# Predicting SFA stenosis severity with cine PC flow measurements during suprasystolic thigh compression

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***Objectives:*** Patients with claudication (difficulty walking), rest pain or foot ulcers often have peripheral arterial disease (PAD) diffusely involving the arteries of the entire lower extremity. It may be difficult to determine which arterial segments, if any, have flow limiting stenoses and can benefit from angioplasty or bypass. The purpose of this study is to determine the hemodynamic significance of SFA stenoses using 2D cine phase contrast (PC) flow measurements augmented with hyperemic stimulation of flow following suprasystolic thigh compression.

***Materials and Methods:*** Fourteen patients with suspected peripheral vascular disease underwent routine 3-station bolus chase peripheral MRA on a 1.5 T MR scanner (GE Signa EXCITE). 2D cine PC flow data proximal and distal to SFA disease were obtained pre, during and post suprasystolic (200 mm Hg) thigh compression for 3 minutes using dedicated thigh cuffs (SmartTourniquet, Topspins, Ann Arbor, MI). Velocity encoding was 100 cm/s in the superior to inferior direction. A pulse oximeter on the left index finger was used for peripheral gating with the minimum trigger delay, 4 views per segment and reconstruction of 50 images spanning the R-R interval with temporal resolution of 15-20 ms depending upon patients' heart rates. All 2D cine PC data were post-processed using Medis flow analysis software to obtain flow velocity and flow volume and were correlated with the SFA disease severity which was determined on Gd-enhanced 3D MRA images. Data were acquired in 9 healthy volunteers.

***Results***: For 28 arterial segments in 14 patients, 7 were widely patent, 6 had mild-to-moderate stenoses, 7 were severely stenotic and 8 were occluded. During compression, flow velocity and flow volume decreased the same amount below and above the SFA with normal arteries and arteries with only mild stenoses. In severe stenoses and occlusions, the decrease of flow volume and flow velocity below the lesions was much greater than above the lesions (70% vs. 30%) likely related to collateral flow. The average ratio of flow volume during/pre suprasystolic compression was 0.47 for the normal arteries, 0.56 for mild stenoses compared to 0.25 for severe stenoses and 0.37 for occlusions, suggesting that collateral arteries were better suppressed than the SFA by thigh compression. The peak delay was prolonged during suprasystolic compression for severe stenoses (from 75 to 233 ms, p = 0.049). After thigh compression, hyperemia was found in 19 arterial segments compared to baseline flow at rest (normal: 3/7; mild: 6/6; severe: 6/7; occlusion: 4/8).

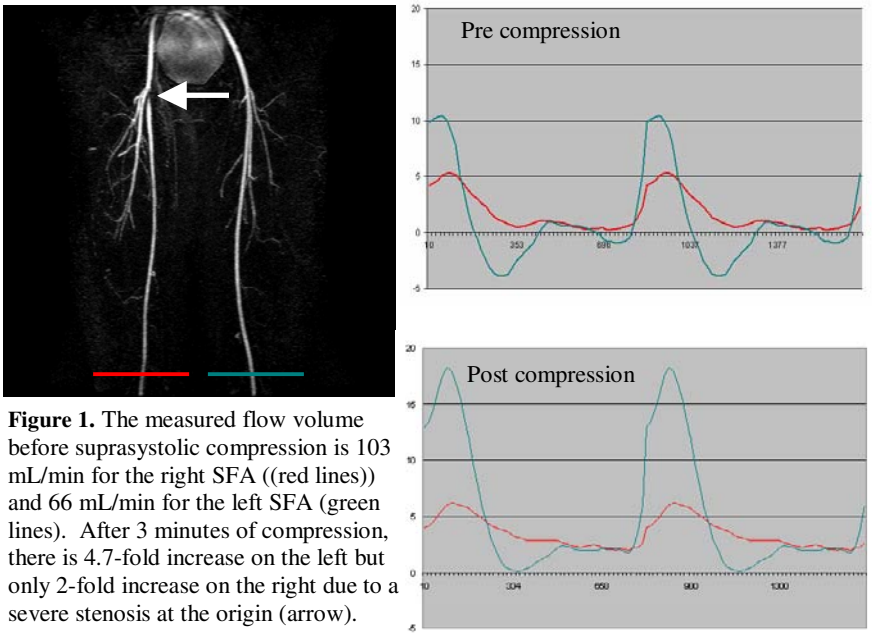


**Figure 1.** The measured flow volume before suprasystolic compression is 103 mL/min for the right SFA ((red lines)) and 66 mL/min for the left SFA (green lines). After 3 minutes of compression, there is 4.7-fold increase on the left but only 2-fold increase on the right due to a severe stenosis at the origin (arrow).

***Discussion:***

Combining functional evaluation with morphological depiction of vascular disease has been investigated by many authors (1-12). Cine PC analysis of flow information may help to reduce interobserver variability on stenosis grading on MRA. Quantitative flow data may also increase the sensitivity and negative predictive value of MRA study thus yielding higher confidence when interpreting 3D MRA images.

In this study, three minutes of 200 mm Hg thigh compression is not sufficient to induce ischemia and hyperemia when the SFA is normal. But when there are severe stenoses with collateral flow, suprasystolic compression causes ischemia and induces subsequent hyperemia upon release of the compression. This likely reflects easier and more complete compression of collateral flow which occurs in more superficial and more easily compressed arteries. This offers an opportunity to identify hemodynamically significant stenoses for which flow is more easily manipulated by compression of collaterals.

***Conclusion***:

Arterial flow measurements at higher flow rates, e.g. after exercise or induced ischemia with suprasystolic thigh compression may be helpful to determine if a borderline stenosis is flow limiting.

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