Distal transsylvian keyhole approach for unruptured anterior circulation small aneurysms

Ririko Takeda1 · Hiroki Kurita1

Abstract
Background To reduce complications associated with conventional pterional craniotomy, a transsylvian keyhole approach for unruptured small anterior circulation aneurysms is proposed.
Methods A 7-cm linear scalp incision is made along the hairline, beginning at the zygoma, followed by minimal temporal muscle dissection. Two burr holes are drilled out at McCarty’s point and the temporal bone, and a 3-cm equilateral triangle bone flap is made, whose apex is located above the sylvian point. After the sphenoid ridge is drilled off, aneurysms are exposed and clipped with conventional microsurgical instruments.

Conclusions This approach permits access to aneurysms via the transsylvian corridor with a smaller area of potential injury of superficial structures.

Keywords Keyhole approach · Transsylvian approach · Cerebral aneurysm · Clipping

Introduction
In line with recent advances in endovascular surgery, the need for less invasive direct aneurysm surgery has been increasing. Some types of keyhole approaches have been developed as alternatives to the conventional pterional craniotomy. However, most reported approaches are via supraorbital or subfrontal routes [1, 3, 7] and have drawbacks including a narrow surgical corridor, need for special microsurgical instruments, and damage to the superior orbital nerve [4]. In this study, the surgical techniques and important factors that enable usual pterional conventional microsurgical manipulations for anterior-circulation aneurysms via a keyhole approach are described.

Relevant surgical anatomy
It is important to understand the running of a facial nerve for its preservation in this approach. At the axial level of the upper edge of the zygomatic arch, the mean distance between the anterior border of the tragus and the most posterior branch of the facial nerve is 15.3 mm (range, 11.0–22.9 mm; SD, 3.5 mm) [6]. The branches of the facial nerve that innervates the orbicularis and frontalis muscle are located in the surface of superficial layers of deep temporal fascia and cross at a mean...
distance of 40.4 mm (range, 35.2–45.6 mm; SD, 3.3 mm) above the lateral canthus of the eye [6]. The most posterior temporal branch to the frontalis muscle that intersected the superior temporal line is located a mean distance of 34.9 mm (range, 29.1–40.6 mm; SD, 4.4 mm) posterosuperior to the lateral canthus of the eye [6].

**Description of the technique**

**Craniotomy**

After injection of lidocaine to the supraorbital and infraorbital nerves as preemptive analgesia, the skin
incision is started at the level of the upper rim of the zygomatic arch and 2.0 cm anterior to the external acoustic meatus. The incision curves forward, passing 5 cm lateral from the lateral canthus of the eye, and ends at about 7 cm in length inside the hairline (Fig. 1a, b). This design of the skin incision contains a sufficient safety margin to avoid facial nerve injury. The temporal fascia is sharply cut, and subfascial dissection is performed, protecting the temporal branch of the facial nerve [2]. After the fascia is reflected anteriorly along with the skin flap (Fig. 1c), the temporal muscle is dissected—beginning at McCarty’s point from the temporal plane—by the retrograde dissection method [5], and the bulky temporal muscle is retracted laterally so as not to disturb visualization along the sphenoid ridge (Fig. 1d–f). The dissection needs no incision of temporal muscle. Two burr holes are drilled at McCarty’s point and in temporal bone (Fig. 1g), and the bone flap is removed (Fig. 1h). The sphenoid ridge is removed as in the conventional pterional approach. The dura mater is cut in a semi-arched shape and opened to a size of 30–40 mm (Fig. 1i).

Because of minimal preparation and dissection of bones and muscles, iatrogenic surgical trauma, cranial deformities, and temporal muscle atrophy are significantly decreased postoperatively (Fig. 6).

We use a perforator to shape the two burr holes in this approach as well as conventional pterional craniotomy, because it is a familiar and routine procedure for us. However, to minimize the further bone lost and avoid the use of calcium phosphates, the use of a drill instead of a perforator is recommended.

**Microsurgical technique**

In the microsurgical view, we can see the sylvian fissure at the center and the frontal and temporal lobes on both sides. The sylvian point [8], which is the confluence of three rami of the sylvian fissure and a suitable to start for opening the sylvian fissure because of the wide subarachnoid space, is included in the operative view. The sphenoid ridge is removed to the lateral edge of the superior orbital fissure. Therefore, we can see that this size of craniotomy provides sufficient working space and a familiar view for sharp dissection of the sylvian fissure from the sylvian point to the internal carotid cistern, equal to a conventional large pterional craniotomy (Fig. 2a–d).
Indications

Good candidates for this approach are selected patients with small unruptured aneurysms in the anterior circulation, which include: (1) all middle cerebral artery (MCA) bifurcation aneurysms (Fig. 3); (2) laterally and posteriorly projected internal carotid-posterior communication (IC-PC) aneurysms; (3) internal carotid-anterior choroidal (IC-AchoA) artery aneurysms (Fig. 5); (4) anteriorly projected anterior communicating (Acom) aneurysms (Fig. 4). For posteriorly projected IC-PC aneurysms, additional dissection of retrocarotid cisterns and temporal lobe retraction are necessary (anterior temporal approach). Anteriorly projected Acom aneurysms are also safely clipped with additional exposure and dissection of ipsilateral suprachiasmatic cisterns and the interhemispheric fissure. However, some superiorly or posteriorly projected Acom aneurysms require wide opening of the interhemispheric fissure, so that the conventional pterional approach is better for these aneurysms (Figs. 5 and 6).

Conversely, this technique is contraindicated for patients with ruptured aneurysms, complex aneurysms including large or partially thrombosed aneurysms, and those requiring removal of the anterior clinoid process or bypass.

Limitations

This approach provides the same clear anatomic exposure as the conventional pterional approach, and it provides a familiar view to neurosurgeons. The sylvian fissure is seen in the center of the surgical window. The approaches from the sylvian fissure to the carotid cisterns, suprachiasmatic cistern, and
interhemispheric cistern are the same as with the conventional
pterional approach, and the viewing angle along with the mi-
croscopic lighting is also equal to wide craniotomy.

The surgical procedure is carried out with conventional
microsurgical, bayonet-shaped short instruments, without spe-
cialized skills. No particular instruments and devices—for ex-
ample, a neuroendoscope to compensate for the limitation of
the visualization—are needed.

More severe brain traction is not needed in this approach.
As in the conventional pterional approach, wide opening of
the fissure and cisterns requires less brain traction in dissection
of the aneurysm.

However, the small size of the bone flap allows a more
limited angle of clip applier insertion.

How to avoid complications

The key point to overcoming the problem of the limited angle
of clip applier insertion is complete dissection of the aneurysm
complex from surrounding structures, which makes the aneu-
rysms ‘movable’ to permit changing their direction to that
most suitable for neck clipping.

Specific perioperative considerations

Certainly, this approach cannot be applied to all patients with
aneurysms. With careful evaluation of each patient for the
possibility of proximal control, direction of the aneurysm,
and application of the aneurysm clip, this approach should
constitute an effective craniotomy technique.

Specific information to give to the patient
about surgery and potential risks

This approach has a smaller area than the conventional
pterional approach, but results in a pleasing cosmetic outcome
while minimizing the likelihood of procedure-related
morbidity.

Compliance with ethical standards

Disclosures The authors report no conflict of interest concerning the
materials or methods used in this study or the findings specified in this
paper.

Informed consent The patients have consented to submission of this
“How I Do It” to the journal.

Open Access This article is distributed under the terms of the Creative
Commons Attribution 4.0 International License (http://
creativecommons.org/licenses/by/4.0/), which permits unrestricted use,
distribution, and reproduction in any medium, provided you give
appropriate credit to the original author(s) and the source, provide a link
to the Creative Commons license, and indicate if changes were made.

References

1. Cheng WY, Lee HT, Sun MH, Shen CC (2006) A pterion keyhole
approach for the treatment of anterior circulation aneurysms. Minim
Invasive Neurosurg 49:257–262
2. Coscarella E, Vishteh G, Spetzler RF, Seoane E, Zabramski JM
(2000) Subfascial and submuscular methods of temporal muscle dis-
section and their relationship to the frontal branch of the facial nerve.
J Neurosurg 92:877–880
3. Mori K, Yamamoto T, Oyama K, Watanabe M, Nonaka S, Hara T,
Honma K (2008) Lateral supraorbital keyhole approach to clip
unruptured anterior communicating artery aneurysm. Minim
Invasive Neurosurg 51:291–297
4. Nathal E, Gomez-Amador JL (2005) Anatomic and surgical basis of
the sphenoid ridge keyhole approach for cerebral aneurysms.
Neurosurgery 56(1 Suppl):178–185 discussion 178-85
5. Oikawa S, Mizuno M, Muraoka S, Kobayashi S (1996) Retrograde
dissection of the temporalis muscle preventing muscle atrophy for
pterional craniotomy. Technical note. J Neurosurg 84:297–299
6. Poblete T, Jiang X, Komune N, Matsushima K, Rhoton AL Jr (2015)
Preservation of the facial nerves to the frontalis muscle during
pterional craniotomy. J Neurosurg 122:1274–1282
7. Reisch R, Perneczky A, Filippi R (2003) Surgical technique of the
supraorbital key-hole craniotomy. Surg Neurol 59:223–227
8. Ture U, Yasagil DC, Al-Mefly O, Yasagil MG (1999) Topographic
anatomy of the insular region. J Neurosurg 90:720–733