Application of curve-fitting to improve the accuracy and reliability of distance-density curve matching angiographic blood flow measurement methods.

Blood flow rate is an important parameter for functional evaluation of vascular disease. If instantaneous blood flow measurements from digital cerebral angiograms could be performed during endovascular interventional procedures, this could provide interventional radiologists with minimally invasive real-time flow measurements.

Previous research has indicated that distance-density curve matching (DDCM) methods are a promising class of videodensitometric techniques. However, the published techniques have low resistance to noise and image artifacts, and suffer from a relatively low theoretical upper limit imposed on the measurable flow rate. As a result, during contrast wash-out the variability between consecutive measurements may achieve values as high as 107.3%.

We propose to fit smooth curves to profiles of differences between distance-density curves obtained at consecutive frames. The fitted curves can potentially reduce the effects of noise, image defects and flow irregularities. Extrapolation of fitted curves beyond the existing data may increase the theoretical limit on the maximum measurable flow rate.

The proposed modifications were evaluated using both simulated angiograms and angiograms obtained by imaging a flow phantom under clinically realistic flow and contrast injection conditions. They were also compared with other videodensitometric techniques. The use of the curve-fitting modification resulted in reduction of variability between consecutive measurements from 86.7% to 39.2% at the cost of increasing bias from 10.9% to 16.5%.

Our results indicate that under the conditions of constant flow the proposed modifications yield some improvement in both accuracy and reliability of instantaneous flow rate measurements.