Microsurgical anatomy of the tentorial sinuses

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The tentorial sinuses and/or the bridging veins present an obstacle in certain surgical procedures. Several studies of the tentorial sinus and/or the bridging veins have been published, but the descriptions were often not complete. Increasing use of microsurgical procedures around the tentorium has created a need for more detailed anatomical information on venous systems of the cerebellar tentorium.

In the present study, the microsurgical anatomy of the tentorial sinuses and bridging veins was examined. Particular emphasis was placed on their identity as terminal passages of venous drainage from the brain to the large dural sinuses.

Materials and Methods

Cerebral and cerebellar hemispheres and cerebellar tentoria were obtained from formalin-fixed brains of adult human cadavers. Before the cranium was opened, the intracranial veins were perfused with colored latex through the jugular vein to facilitate dissection. Thirteen cerebellar tentoria (26 sides), 10 cerebella (20 sides), and 10 cerebra (20 sides) were used for this study. The cerebral and cerebellar hemispheres were first examined inside the cranium, then the bridging veins were cut away during removal. The cerebral and cerebellar hemispheres and the superior and inferior surfaces of the tentoria were observed under a surgical microscope at × 3 to × 40 magnification.

Results

Classification of Tentorial Sinuses

The sinuses coursing in the cerebellar tentorium were classified according to draining patterns into four groups: Group I, in which the sinuses receive venous blood from the cerebral hemisphere through bridging veins; Group II, in which the sinuses are drained and formed by the terminal portions of the cerebellar hemispheric or vermian veins; Group III, in which many small veins originating in the tentorium join to form a small sinus; and Group IV, a special type of Group I or II in which the sinus is formed by a bridging vein from the cerebral hemisphere or brain stem to the tentorial free edge (Fig. 1). The number of sinuses in each group is presented in Table 1.

Group I: Tentorial Sinuses Draining the Cerebral Hemisphere

Several cerebral veins usually converged at the superior surface of the cerebellar tentorium to form bridging
Table 1

<table>
<thead>
<tr>
<th>Group</th>
<th>No. (%) of Hemispheres Involved</th>
<th>No. of Sinuses</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>18 (69.2%)</td>
<td>21</td>
</tr>
<tr>
<td>II</td>
<td>23 (88.5%)</td>
<td>37</td>
</tr>
<tr>
<td>III</td>
<td>11 (42.3%)</td>
<td>13</td>
</tr>
<tr>
<td>IV</td>
<td>2 (7.6%)</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 2

<table>
<thead>
<tr>
<th>Location in Tentorium</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
</tr>
<tr>
<td>medial</td>
<td>3</td>
</tr>
<tr>
<td>middle</td>
<td>11</td>
</tr>
<tr>
<td>lateral</td>
<td>23</td>
</tr>
<tr>
<td>total</td>
<td>37</td>
</tr>
</tbody>
</table>

Fig. 1. Illustration of the four groups of tentorial sinuses. In Group I the tentorial sinuses receive venous blood from the cerebral hemisphere; in Group II the sinuses receive venous blood from the cerebellum; in Group III the sinuses originate from the tentorium itself; and in Group IV the sinuses are formed by a bridging vein to the tentorial free edge.

Fig. 2. Group I tentorial sinuses. Left: Some cerebral veins, including the vein of Labbé, form bridging veins to drain into the transverse and sigmoid sinuses. They are frequently present in the posterolateral part of the tentorium. Right: Some of the bridging veins form short Group I tentorial sinuses.
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**Fig. 3.** Group II tentorial sinuses. **Upper Left:** Posterior view of the occipital lobes and cerebellar suboccipital surfaces. The tentorium is lifted to show the bridging veins from the cerebellum to the tentorium. The inferior vermian veins and the medial inferior hemispheric veins form two vermian bridging veins (*short arrows*) over the posterior cerebellar incisura. The inferior hemispheric veins form one hemispheric bridging vein (*long arrows*) on each tentorial cerebellar surface draining into the tentorial sinus. **Upper Right:** Inferior view of the tentorium and the tentorial incisura, with the cerebellum removed. There are two tentorial sinuses with the cut ends of bridging veins. The tentorial sinus on the right side drains into the transverse sinus, and that on the left joins the torcula. **Lower Left:** Superior view of the cerebellar tentorial surface with the open tentorial sinuses. The tentorium was removed, but three tentorial sinuses of this group are left and opened. The superior and inferior hemispheric veins join to form the sinuses. One of the three joins the torcula, and the remaining two drain into the transverse sinuses. **Lower Right:** Superior view of the cerebellar tentorial surface showing two bridging veins on the left side (*arrows*), but none on the right side. The right cerebellar hemispheric veins course transversely to drain into the petrosal sinus. The bridging veins were present near the postclival fissure between the simple and superior semilunar lobules.

cerebellar surface, the inferior and superior hemispheric veins joined and formed bridging veins to drain into the tentorial sinus (Fig. 3 *lower pair*). Near the midline, some of the veins converging in the posterior cerebellar incisura drained into a short tentorial sinus after forming a bridging vein (Fig. 3 *lower left*). Because the tentorial sinuses of Group II were frequently present as a large sinus, they were separated into five subtypes, according to their draining veins and the direction of termination (Fig. 4). In Type 1, the sinus courses transversely to drain into the straight sinus. In Type 2a, the sinus drains the medial cerebellar hemisphere and courses posteromedially to drain into the torcular. In Type 2b, the sinus draining the vermis is short and in a manner similar to the Type 2a sinus. In Type 3, the sinus draining most of the cerebellar hemisphere courses directly posteriorly to the middle one-third of the transverse sinus. In Type 4, the sinus drains the lateral tentorial cerebellar surface then runs posterolaterally to drain into the junction of the superior petrosal and transverse sinuses. All of the Group II tentorial sinuses were present in the posterior half of the cerebellar tentorium. The frequency of the Group II sinus subtypes is shown in Table 3.

The bridging veins draining into the tentorial sinus of Group II were of two kinds: the vermian bridging vein on the vermis in the midline (Fig. 3 *upper left*) and the hemispheric bridging vein located on the lateral...
cerebellar surface (Fig. 3 lower right). Most of the former veins were the terminal portions of the inferior vermian vein. There were a total of 15 vermian bridging veins distributed in nine (90%) of 10 cases. Hemispheric bridging veins, formed by the joining of the inferior and superior hemispheric veins, were found in 16 (80%) of 20 sides, and totaled 32 (the largest number on one side was three). Twenty-six (81%) of these 32 veins were present near the postcivial fissure between the simple and superior semilunar lobules (Fig. 3 lower pair). These hemispheric bridging veins were less frequently located in the lateral one-third of the hemisphere than in the middle and medial one-thirds.

Group III: Tentorial Sinus Arising in the Tentorium

The tentorial sinuses originating in the tentorium were present near the tentorial free edge or the straight sinus (Fig. 5). These were small sinuses with no bridging veins, and drained in two different directions. One type was a tentorial sinus originating from the posterior part of the tentorial incisura and running anteriorly along the tentorial edge to drain into the superior petrosal sinus. The other originated near the incisura and ran posteriorly along the straight sinus to drain into the posterior portion of the straight sinus or the torcular (Fig. 5).

Group IV: Tentorial Sinus Formed by a Bridging Vein to the Tentorial Free Edge

A rarer type of tentorial sinus was found in two cases. In one, the basal vein of Rosenthal terminated as a bridging vein to the tentorial free edge, forming a tentorial sinus (Fig. 6 left). The sinus ran posteriorly from the tentorial edge to the torcular, almost parallel to the straight sinus. In the other case, the peduncular vein running on the midbrain became a bridging vein to the tentorial edge (Fig. 6 right), forming a short tentorial sinus which coursed laterally to drain into the superior petrosal sinus.

Discussion

Gibbs and Gibbs, in their study on the torcular and lateral sinuses, seem to have been the first to describe tentorial sinuses. They observed two sinuses in the tentorium which received blood from the superior cerebellar veins and emptied into the transverse sinus near the straight sinus. After their report, the tentorial sinuses were noted in studies of the dural sinuses near the torcular. Browder, et al., showed variations in the tentorial sinuses, using Vinlyite casts made by injecting a Vinlyite-acetone mixture into the tentorium through the transverse and occipital sinuses. Neuroradiologists also remarked upon tentorial sinuses observed during radiological studies. Babin and Megret described the tentorial sinus as one of the variations in the drainage of the basal vein. Huang and Wolf described the tentorial sinus as a terminal portion of the tentorial draining group of veins in the posterior fossa. Neurosurgeons have a special interest in the tentorial sinuses and bridging veins to the tentorium because these tissues present obstacles during surgery.
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Fig. 6. Group IV tentorial sinus. *Left:* Superolateral view of the left side of the tentorium with the tentorial sinuses opened. The midbrain, the pineal body, and the veins of Galen can be seen. The left basal vein of Rosenthal forms a bridging vein to the tentorial edge, which drains into the large Group IV tentorial sinus. The bridging vein is held with forceps. The tentorial sinus courses posteroomedially to join the posterior portion of the straight sinus. *Right:* Superolateral view of the left side of the tentorium in a different brain. The midbrain, the oculomotor nerve, the posterior cerebral artery, and the basilar artery are visible. A bridging vein to the tentorial edge arises from the anterior surface of the midbrain. The bridging vein forms the tentorial sinus which courses laterally to drain into the superior petrosal sinus.

Most previous studies have shown only part of the tentorial sinuses, and the entire anatomy of these sinuses and draining veins has not been demonstrated systematically. Anatomical variations in the tentorial sinuses were believed to be great. Group II tentorial sinuses draining the cerebellum were often reported in detail because of their large size. We described them in a report on microsurgical anatomy of the veins of the posterior fossa.

In the present study, the whole venous system was examined, including the cerebral and cerebellar veins, in relation to the cerebellar tentorium, and the tentorial sinuses were classified. The Group III tentorial sinus, originating in the tentorium itself, is not mentioned in any previously reported studies. The other three groups of sinuses are terminal portions of the venous system from the cerebrum or cerebellum to the large dural sinuses. Some Group I tentorial sinuses had the appearance of veins that were attached to or present just within the innermost layer of the tentorial dura, described by Seeger as a "subdural course" of the veins. The Group II sinuses correspond to the terminal portion of the veins of the tentorial group described by Huang and Wolf in angiographic studies of the veins of the posterior fossa. Some of the tentorial sinuses in Group IV seem to be compatible with variations of the basal vein of Rosenthal described by neuroradiologists. These tentorial sinuses may be remnants of the embryonic tentorial sinus.

Bridging veins to the tentorium should be considered together with the tentorial sinus. On preoperative venograms, the location of bridging veins can be anticipated when the course of the tentorial sinuses is identified. Since the tentorial sinuses and the bridging veins are present as a rule, as shown in the present study, knowledge of their anatomy is important in surgical procedures such as transoccipital transtentorial, infratentorial supracerebellar, and subtemporal transcerebellar approaches. When sectioning the tentorium, the direction of incision and appropriate method of hemostasis should be considered to reduce venous congestion or bleeding.

Acknowledgments

We express our thanks to Professor Emeritus K. Kitamura, Neurological Institute, Faculty of Medicine, Kyushu University for valuable suggestions and to M. Ohara for comments.

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Manuscript received March 14, 1989.
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