procedures may be converted to surgical treatment. Improvement of operative outcomes while minimizing injury is the goal of modern neurosurgery. Keyhole neurosurgery is the combination of technical advances and concept of minimally invasive surgery. The microsurgical treatment of posterior cerebral circulation aneurysms via a keyhole approach could obtain satisfactory results through thorough preoperative planning and a full grasp of the indications.

Preoperative Planning

Surgical treatment for posterior cerebral circulation aneurysm often challenges neurosurgeons because of its deep-seated