A New Method Evaluating Vessel Stenosis with the Digital Subtraction Angiography

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Summary

Two ways of determining flow in vessels using a digital subtraction unit are evaluated. The first method uses time density curves the second the opaque media bolus profile. Both methods are applied to a phantom having different degrees and lengths of stenoses as well as different system pressures and different afterloads. The flow calculated by both methods is related to the actual flow and the results are discussed.

Introduction

The pathological significance of the degree of vessel stenosis is related to the actual change of flow (8). A digital angiographic system allows image information by pixel. Blood flow can be determined by evaluating temporal changes in radiographic densities at a certain pixel above a vessel during an angiographic series. This means to measure at a constant place over a period of time. The resulting curves (TDC) are commonly used to determine blood flow in digital angiography.

To get reliable flow parameters the acquisition rate has to be high enough, at least six frames per second. Some authors recommend acquisition rates even as high as 25 frames per second (5,6). The disadvantages are high radiation dose to the patient and worse imaging quality.

Using the second method, the acquisition rate can be even lowered. Flow measurement depends on measuring at several different points at the same time. The information then received differs from the one received by evaluating TDCs, but is a parameter reliable enough to calculate the flow with a lower frame rate.
Method

The phantom consists of two parallel vessels filled with water coming from an elevated storage. The water passes an electronically controlled proportional magnetic valve. Behind the valve a straight F5 catheter is inserted into the vessel to administer opaque media. The vessel then splits into two parallel branches in which the primary flow is equal. The opaque media bolus passes thru both vessels simultaneously as long as the lumina are identical. The afterload is changed by elevating or lowering the ends of the vessel.

Magnetic valve and elevated water storage control the primary flow. The column of water simulates normal blood pressure. Three elevations can be chosen: equaling 90 Torr, 110 Torr, or 130 Torr. The circumference of the circular water container is 141 cm, so the pressure difference between start and end of a single run is at the most 0.32 cm column of water equal to a change of 0.2% to 0.3% depending on the chosen system pressure.