



THE ROLE OF COLLATERAL CIRCULATION IN PRESERVING MYOCARDIAL FUNCTION

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ABSTRACT

The coronary collateral circulation is an alternative source of blood supply to the myocardium jeopardized by the failure of the original stenotic or occluded vessel to provide adequate blood flow to this region. One hundred coronary angiograms and left ventriculograms of patients with coronary artery disease from the Cardiology Department of University Clinics Centre in Sarajevo were reviewed. The role of collateral circulation in preserving myocardial function was assessed by comparing regional left ventricular contractility in 34 instances of total arterial occlusion and adequate collateral circulation with that in 34 instances of total arterial occlusion and inadequate collateral circulation. Among the group with adequate collaterals, regional left ventricular contraction was normal in 41%, hypokinetic in 53% and akinetic or dyskinetic in only 5%. Among the group with inadequate collaterals, regional contraction was normal in 9%, hypokinetic in 20% and akinetic or dyskinetic in 70%. These data indicate that collateral circulation plays an important role in preserving myocardial contractility in patients with coronary artery disease.

KEY WORDS: coronary artery disease, angiography, collaterals, ventricular wall motion

INTRODUCTION

The normal human heart has been found to contain a profusion of small, anastomotic vessels classified as “homocoronary” anastomoses if they connect segments of the same artery and “intercoronary” anastomoses if they connect branches of different arteries. Although the anastomoses can be identified in autopsy specimens, they cannot be demonstrated angiographically when normal or only mildly impaired circulation is present because they carry only minimal flow and their small size is beyond the limits of resolution of presently available imaging systems for coronary arteriography. If obstruction of a major artery occurs, however, a transanastomotic pressure gradient is created in those anastomoses connecting the distal segment of the involved artery with either the proximal segment of the same artery or nearby segments of other arteries. Because of this gradient, an increased volume of blood is propelled

through the anastomoses, which progressively dilate and eventually become visible angiographically as collateral channels (1,2) The collateral circulation has been studied in experimental animal models with certain limitations on their applicability to humans. The in vivo assessment of collateral function in humans developed from a qualitative anatomic evaluation by angiography to a physiological assessment by microsensors recording coronary flow velocity and pressure during cardiac catheterization. Most of these studies were done in selected patients with single vessel disease, nonocclusive lesions, and normal ventricular function (3,4,5,6). Little is known of the prominent role of collaterals in chronic total coronary occlusions. In chronic total occlusions, the collaterals are capable of complete preservation of myocardial function or of providing a minimum perfusion for hibernating myocardium. Both the extent of preserved regional function and the duration of the occlusion would be likely determinants of collateral function (7,8,9,10,11,12) The purpose of this study is to define the specific pathways of the coronary collateral circulation, and second, to determine the effect of this collateral circulation upon left myocardial function.

MATERIAL AND METHODS

Coronary angiograms and left ventriculograms of hundred patients with significant coronary artery disease were analyzed. Coronary arteriography was performed by the percutaneous transfemoral approach originally described by Judkins. Serial radiographs of the coronary arteries were obtained in the right and left anterior oblique projections. For all patients we applied left ventriculography for the evaluation of its function, ejection fraction and kinetics. Left ventriculography was performed in the right anterior oblique projection. The effect of collaterals upon myocardial function was studied in 68 instances with occlusion of the left anterior descending artery (LAD) and right coronary (RC) artery. On the angiograms we analyzed collaterals as "good" (average caliber greater than 1,0 mm) and "bad" (average caliber 1mm and less). Based on value of ejection fraction (EF) we analyzed the role of collateral circulation in preserving of left myocardial function. The performance of the various regions of the left ventricle was evaluated by studying contractility of the chamber as seen at ventriculography. Regional function was considered normal, if there was uniform, forceful and nearly concentric contraction of the endocardial surface. It was considered mildly impaired if hypokinesia was present, and severely impaired if akinesia or dyskinesia occurred. Regional contractility

of the affected myocardial segments in the groups with adequate and inadequate collateral circulation was then compared. The investigations were done with respect to ethical standards regulated by Helsinki Declaration.

RESULTS

Among the 100 angiograms with narrowing greater than 90% or complete occlusion of the coronary arteries, adequate collateral circulation was visualized in 34 instances (Figure 1 and 2). We established equal number of instances with inadequate collateral circulation. The different collateral pathways were noted in patients with right and left coronary obstruction. Homocoronary and intercoronary pathways, a network of very small and short channels is frequently seen bridging a localized obstruction of a major coronary artery. Our results showed the differences in associated regional left ventricular function contractility into groups with

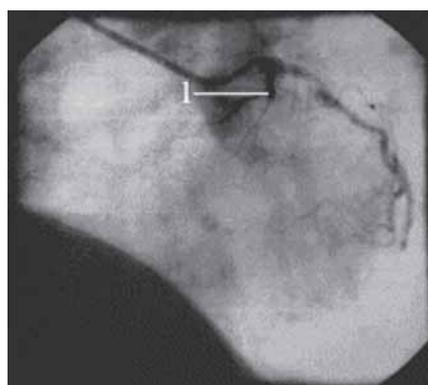


FIGURE 1. Left coronary angiogram (LAO projection)
1. Proximal occlusion of the left coronary artery

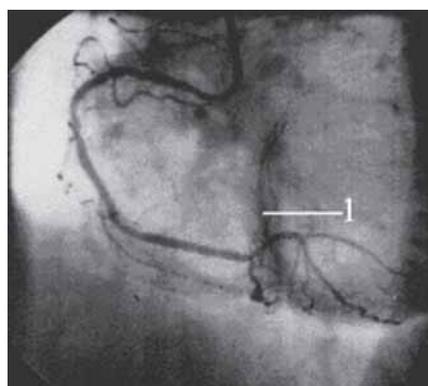


FIGURE 2. Right coronary angiogram (LAO projection)
1. Distal part of left anterior descending artery filling from the posterior descending artery

adequate and inadequate collateral circulation. It was found that in the group with adequate collateral circulation (34 instances), regional left ventricular function was normal in 14 cases (41%), mildly impaired, (hypokinetic) in 18 (53%). In only 2 instances (5%) were akinesia or dyskinesia seen. (severely impaired). On the other hand, in the group with inadequate collateral circulation, normal regional contractility was present in only 3 (9%), and hypokinesia in 7(20%). The vast majority, 24 cases or 72%, demonstrated akinesia or dyskinesia of the corresponding myocardial segment. Using Student-t-test the differences between the groups were significant at the 0,01 level. In the group with adequate collaterals and good left ventricular function the values of ejective fraction (EF) was about 60%, in the second one was about 36%.

DISCUSSION

This study indicates that collateral circulation plays a major role in preserving myocardial function in patients with coronary artery disease, a view which has been substantiated in material presented recently by several other groups. Investigators (1,2,) found that contraction abnormalities were slightly more prevalent among the group with collaterals and concluded, therefore, that collateral circulation did not protect against development of an abnormal left ventricular contraction pat-

tern. Although the present study and recent work of other groups (3,4,5,6) have indicated that effective collateral circulation helps preserve myocardial function in patients with coronary artery disease, several additional aspects may require further clarification. First, it must be determined whether the existence of a well-developed collateral circulation can prevent future infarction or death. Authors (7,8) have investigated this point and concluded that it does not provide such protection. On the other hand (9,10) has stated that patients with adequate collateral circulation emanating from non-stenotic arteries have a significantly better prognosis than patients with poorly developed collaterals. A recent study by (11,12) has confirmed that an improved long term prognosis is associated with good collateralization in patients with angiographically documented single and double vessel coronary disease. The surgical significance of collateral circulation likewise has not yet been properly evaluated. On the one hand, by preserving both left ventricular contractility and patency of the distal segments of obstructed arteries, collateral circulation maintains conditions which are favorable for the construction of successful coronary bypass grafts. On the other hand, there may be cases in which the autorevascularization of collateral circulation is sufficient to obviate the necessity of surgical revascularization.

CONCLUSION

Collateral circulation was better in patients with coronary occlusion and normal regional function than in those with impaired regional function. The present study have indicated that effective collateral circulation helps preserve myocardial function in patients with coronary artery disease. The effective collaterals with diameter more than 1mm have importance role in protection of left ventricle function (EF-60%). On the other hand, collaterals with diameter less than 1mm can not preserve left ventricular function. (EF-36).

REFERENCES

- (1) Levin D.C. Pathways and functional significance of the coronary collateral circulation. *Circulation* 1974; 50 (4): 647-865.
- (2) Kamenica S. Karakteristike i značaj koronarnog kolateralnog krvotoka u naših bolesnika sa totalnom okluzijom glavnog stabla leve koronarne arterije. *Vojnosanit. Pregl.* 1984; 41:4, 235-239.
- (3) Hasanović A. Myocardial perfusion scintigraphy and echocardiography in patients with coronary collaterals. *Med. Jour.* 2002;8(1):32-35.
- (4) Hasanović A., Šišić F., Dilberović F., Ovcina F. Collateral circulation in human heart. *Bosn. J. Basic Med. Sci.* 2005; 5(2):87-91.
- (5) Seiler C., Billinger M., Fleisch M., Meier B. Washout collaterometry: a new method of assessing collaterals using angiographic contrast clearance during coronary occlusion. *Heart* 2001;86:540-546.
- (6) Rockstroh J., Brown G. Coronary collateral size, flow capacity, and growth. *Circulation* 2002; 105:168.
- (7) Pohl T., Hochstrasser P., Billinger M., Fleish M., Mailer B., Seiler C. Influence on collateral flow of recanalising chronic total coronary occlusions: a case-control study. *Heart* 2001; 86: 438-443.
- (8) Werner G.S., Ferrari M., Betge S., Gastman O., Richartz M.B., Figulla H.R. Collateral function in chronic total coronary occlusions is related to regional myocardial function and duration of occlusion. *Circulation* 2001;104: 2784
- (9) Timothy D.H. Therapeutic angiogenesis. *BMJ* 1999; 318:1536-1539
- (10) Werner S.G., Richartz B.M., Gastman O. Immediate changes of collateral function after successful recanalisation of chronic total coronary occlusions. *Circulation* 2000;102:2959
- (11) Seiler C., Fleisch M., Meier B. Direct intracoronary evidence of collateral steal in humans. *Circulation* 1997; 96:4261-4267.
- (12) Rapps J.A., Myers P.R., Zhong Q., Parker J.L. Development of endothelium-dependent relaxation in canine coronary collateral arteries. *Circulation* 1998; 98:1675-1683.