Supplemental Material

Steal syndromes

The steal phenomenon is a prominent characteristic of the collateral circulation, occurring “when the distal segment of an obstructed artery is perfused through collaterals that divert blood from adjacent arterial territories. They develop whenever there are (a) gradients from high to low pressure systems and (b) adequate arterial or arteriolar anastomoses.” (Toole JF, McGraw CP. Annu Rev Med 1975; 26: 321–329). In other words, blood is siphoned along collateral arteries to reach a low pressure territory distal to the occlusion. They are characterized by alternative directions of blood flow in the collateral vessels. Complete or partial inversion of the Doppler spectrum is the most striking feature in vascular sonography.

Right CCA steal, right SCA steal and INA steal

In the literature, the terms right SCA steal, innominate steal, and right CCA steal can be used interchangeably. In our opinion the INA steal should be restricted to high-grade stenosis or occlusion of the INA, reversed flow only in the right VA, or reversal in both the right VA and CCA. The right SCA steal should be limited to reversed flow of the right VA secondary to severe obstructive lesions of the right SCA, or both the SCA and the INA. The right CCA steal should be designated as the steal phenomena secondary to severe stenosis or occlusion of the right CCA or the right CCA and INA, with forward blood flow in the stenotic CCA and retrograde flow in the ICA or ECA (Figure 3 Online).

> Figure 1 Online Classification of the subclavian artery steals according to the VA waveform configuration. Complete steal manifests as complete flow reversal throughout the entire cardiac cycle. Partial steal demonstrates reversed flow during systole. Pre-steal steal shows antegrade flow with a markedly midsystolic deceleration in peak systole (“bunny” sign) or delayed early-systolic acceleration (“zigzag” sign).
The schematic drawing shows lesion locations in the innominate steal, subclavian steal and common carotid steal, as well as the directional change of the blood flow in the INA, SCA and CCA steals (only demonstrates the right-side in detail from b to h). 

**a** The lesion locations of the innominate, bilateral SCA and CCA obstructive diseases. **b, c** The innominate steal results from the occlusion or severe stenosis of the INA. The blood flow reversal may occur at the right carotid artery and vertebral artery, or merely at the VA. **d, e** The SCA steal results from the occlusion or severe stenosis of the SCA. The blood flow reversal may occur at the right VA. **f-h** The CCA steal results from the occlusion or severe stenosis of the CCA. The blood flow reversal may occur at the ICA or ECA. Both right CCA and INA obstruction are omitted.
**Figure 3 complementary online** Double steal phenomena of the right CCA (RCCA) and right SCA (RSCA) in a 41-year-old woman with Takayasu arteritis (TA, patient 2) in the quiescent and active stages. 

A. The antegrade flow was shown in the trunk of RECA with reduced velocity, and the retrograde flow was seen in one branch of it (B2).

B. The INA and RSCA orifice was obliterated. The proximal RSCA was fed by the thyrocervical trunk (TC) with retrograde flow during the whole cardiac cycle.

C. An artificial stent was deployed in the proximal LCCA due to the lumen stenosis secondary to TA. The thickness of the wall around the stent is normal in the quiescent stage. The obviously increased velocity of blood flow confirmed intra-stent restenosis when TA relapsed.

**Figure 5 complementary online** Partial steal of the LCCA concomitant latent steal in a 42-year-old woman with TA (patient 4) in the quiescent phase.

A. The velocity of the severely stenotic LCCA was decreased significantly with an aberrant waveform configuration.

B. The cerebral MRA showed that the carotid siphon segment (C2) of the LICA was stenosed.

C. CTA demonstrated the diffuse stenosis of the LCCA and the collaterals connecting with the LCCA bifurcation (white arrowhead).
Figure 6 complementary online  Variability of the LCCA partial steal in a 40-year-old woman with TA (patient 5). A The spectrum of the LECA was similar to that of a thick collateral connected to it. B, C The LECA had antegrade flow and one branch of it (B2) had retrograde flow.
Figure 8 complementary online. Change of the LCCA latent steal in a 22-year-old woman with TA (patient 7) in the active and quiescent stages.

A. The stenosis of the LCCA was relieved once the inflammation resolved.
B. The LECA continued to provide blood for the LICA with the retrograde flow. The LICA kept the antegrade flow with normal velocity.
C, D. With the perfusion from the collaterals, the RICA re-canalized with antegrade flow. The left superior thyroid artery was the part of the collateral system with retrograde flow.
E. The V1 segment of the RVA (RVA1) re-canalized after inflammation subsided. The velocity of the blood flow in the V2 segment (RV2) mildly increased.
F. Cerebral MRA follow-up demonstrated recanalization of the stenotic RICA. Red arrowhead indicates the ACoA, pink and blue arrows indicate the RPCoA and LPCoA, respectively.
Figure 9 complementary online  Double steal phenomena of both RCCA and INA in a 60-year-old woman with TA (patient 8). The latent steal of the RCCA occurred after thrombosis in the artificial vessels. A Before thrombosis in the artificial vessels, the LCCA and RCCA were obliterated. The artificial vessel connected the proximal RICA with the AOA. B The RICA was perfused by abundant blood flow from the artificial vessel with increased velocity. C The artificial vessel connecting the AAO with the INA was severely stenotic with significantly increased velocity. The spectrum of the RVA had the typically systolic spikes followed by the mid-systolic deceleration – ”bunny sign”, which indicated the pre-steal of the INA.

Figure 10 complementary online  Latent steals in both CCAs in a 43-year-old man with TA (patient 9). Cervical CTA showed the occlusion of the distal INA, the RSCA, the proximal RCCA, and stenosis of the middle and distal RCCA. The LCCA was diffusely severely stenotic with sub-occlusion at the middle segment. Both bilateral ICAs and ECAs were normal, and dilated collaterals (superior thyroid arteries) connected with the bilateral ECAs. The LSCA was occluded at the orifice. A fine collateral entered the diffusely stenotic LVA2 (yellow arrowhead).