Operative Anatomy and Classification of the Sylvian Veins for the Distal Transsylvian Approach

Ken KAZUMATA, Hiroyasu KAMIYAMA, Tatsuya ISHIKAWA, Katsumi TAKIZAWA, Takahiro MAEDA, Kennichi MAKINO, and Satoshi GOTOH

Department of Neurosurgery, Asahikawa Red Cross Hospital, Asahikawa, Hokkaido

Abstract

Methods for preservation of the sylvian veins in the transsylvian approach have not been established because of the considerable variations. This study attempted to classify the sylvian veins to facilitate systematic dissection of the sylvian fissure for sylvian veins to be preserved. The operative anatomy of the sylvian vein was examined in 82 hemispheres. The type of drainage and the pattern of branching were investigated. The superficial sylvian vein (SSV) was classified into three types according to the number of stems draining into the dural sinus on the inner surface of the sphenoid bone: The SSV was absent or hypoplastic in eight cases, the SSV was single in 38 cases, and the SSV was double in 36 cases. The SSV drained into neither the sphenoparietal sinus nor the cavernous sinus in nine cases. An anastomosis between the SSV and the deep middle cerebral vein (DMCV) was observed in 42 cases. The frontobasal bridging vein (FBBV) drained into the sphenoparietal sinus in 47 cases. The type of connection was further subdivided into four types according to the connections with the DMCV and FBBV. The venous anatomy of sylvian fissure indicates that dissection (skeletonization) of the main stem of sylvian veins from the temporal lobe should be performed to preserve the tributaries from the frontal lobe.

Key words: transsylvian approach, sylvian vein, sylvian fissure

Introduction

The sylvian veins show frequent variations in size and connection.1,2,6,8,9 Previous studies of the sylvian veins have focused on the outflow point, using angiography, three-dimensional computed tomography (CT), or cadaver study.3,10–13 The gold standard for surgery in this area suggests that “the arachnoid of the sylvian fissure should be opened on the frontal side of the veins, so that they will not cross the sylvian fissure when the frontal lobe is retracted. Occasionally two or three fronto-orbital venous tributaries that cross the sylvian fissure to enter the middle cerebral vein need to be sacrificed to complete the dissection.”17 However, the sacrifice of the sylvian veins could result in postoperative venous infarction or contusion of the frontal lobe.7,10 We have employed the distal transsylvian approach to preserve the sylvian veins and tributaries.6 However, a systematic stepwise method of microsurgical dissection to preserve the sylvian veins is difficult to describe because of the frequent variations in the sylvian veins.

This study investigated the anatomical variations of the sylvian veins in the sylvian fissure in 82 sides in 82 patients undergoing surgical exploration who required the transsylvian approach because of pathology such as cerebral aneurysm or parasellar tumor. Based on the pattern followed by these variations, an optimum method of the dissection is proposed, which allows adequate working space without sacrificing of the sylvian veins.

Patients and Methods

Eighty-two patients with internal carotid artery (ICA) or distal basilar artery aneurysm, or parachiasmatic neoplasm necessitating the transsylvian approach or a modification such as the anterior temporal approach were treated at the Neurosurgical Department of Asahikawa Red Cross Hospital between 1998 and 2001.

Microsurgical dissection of 82 sides was performed through the distal transsylvian approach as described in detail elsewhere.61 Briefly, dissection was started about 1–2 cm distal to the lateral
orbitofrontal gyrus. The anterior trunk of middle cerebral artery (MCA) on the insular surface was identified, then the dissection proceeded to follow the M₁ segment and ICA in a retrograde fashion. The last step of dissection was incision of the arachnoid trabecula wall over the carotid cistern. The drainage route and pattern of branching of the sylvian veins were recorded during the operation and also on videotapes.

Results

I. Nomenclature

The variations of sylvian veins were classified according to the branching and drainage pathway patterns (Fig. 1). Veins in the sylvian fissure can be categorized into the superficial, intermediate, and basal parts.

Superficial part: The superficial part consists of the superficial sylvian vein (SSV) (superficial middle cerebral vein). Usually, the SSV consists of the fronto-orbital (fronto-SSV: fSSV), fronto-parietal (parieto-SSV), and anterior temporal (temporo-SSV: tSSV) veins.¹,² We defined single SSV as an SSV with tributaries from both the frontal and temporal lobes that drains into the dural sinus as a single trunk. Double SSVs at the entrance of the dural sinus consist of one SSV with tributaries from the frontal lobe (fSSV), and another SSV with tributaries from the temporal lobe (tSSV). There is also a small vein at the anterior temporal region, which has tributaries from the middle and inferior temporal gyri, and may be called the temporopolar vein. However, this study did not analyze the temporopolar vein.

Intermediate part: The intermediate part consists of insular veins. A previous study found the insular veins consist of four veins of the anterior limiting sulcus, precentral sulcus, central sulcus, and posterior limiting sulcus.¹²,¹⁶) Drainage of the common stem of the insular vein can be classified into two types: the classic pattern with a common stem draining into the basal vein, and the nonclassic pattern with a common stem draining into the sphenoparietal sinus (SPS).¹² This study assessed the anastomosis between the common stem of the insular veins and the SSV. Absence of an anastomosis in the operative field indicated the common stem of the insular veins primarily drained into the basal vein. In this type, the intermediate part has no influence on sylvian dissection.

Basal part: The basal part consists of the olfactory vein, posterior fronto-orbital vein, anterior cerebral vein, and twigs from the optic chiasm. All these veins are components of the first part of the basal vein.¹⁰ If these veins drain into the basal vein, there is no vein that passes over the ICA. In this study, a small vein running from the frontal base and draining into the SPS was called a frontobasal bridging vein (FBBV). An FBBV can drain into the SPS as a single trunk, or as a common stem with the SSV or an anastomotic vein with the common stem of the insular veins (common vertical trunk).¹⁵

II. Drainage pattern

SSV: The drainage and multiplicity of the SSV was classified into three types: Type I, the SSV was absent or very hypoplastic (8 cases, 10%); Type II, the SSV consisted of a single main stem draining into the SPS (38 cases, 46%); and Type III, the SSV consisted of two main stems (fSSV and tSSV) drain-
Fig. 2  Diagrams showing the patterns of branching of Type II.  A: superficial sylvian vein (SSV) only, B: SSV + frontobasal bridging vein (FBBV), C: SSV + deep middle cerebral vein (DMCV), D: SSV + DMCV + FBBV.

Fig. 3  Diagrams showing the patterns of branching of Type III.  A: temporo-superficial sylvian vein (tSSV) + fronto-superficial sylvian vein (fSSV), B: tSSV + (fSSV + frontobasal bridging vein [FBBV]), C: tSSV + (fSSV + deep middle cerebral vein [DMCV]), D: tSSV + (fSSV + DMCV + FBBV).

Insular veins: The insular veins formed an anastomotic stem trunk and drained into the SPS in 42 cases (51%). There was no anastomosis between the insular veins and the SPS in 40 cases (49%).

FBBV: An FBBV was found in 47 cases. The olfactory vein, posterior fronto-orbital vein, anterior cerebral vein, and twigs from the optic chiasm were considered to form the first part of the basal vein in 35 cases.10)

III. Type of branching

The patterns of branching could be further classified. Type II showed four subtypes (Fig. 2): Type IIa, only the SSV, but not the deep middle cerebral vein (DMCV) and FBBV, drained into the SPS (3 cases); Type IIb, the FBBV drained into the SSV and the SSV drained into the SPS (8 cases); Type IIc, the DMCV drained into the SSV and the SSV drained into the SPS (10 cases); and Type IIId, both the FBBV and DMCV drained into the SSV and the SSV drained into the SPS (10 cases). The pattern of branching did not fall into this classification in seven cases of Type II.

Type III showed four subtypes similar to those of Type II plus a tSSV (Fig. 3): Type IIIa, only the tSSV + fSSV, but not the DMCV and FBBV, drained into the SPS (7 cases); Type IIIb, the DMCV drained into the fSSV and the fSSV and tSSV drained into the SPS (8 cases); Type IIIc, the FBBV drained into the fSSV and the fSSV and tSSV drained into the SPS (10 cases); and Type IIIId, both the FBBV and DMCV drained into the fSSV and the fSSV and tSSV drained into the SPS (9 cases). The pattern of branching did not fall into this classification in two cases of Type III.

Discussion

I. Operative anatomy of the sylvian vein

The present study revealed that the SSV was present in 90% of cases. Previous studies of the drainage pathway of the SSV found that the SSV drains into the SPS in 68.2%, cavernous sinus directly in 21%, middle meningeal vein in 10%, superior petrosal sinus in 0.71%, and emissary vein in the foramen lacerum in 0.71%.3) The drainage route can be assessed preoperatively by angiography or three-dimensional CT angiography.11–13,15) In our study, the entrance of the SSV was recognized at the pretemporal dura matter in the operative field in

Neurol Med Chir (Tokyo) 43, September, 2003
Fig. 4  A: Diagram showing a coronal section of the distal part of the sylvian fissure. The double layer of the arachnoid membrane envelops superficial sylvian vein (SSV) circumferentially. The arachnoid trabecula wall spreads over the insular surface and M₂ segment of middle cerebral artery (MCA). The anterior division of the MCA is usually recognized at the initial stage of dissection. The posterior division of the MCA is located more laterally, and the deep middle cerebral vein (DMCV) is located underneath. fSSV: fronto-SSV, tSSV: temporo-SSV. B: Diagram showing the importance of microsurgical dissection between the fSSV and tSSV. The vein of the lateral fronto-orbital gyrus will not cross the sylvian fissure. The lateral fronto-orbital gyrus often herniates into the temporal operculum, so the dissection is easier to perform in the distal to proximal direction (arrow).

Fig. 5  Diagrams showing the dissection of the sylvian veins in Type II. A: Incorrect dissection between the frontal lobe and superficial sylvian vein (SSV) (arrow). The working space is limited by the length of A, unless the vein of the lateral fronto-orbital gyrus is sacrificed. B: Correct dissection should be performed between the SSV and superior temporal gyrus (arrows). The working space is increased to the length of A plus B. C: Completed dissection. Small tributaries from the superior temporal gyrus can be mobilized in most cases (arrows). DMCV: deep middle cerebral vein, ICA: internal carotid artery, ON: optic nerve.

90% of cases. This finding is consistent with the previous findings that the SSV drains either into the SPS or directly into the cavernous sinus in 62–89% of cases.3,11) The venous drainage of insula is primarily via the DMCV. The drainage of the common stem of the insular vein can be classified into two types: the classic pattern with a common stem draining into the basal vein, and the nonclassic pattern with a common stem draining into the SPS as a common vertical trunk.15) The venous configuration of the insula reflects a mixture of superficial and deep
Fig. 6 Diagram showing the dissection of the sylvian veins in Type III. A: Arrows indicate the site of dissection that is necessary to obtain the maximum working space. The deep middle cerebral vein (DMCV) courses behind the posterior division of the middle cerebral artery, then drains into the fronto-superficial sylvian vein (fSSV) or vein of the lateral fronto-orbital gyrus. The proximal part of the DMCV is dissected from the frontal and temporal lobes. The sylvian vein complex consists of the fSSV (common vertical trunk) which can be mobilized toward the frontal side. FBBV: frontobasal bridging vein, tSSV: temporo-superficial sylvian vein. B: The veins of the lateral orbitofrontal gyrus frequently join with the DMCV, and drain into the fSSV. If the proximal segment of the anterior temporal artery (arrow) courses like a loop in the planum polare, the common vertical trunk is anchored on the anterior temporal artery (circle).

Fig. 7 Diagrams showing dissection of the sylvian veins in the sphenobasal or sphenopetrosal vein type. A: Dissection for the sphenobasal and sphenopetrosal vein types. Arrows indicate the proximal part of the sylvian vein. SSV: superficial sylvian vein. B: The method of dissection is similar to those used in Types II and III. FBBV: frontobasal bridging vein.

connections. We found a significant anastomosis between the SSV and the common trunk of insular veins in 51% of cases. This anastomotic trunk has been called a common vertical trunk, with which the tributaries from the frontal base (FBBVs) can also join. In the majority of cases, the anastomosis of the common stem of the insular veins and the SSV occurs between the fSSV and the common stem of
the insular veins. The anastomosis of the common stem of the insular veins and the SSV may also occur between the lateral fronto-orbital vein and the common stem of the insular veins. However, none of our cases showed a significant anastomosis between the common stem of the insular veins and tSSV. The anastomotic trunk usually courses behind the posterior division of the MCA, and then passes along the medial temporal lobe. The common stem of the insular veins less frequently flows into the SPS without connection with the SSV.

In this study, the tributaries from the frontal base were named FBBVs. The FBBVs consisted of the olfactory vein, posterior fronto-orbital vein, anterior cerebral vein, and twigs from the optic chiasm which can form the first part of basal vein. The FBBV was found in 57% of cases. The FBBV can drain into the SPS as a single trunk or a common stem with the SSV or as an anastomotic vein with the common stem of the insular veins.

II. Method of dissection of the sylvian veins

SSV: The arachnoid membrane envelopes the SSVs circumferentially (Fig. 4A). It is safe to enter the sylvian fissure between the two large SSVs at the distal part of fissure, because the pia mater is more fragile than the arachnoid membrane. Dissection is generally recommended at the frontal side of the SSV. However, the lateral fronto-orbital vein frequently restricts the working space. Therefore, except in rare cases of absence of the lateral fronto-orbital vein, the plane of dissection should proceed between the temporal pia mater and the SSV to preserve the lateral fronto-orbital veins in Type II (Fig. 5). Relatively small tributaries from the superior temporal gyrus can be mobilized from the temporal pia mater in Type II. The stem of the SSV can usually be mobilized safely from the anterior temporal pia mater. All significant tributaries, the vein of the lateral fronto-orbital gyrus, DMCV, and FBBV, are connected with the frontal lobe in Type III. Therefore, dissection should be carried out between the fSSV and tSSV (Fig. 6). The fSSV is usually impossible to identify at the initial stage in the distal transsylvian approach, so the dissection should proceed toward the temporal side after encountering the meeting point of the SSV. If this procedure does not provide adequately wide exposure of the Sylvian veinacea, the arachnoid membrane of the fSSV must be peeled off, which increases the flexibility of the Sylvian veins and allows retraction.

Dissection in the sphenobasal and sphenopetrosal vein types should proceed by incision of the arachnoid membrane until the base of the temporal pole is recognized (Fig. 7). However, liberation of the temporal pole tends to be incomplete when the anterior temporal approach is planned. Therefore, the extradural temporopolar approach is useful to access the lateral retrocarotid space in these types of vein. Dissection between the orbital fascia and the temporal dura allows posterolateral retraction of the SSV with the temporal lobe.

Insular veins: The presence of a common vertical trunk (anastomosis between the DMCV and SSV) requires dissection between the common vertical trunk and the frontal lobe. However, if the anterior temporal approach is employed, the dissection should also be carried out between the common vertical trunk and medial temporal lobe. The proximal segment of the anterior temporal artery overlies the common vertical trunk, so the anterior temporal artery anchors the common vertical trunk when the dissection carried out between the vein and medial temporal lobe (Fig. 6B). In this case, mobilization of the proximal anterior temporal artery increases the flexibility of the common vertical trunk.

FBBV: The arachnoid sheath over the FBBV can be incised to increase the flexibility. However, this vein has a short cisternal segment, so the working space is sometimes quite limited, especially when the subfrontal approach is employed. Sacrifice of the FBBV can lead to unexpected brain contusion at the base of the frontal lobe. The high incidence of the FBBV at 50% may complicate surgery for anterior communicating artery aneurysm by the pterional approach.

References

6) Ito Z: Microsurgery of Cerebral Aneurysm. Tokyo, Nishimura/Elsevier, 1985, pp 95–201

Neurol Med Chir (Tokyo) 43, September, 2003
disorders and postoperative brain damage associated
with the pterional approach in aneurysm surgery.

Neurol Med Chir (Tokyo) 32: 733–738, 1992

8) Oka K, Rhoton AL, Barry M, Rodriguez R: Microsurgical
anatomy of the superficial veins of cerebrum.
Neurosurgery 17: 711–748, 1985

9) Ono M, Rhoton AL, Peace D: Microsurgical anatomy
of the deep venous system of the brain. Neurosurgery
15: 621–657, 1984

10) Saito F, Haraoka J, Ito H, Nishioka H, Inaba I,
Yamada Y: [Venous complication in pterional
approach: about fronto-temporal bridging veins].

11) Stein RL, Rosenbaum AE: Deep supratentorial veins,
in Newton TH, Potts DG (eds): Radiology of the Skull
pp 1903–2110

12) Suzuki Y, Matsumoto K: Variations of the superficial
middle cerebral vein: classification using three-

13) Taber KH, Hayman A, Muszynski CA: A guide to the
venous drainage of the anterior Sylvian fissure. J


14) Varnavas GG, Grand W: The insular cortex: morpho-
logical and vascular anatomic characteristics.

15) Wolf BS, Hung YP: The superficial sylvian venous
drainage system. AJR Am J Roentgenol 89: 398–410,
1963

16) Wolf BS, Hung YP: The insula and deep middle
cerebral venous drainage system. Normal anatomy
and angiography. AJR Am J Roentgenol 90: 474–489,
1963

17) Yasargil MG: Microneurosurgery, vol 1. Stuttgart,
New York, Georg Thieme Verlag, 1984, pp 5–57

Address reprint requests to: K. Kazumata, M.D., Depart-
ment of Neurosurgery, Asahikawa Red Cross
Hospital, Akebono 1 jo 1 chome, Asahikawa,
Hokkaido 070–8530, Japan.
e-mail: kazumata@asahikawa-rch.gr.jp

Commentary on this paper appears on the next page.
Commentary

The sulci, fissures and subarachnoid cisterns are natural pathways for the circulation of the cerebrospinal fluid that may be used by the surgeon to reach the deep regions of the brain and the skull base with little risk of damage to the neural and vascular structures. With elegance, organization, clearness and objectivity, Dr. Kazumata et al. have reported the anatomy of the sylvian veins (superficial, deep middle cerebral vein, insular veins) and their variations, classifying them based on their drainage pattern and type of branching, and proposing a safe and systematic method of the sylvian fissure dissection that preserves the venous system, avoiding contusions, infarctions and other complications. The authors defend the important concept “Neurosurgeon as a neuroanatomist,” and they present some new information which increases the available methods, permitting neurosurgeons to better plan our approaches and consequently safer operations.

References

2) Siqueira MG: Technical Difficulties in the Microsurgical Dissection of the Sylvian Fissure and Cistern: Prospective Identification of the Responsible Factors in 152 Elective Neurological Surgeries. São Paulo, Brazil, University of São Paulo, School of Medicine, 2000 (Thesis)

Pedro Augustto de SANTANA, Jr., M.D.
and Evandro de OLIVEIRA, M.D.
Instituto de Ciências Neurológicas
São Paulo, Brazil

This is an excellent study to describe the operative anatomy of the sylvian veins for the distal transsylvian approach. The authors observed the veins in and around the sylvian fissure in 82 patients during surgical procedures, and classified the superficial sylvian veins into three types according to the number of stems draining into the dural sinus on the inner surface of the sphenoid bone. The type of connection was further subdivided into four types according to the connections with the deep middle cerebral vein and frontobasal bridging vein. From the results, they emphasized the importance to preserve the tributaries from the frontal base. We agree with their opinion. Many authors have suggested that the arachnoid membrane of the sylvian fissure should be opened on the frontal side of the veins. In this procedure, surgeons sometimes have to sacrifice the fronto-orbital venous tributaries, resulting in postoperative venous infarction or contusion of the frontal lobe. Therefore, the relationships of the sylvian veins and the role of each tributary in the frontoparietal and temporal lobes should be understood systematically. The relationships between the frontal cortical draining veins into the superior sagittal sinus and sylvian veins are also important to understand the collateral venous drainage in the frontal lobe.

Kiyotaka FUJII, M.D.
Department of Neurosurgery
Kitasato University School of Medicine
Sagamihara, Kanagawa, Japan