Case Report

Preoperative visualization of the marginal tentorial artery as an unusual collateral pathway in a patient with symptomatic bilateral vertebral artery occlusion undergoing arterial bypass surgery: A 7.0-T magnetic resonance imaging study

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Abstract

**Background:** Extracranial–intracranial arterial bypass surgery is rarely performed for recurrent or progressing stroke due to vertebrobasilar artery steno-occlusive disease. Non-enhanced 7.0-T magnetic resonance (MR) imaging reveals cerebral arteries more clearly than 3.0-T or less MR imaging.

**Case Description:** A 45-year-old man developed recurrent transient ischemic attacks due to hemodynamic ischemia caused by occlusion of bilateral vertebral arteries despite antiplatelet therapy. MR angiography with a 7.0-T imager demonstrated that each marginal tentorial artery ran along the tentorial edge and anastomosed with each posterior cerebral artery (PCA) as collateral circulation. Superficial temporal artery (STA)–superior cerebellar artery (SCA) or PCA bypass surgery was planned through a subtemporal approach. During surgery, the SCA was not visible when the tentorial edge was elevated. The tentorium was not cut, and the STA was anastomosed with the P2 segment of the PCA. Ischemic symptoms completely resolved after surgery.

**Conclusions:** Preoperative 7.0-T MR imaging visualized the marginal tentorial artery as an unusual collateral pathway in a patient with symptomatic bilateral vertebral artery occlusion undergoing arterial bypass surgery.

**Key Words:** 7.0-T MR imaging, arterial bypass surgery, collateral circulation, vertebral artery occlusion

INTRODUCTION

Symptomatic vertebrobasilar artery steno-occlusive disease is commonly treated with antiplatelet drugs. However, the early risk of stroke recurrence in patients with such pathogenesis is high, and these patients require active preventive treatment. Extracranial–intracranial arterial bypass surgery such as superficial temporal artery (STA) to superior cerebellar artery (SCA) anastomosis is rarely performed for recurrent or progressing stroke due to vertebrobasilar steno-occlusive disease. With STA–SCA anastomosis, the SCA as a recipient artery...
is located under the tentorium. The tentorium is thus
usually cut to expose the SCA and obtain a wide and
shallow operative field.\textsuperscript{6,13} Non-enhanced 7.0-T magnetic
resonance (MR) imaging clearly reveals cerebral arteries
that are not visible on MR imaging at 3.0 T or less.\textsuperscript{3,5,7,9,10}

In this report, we describe a case involving a patient
with frequent ischemic attacks and hemodynamic
brain ischemia caused by occlusion of bilateral vertebral arteries (VAs). Preoperative 7.0-T MR imaging
demonstrated collateral circulation running along the
tentorial edge that had not been identified on
cerebral angiography with arterial catheterization.
Based on this MR finding, we performed STA–posterior
cerebral artery (PCA) anastomosis instead of STA–SCA
anastomosis, which would have involved cutting the
tentorium.

CASE REPORT

History and examination
A 45-year-old man presented with minor stroke appearing
as symptoms of dizziness and defects of the visual field,
and 0.5-T MR imaging showed an infarct in the right
occipital lobe. Administration of an antiplatelet drug
was initiated. Six months later, the patient experienced
transient ischemic attacks manifesting as dizziness and
disturbance of consciousness. MR imaging using a 1.5-T
imager showed spotty new ischemic lesions in the right
cerebellum, pons, and left thalamus. MR angiography
with the same imager revealed occlusion of bilateral VAs.

Cerebral angiography with arterial catheterization
showed occlusion at the V3 segments of bilateral VAs.
On common carotid angiography, bilateral posterior
communicating arteries, bilateral marginal tentorial
arteries, and the upper part of the basilar artery were
faintly visible [Figure 1]. However, whether the former
two arteries perfused the latter was unclear.

Three-dimensional time-of-flight MR angiography
with a 7.0-T imager (Signa 950; GE Medical Systems,
Milwaukee, WI, USA) demonstrated that each marginal
tentorial artery originating from each internal carotid
artery ran along the tentorial edge and anastomosed with
each PCA [Figure 2a]. The right SCA was located below
each marginal tentorial artery [Figure 2b].

Quantitative brain perfusion single-photon emission
computed tomography (SPECT)\textsuperscript{11} showed decreased
cerebrovascular reactivity to acetazolamide in the
cerebellum and bilateral occipital lobes; in the latter,
blood flow was also reduced [Figure 3].

Operation and postoperative course
The patient suffered frequent orthostatic dizziness and
we planned STA–SCA or PCA bypass surgery using
a subtemporal approach through a right temporal
craniotomy. During surgery, the SCA was not visible
when the tentorial edge was elevated, as expected from
preoperative 7.0-T MR angiography [Figure 2b]. The
tentorium was not cut because it included the marginal
tentorial artery as collateral circulation [Figure 2a], and
the STA was anastomosed with the P2 segment of the
PCA.

Orthostatic dizziness completely resolved after surgery
and postoperative angiography demonstrated that
the entire posterior circulation was perfused via an
anastomosed STA [Figure 4].

DISCUSSION

The patient discussed in this report suffered frequent
ischemic attacks due to hemodynamic brain ischemia in
the posterior circulation as detected on brain perfusion
SPECT, and underwent vascular reconstructive surgery.
The degree of atherosclerosis is usually greater in the
proximal portion of the PCA than in the SCA,\textsuperscript{13}
and the former runs in the crural cistern deeper than
the latter. Thus, on extracranial–intracranial arterial
bypass surgery for the posterior circulation, the SCA

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure1.png}
\caption{Preoperative common carotid angiography (a, right; b, left) shows bilateral marginal tentorial arteries (arrows) and the upper part of the basilar artery. The whole courses of the former arteries are unclear.}
\end{figure}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure2.png}
\caption{Maximum intensity projection of preoperative three-dimensional time-of-flight magnetic resonance angiography using a 7.0-T imager and a 32-channel phased array coil for the brain to optimize signal detection with the image sequence from a spoiled gradient echo (repetition time, 12 ms; echo time, 2.9 ms; flip angle, 12°; matrix size, 512 × 512; field of view, 22 × 22 cm; slice thickness, 1.0 mm) revealing that each marginal tentorial artery originating from each internal carotid artery runs along the tentorial edge and anastomoses with each posterior cerebral artery (a). The right superior cerebellar artery is located below the right marginal tentorial artery (b).}
\end{figure}
is used more frequently than the PCA as a recipient artery.\(^1,13\) In the present case, preoperative 7.0-T MR imaging demonstrated the collateral circulation running along the tentorial edge, suggesting that the affected area acutely fell into more severe brain ischemia when the tentorium was cut. Furthermore, the SCA was not visible when the tentorial edge was elevated during surgery. The STA was thus anastomosed with the PCA instead of the SCA.

When the VAs are occluded bilaterally and collateral flow via the posterior communicating arteries is insufficient and, as a result, basilar arterial blood supply is tenuous, retrograde flow through the anterior spinal artery can provide collateral circulation.\(^8\) The present case suggested the marginal tentorial artery might offer another potentially important collateral supply to the neural contents of the posterior fossa.

Several investigators have demonstrated that 7.0-T MR imaging visualized the perforating arteries as well as the large vessels of the circle of Willis or the first- and second-order branches in more detail than 1.5- or 3.0-T MR imaging.\(^5,7,10\) In addition, 7.0-T MR imaging also showed similar angiographic findings to angiography with arterial catheterization, regarding visualization of the lenticulostriate arteries.\(^11\) In the present case, the collateral circulation from the marginal tentorial artery to the PCA was displayed more clearly on 7.0-T MR imaging than on angiography with arterial catheterization. Thus, 7.0-T MR imaging may be advantageous for displaying unexpected collateral pathways such as the marginal tentorial artery in patients with vertebrobasilar occlusive disease, particularly when vascular reconstructive surgery is considered.
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