Anatomy and functional significance of coronary collaterals

Martin Kaltenbach, M.D.
Gilbert Kober, M.D.

Frankfurt am Main, West Germany

Today the discussion on existence or nonexistence of coronary collaterals is historical. Collaterals can be visualized during coronary angiography as well as on postmortem studies. In the beating heart they are seen in the majority of patients with severe obstructive coronary heart disease.

The anatomical distribution is well defined. Collateral connections between right and left coronary arteries exist mainly in the area of the anterior right ventricular wall, the posterior left ventricular wall, around the apex of the heart, through the atrioventricular groove via atrial arteries, and within the intraventricular septum.

Collaterals can occur in the subepicardial, intramural, or subendocardial layers. Collaterals in the subepicardial layer show extensive variation in number and size; sometimes one single collateral vessel can measure more than 1 mm in diameter. The transseptal, intramural collaterals on the other hand are more uniform and mainly depend on anatomic variation of posterior and anterior septal branches. The subendocardial collaterals often seen in postmortem angiograms cannot be well separated angiographically (Fulton).

The functional significance of collaterals is in no doubt in clinical situations such as total occlusion of the left main coronary artery with well-conserved

left ventricular function. In other situations, however, functional significance of collaterals remains questionable. The well-known relationship between severity of coronary artery disease and angiographic presence of coronary collaterals can be interpreted in different ways. The conclusion that existence of good collaterals is a sign of poor prognosis does not reflect the whole truth. From experimental studies as well as from estimation of collateral blood flow during coronary surgery, it can be concluded that myocardial oxygen demand under resting conditions can be met by well-developed collaterals.

Blood flow to collateral-dependent myocardium becomes, however, impaired during stress even with good collateralization (Flameng, Walter, Schwarz, Schaper).

From cinecoronary arteriograms, collateral blood flow can be semiquantitatively evaluated by means of a scoring system. The collateral score includes size of perfused myocardial area, size, and number of collaterals as well as the resulting flow in the collateral receiving vessel. By means of this semiquantitative evaluation the functional significance of coronary collaterals can be demonstrated under different situations such as single-, double-, and triple-vessel disease. On the other hand, no relationship between preservation of myocardium and collaterals can be derived if one looks merely at the existence or nonexistence of collateral vessels.

A controversial problem still under discussion is the time requirement in relation to the potential development of collaterals. From experiments as well as from repeated angiograms in humans (Bourassa), it can be concluded that after creation of a positive pressure gradient along a collateral channel the opening and potential development of collaterals is finished within a rather short period of time. There is no evidence that factors like physical activity or drug therapy are of significant additional influence on the speed or amount of collateral development.

Today, therefore, collaterals can be considered one important factor against fatal influence of coronary artery occlusion. The potential benefit is limited and much dependent on individual factors. Those factors include coronary anatomy, i.e., size, number, and localization of collaterals within the heart and localization within the ventricular wall. It also includes perfusion pressure and diastolic filling pressure, i.e., diastolic pressure within the ventricular wall. In addition, the anatomy of collaterals giving and collaterals receiving vessels as well as the time factor are of influence.