

Case 6

# Dynamic Volume Perfusion CT in a Case of Childhood Moyamoya Disease before and after Surgical Revascularization

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## History

An 11-year-old boy was admitted to the hospital complaining of progressive weakness of the right arm for the past 6 days and unclear enunciation, accompanied by nausea and vomiting for the past 2 days. An MR examination raised questions as to a cerebral infarction of the left parietal and frontal lobe, which was confirmed by a CT 11 days later (Fig. 1). DSA images (Fig. 2) indicated the possibility of a Moyamoya disease. CTA and Volume Perfusion CT (VPCT) examinations were ordered for pre-operative planning.

## Diagnosis

Prior to the operation, CTA images (Fig. 3) showed that the ACA A1 segment was occluded on the left, and had severe stenoses on the right. The MCA M1 segments were highly stenosed on both sides. The bilateral vertebral arteries, the posterior cerebral arteries (PCA), and the basilar artery were unusually enlarged. The left posterior communicating artery (PCOM) was noticeably dilated in comparison to the one on the right.

VPCT images demonstrated an exhausted reserve capacity in the left MCA territory indicated by the increase of cerebral blood volume (CBV), the reduction of cerebral blood flow (CBF) and the strong increase of mean transit time (MTT) (above the frequently used penumbra threshold of 145% for relative MTT used in stroke) as shown in

table 1. Time to Drain (TTD) and Time to Start (TTS) were also significantly increased (Fig. 5A).

A direct bypass procedure by anastomosis of the left superficial temporal artery (STA) to the middle cerebral artery (MCA) was performed (Fig. 4).

After successful surgery, VPCT images showed a partially restored reserve capacity in the left MCA territory indicated by normalized CBF and diminished increase of CBV and MTT as shown in table 2. The increase of TTD and TTS also diminished in magnitude and spatial extent (Fig. 5B).

The patient recovered completely from his speech impediment. His right arm, however, remained weaker than the left, but muscle strength improved from III (at admission) to V (at discharge).

## Comments

Moyamoya disease is characterized by a progressive steno-occlusive vasculopathy of the terminal portion of the internal carotid artery and its main branches. It is associated with the development of dilated, fragile collateral vessels at the base of the brain, which are termed "Moyamoya vessels". These collateral vessels have the appearance of a "puff of smoke". Most patients suffer from recurrent ischemic attacks. Dynamic volume perfusion CT can be used to evaluate the details of cerebral hemodynamic changes in patients with Moyamoya

## Examination Protocol

Scanner	SOMATOM Definition Flash
Scan area	Head
Scan length	100 mm
Scan direction	Alternating (Adaptive 4D Spiral)
Scan time	36 s
Tube voltage	70 kV
mAs per image	100
Dose modulation	n. a.
CTDI <sub>vol</sub>	67.6 mGy
DLP	798 mGy cm
Effective dose	1.7 mSv
Rotation time	0.28 s
Pitch	0.55
Slice collimation	32 x 1.2 mm
Slice width	3 mm
Reconstruction increment	2 mm
Reconstruction kernel	H20f
<b>Contrast</b>	
Volume	32 mL + Saline
Flow rate	4.0 mL/s
Start delay	5 s

disease before and after surgery. Cerebral CTA is useful for assessing the abnormalities of the intracranial arteries and the patency of bypass grafts.

	Left	Right	Diff.
CBF	47.7	51.7	-8%
CBV	3.39	2.70	+26%
MTT	5.19	3.38	+54%

Table 1: Pre-operative – Exhausted reserve capacity indicated by increase of the CBV, the reduction of CBF and the strong increase of MTT (54% increase is above the frequently used penumbra threshold of 145% for relative MTT used in stroke).

	Left	Right	Diff.
CBF	54.5	53.4	+2%
CBV	3.32	2.80	+16%
MTT	4.19	3.25	+29%

Table 2: Post-operative – Partially restored reserve capacity indicated by normalized CBF and diminished increase of CBV and MTT.

**1** MR images acquired at admission showed infarction of the left parietal and frontal lobe. CT images acquired 11 days later, confirmed the infarction although with very subtle signs (arrows).

**2** Pre-operative DSA images demonstrated that the ACA A1 segment was stenosed on the right (R, arrow), and occluded on the left (L, arrow). The MCA M1 segments were highly stenosed on both sides (arrowheads). The dilated PCOM and the collateral vessels from PCA to ACA were also seen on the left (L, dashed arrow).

**3** Pre-operative CTA images demonstrated the vascular changes of ACA A1 and MCA M1 as described in Fig. 2. In addition, it also showed that the bilateral vertebral arteries (arrows), PCA (arrowheads), basilar artery (curved arrow) and the left PCOM (dashed arrow) were unusually dilated.

**4** The post-operative overlaid CTA images showed the course of the STA (arrow) MCA bypass (arrowheads).

**5** 3D TTD (A) and TTS (B) maps showed the full extent of the hemodynamic disturbance before surgery and the significant postoperative improvement.