Artifacts due to Reverse Flow in the Artery and Their Correction in TOF Angiography with Presaturation of the Vein

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Introduction: The TOF angiography is based on the inflow enhancement to get the contrast of the vessel over the stationary tissue. By selectively saturating the inflow to an imaging slice, the artery and vein can be selectively acquired. This separation exploits the opposite flow direction in the artery and vein. In 2D TOF angiograms of the artery we often observe dark bands on the artery along the imaging slice selection direction. We trace out the cause of the dark band ands are proposing a new type of saturation to eliminate the artifacts of the dark bands.

Methods: We assume the cause of the dark band as the reverse flow in the artery. The flow pattern in the artery is well observed by use of the doppler sonography where the flow pattern clearly demonstrates the reverse flow in particular in the tibial artery as seen in Fig. 1 (*1*). We investigated the effects of reverse flow on an angiogram by varying the saturation as in Fig. 2. Clearly, we can conclude that the dark bands are caused by the reverse flow in the artery. The irregular appearance of the dark bands may be due to the asynchronous cycling between the cardiac cycle and the phase-encoding steps. The vessel contrast is mainly determined by the inflow enhancement near the DC point of the phase-encoding gradient. The dark bands can be eliminated by designing the saturation band with a ramped profile as in Fig. 3. The ramped profile will saturate the inflow in the vein but will partially saturate the reverse flow in the artery.

Results: The 2D TOF angiograms were taken from a right leg with the Magnum 1.0T system. The quasi-gating was applied to eliminate the flow artifacts due to the pulsatile flow (*3*). Other imaging parameters were TR = 30 ms, TE = 9 ms, number of averages = 1, flip angle = 60, slice thickness = 3 mm, FOV = 220 mm (the same parameters as for Fig. 2), and the gap of 5 mm.

Conclusions: The dark bands in the TOF angiogram were proven to be caused by the reverse flow in the artery. The proposed ramped RF successfully separated out the veins without the dark bands. Furthermore, other techniques such as the Fourier transform arteriography (*4*) and the direction-sensitive saturation RF pulse are under study.

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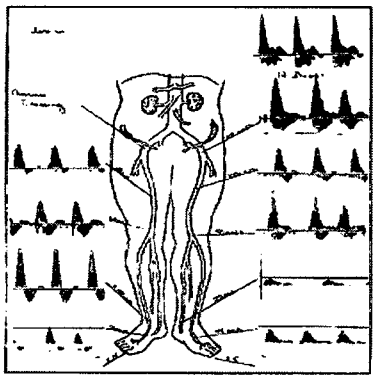
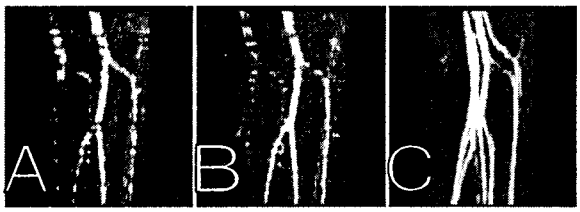
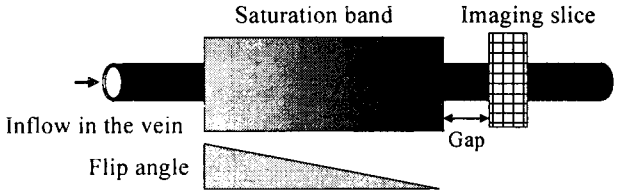


<Fig. 1 >
Doppler sonograms in legs.
Note the reverse flow after the
R-wave in the cardiac cycle.



<Fig. 2>
Angiograms with different saturatingconditions: with the gap of 5 mm (A) and 10 mm (B) by use of the dual-band technique (*2*), and (C) without the saturation. The dark bands obvious in (A) became weaker in (B) and finally disappeared in (C).



<Fig. 3>
The saturation band of a ramp profile.

<Fig. 4>
The angiograms in the tibial arteries acquired with the proposed ramped RF for the saturation. Note for the absence of the dark bands.

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