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*Case report* ■

# Clinical Significance of Collateral Blood Vessels

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## SUMMARY

Special clinical conditions of the heart create collaterals, primarily myocardial ischemia, hypertension, cardiac hypertrophy or atherosclerosis.

The aim of the paper was to show the importance of collateral vessels in clinical practice, particularly in the rehabilitation of coronary heart disease.

The paper presents a case report of a patient 62 years old, anesthesiologist, who came for examination because of the pain in the shoulder, discomfort in the chest and pronounced fatigue with a sense of shortness of breath. Prior to these problems, he was extremely physically active (cultivated three hectares of land every day). Submaximal exercise test was negative, while the coronarography found 100% occlusion of the right coronary artery (RCA), while the left coronary artery (LCA) was characterized by adequate patency. Collateral blood vessel were labelled as well-developed. Risk factors: active smoker, elevated cholesterol values and dyslipidemia, positive heredity. Another risk factor was exposure to stress. Ten years later, a new assessment of coronary artery disease was performed due to marked fatigue and arrhythmias. On the stress test ECG, bigeminy was detected. As previously, coronarography showed 100% occlusion of RCA, with 30% narrowing of LCA. Echocardiographic findings of the heart were regular.

Angiogenesis occurs under the influence of adenosine in hypoxic conditions, when stenosis must be at least 70% and is influenced by EDRF. Collateral blood vessels are of great importance in the pathophysiology and prognosis of coronary artery disease and myocardial infarction. Owing to the collateral, the same changes in the angiogram of large coronary blood vessels do not give the same electrocardiographic and clinical presentation. Well-developed collateral circulation prevents the spread of necrosis, and serious damage due to collagen formation after myocardial infarction. Speed and level of collateral development depends on the degree of stenosis and time of exposure to ischemia. The development of collateral blood vessels is probably genetically predetermined.

**Key words:** collateral blood vessel, hypoxia, coronary rehabilitation

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## INTRODUCTION

Special clinical conditions of the heart create collaterals, primarily myocardial ischemia, hypertension, cardiac hypertrophy or atherosclerosis. Collateral blood vessels could be intracardiac or extracardiac. The intracardiac ones could be located intracoronary when the arterial collateral circulation is at the same level of coronary arteries and present in the whole heart under epicardial and intercoronary (heterocoronary) collaterals in the presence of anastomosis between the two different arteries, usually localized subepicardially. Intracoronary anastomoses develop in the fetal period and persists postnatally till eight months of age. After that period, their size and number are reduced. However, it is found that some people do not have collateral circulation or react to provocative factors, which leads to conclusion that the development of collaterals is probably genetically predetermined. There are collaterals which are constantly involved in the circulation and those are created ad hoc in response to provocative factors - ischemia, hypertension, atherosclerosis; the latter are called collateral channels. The first intercoronary anastomoses were described by von Haller in 1789. These anastomoses are usually located in the interventricular and interatrial septum. In the area of interventricular septum, the anterior and posterior penetrating arteries commonly make anastomosis in the middle part of the ventricular septum, initial parts of the left and right coronary arteries, right ventricular branch of LAD and RCA, r.interventricularis anterior (LAD) and r. interventricularis posterior on apex, r.interventricularis posterior with r. marginalis dexter, r. marginalis sinister, small branch behind the artery which connects the initial part of DCA and LCA. According to Coreia, anastomosis between the left and right atrial, ventricular and septal branches is relatively common among young people. In 1929, Kugel described the anastomosis between the initial part of the left circumflex artery (Lcx) and RCA over the interatrial septum, close to ventricular border, which makes a direct connection with RCA (r. atrialis anastomoticus- Kugel's artery- arteria anastomotica auricularis magna). Sometimes, a separate branch comes from this artery which presents very important collateral path for AV nodus. Artery for SA nodus (r. nodi sinuatrialis) makes anastomosis with the right and left atrial intermediary branches, as well as posterior left atrial branch Lx and Kugel's artery in around 66% of cases. Artery for AV nodus (r. nodi atrioventricularis) makes anastomosis with perforating branches from the initial part of interatrial septum which comes from Lcx, r. interventricularis anterior (RIA) and Kugel's artery.

Occasionally, as a response to ischaemia, extracardiac anastomosis of CA arises. This anastomosis occurs often between CA and front mediastinal, pericardial, rear intercostal, upper and lower diaphragmal, esophageal, pericardiophrenic or bronchial arteries. Extracardiac anastomosis sometimes arises from vasa

vasorum large arteries and veins. These anastomoses are meandering blood vessels entering myocardium through pericardium (1).

Angiogenesis or neovascularization occurs under the influence of adenosine in hypoxic conditions when stenosis of blood vessel must be at least 70% and under the influence of endothelium-derived relaxing factor (EDRF) (2, 3).

Collateral blood vessels have great significance in the pathophysiology and prognosis of coronary artery disease and myocardial infarction. There have been instances of complete occlusion of CA with no electrocardiographic and metabolic changes in lactate level, which are typical markers of ischemia.

Owing to collateral vessels, the same changes in angiogram of large collateral coronary blood vessels do not give the same electrocardiographic and clinical picture.

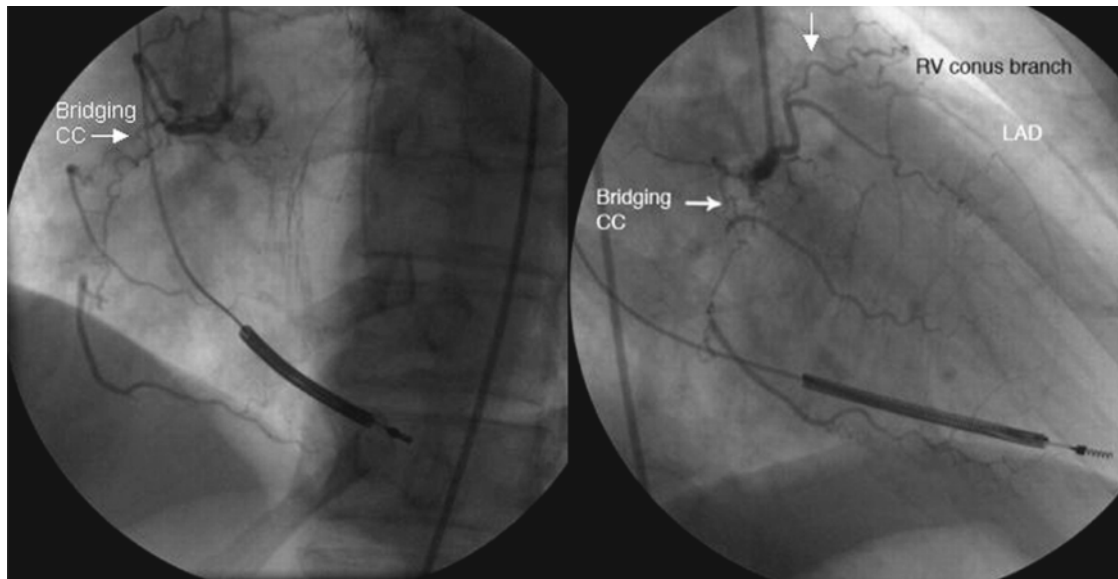
According to Mc Donald, a better developed collateral circulation prevents the spread of necrosis, damage to collagen and serious after-myocardial infarction.

Speed and level of development of collateral vessels depend on the degree of stenosis and ischemia time exposure, which is used in rehabilitation of coronary heart disease (4, 5).

## CASE REPORT

A 62-year-old male, anesthesiologist, presented with atypical pain in the shoulder, chest discomfort, fatigue, and soon after with a sense of shortness of breath. He was a smoker, 45 packs/year. His physical examination was unremarkable, but laboratory analysis showed high levels of triglycerides and cholesterol (8.5mmol/l). He had positive family history for cardiovascular disease. Another risk factor was exposure to stress. Prior to these problems he was extremely physically active (cultivated three hectares of land every day). Submaximal exercise test was negative. In respect to his occupation, history of smoking, positive heredity, he was referred for coronary angiography. On coronarography, 100% occlusion of the right coronary artery (RCA) was found, while the left coronary artery (LCA) was characterised by adequate patency. Coronarography also showed the presence of well-developed collateral blood vessels. He was treated with statins only.

Ten years later, there was a medical check-up due to pronounced fatigue and arrhythmias. On stress test ECG, bigeminy was detected. Levels of triglycerides and cholesterol were 5.86 and 2.40, respectively. Coronary angiography was performed and showed persistent 100% occlusion of RCA, with 30% narrowing of LCA (Figure 1). Echocardiographic findings of the heart were almost regular.



**Figure 1.** Chronic total occlusion of RCA with well-developed collateral blood vessels

Now, he has problems with heavy physical work, he cannot go for running and even more problems when he gets upset. He regularly takes medications and walk every day at least two kilometers.

## DISCUSSION

Coronary collateral circulation in the presence of obstructive coronary artery disease has been well described. In the presence of a significant lesion, the perfusion pressure in the distal vascular bed falls, which causes myocardial ischemia and leads to the recruitment of collateral arteries. These collaterals increase in size and subsequently become angiographically visible. These vessels are generally tortuous, tapered toward the recipient artery, have a variable location and are usually well-demarcated from the supplying and recipient arteries. In addition to a significant stenosis of the coronary arteries, anemia, cardiac hypertrophy and hypoxia can also contribute to the development of collateral coronary circulation (6-8). In our patient, apart from occlusion of DCA which recruited collateral circulation, extreme physical activity also contributed to its development.

## CONCLUSION

It has been proposed that collateral coronary vessels are of two types, congenital and acquired. The acquired forms arise as a consequence of coronary stenosis or are in relation to ventricular hypertrophy and hypoxia. The angiographic appearance clearly separates the congenital and acquired forms. The absence of coronary arterial stenosis, intersulcal location, nontapering appearance, absence of tortuosity, and absence of a clear delineation of the collateral favor a congenital origin. In contrast, the presence of coronary stenosis, tortuosity, tapering appearance, nonsulcal location, and the ability to delineate the collateral vessel favor an acquired coronary collateral vessel. In our patient, apart from occlusion of DCA which recruited collateral circulation, extreme physical activity also contributed to its development.

Secondly, the presence of collaterals does not always imply the presence of obstructive coronary artery disease. The uncommon presence of such collaterals in normal subjects may have a protective role if the patient develops coronary artery disease (8).

## References

1. Pejković B, Bogdanović D. Arterije i vene srca. Savremena administracija, Beograd, 1995: 3-33.
2. Strijdom H, Chamane N, Lochner A. Nitric oxide in the cardiovascular system: a simple molecule with complex actions. *Cardiovasc J Afr* 2009;20(5): 303-10.
3. Vita JA, Hamburg NM. Does endothelial dysfunction contribute to the clinical status of patients with peripheral arterial disease? *Can J Cardiol* 2010; 26 Suppl A:45A-50A.
4. Pasternak R. Acute myocardial infarction in heart disease. 4th Edition, Philadelphia 1992: 1222-313.
5. Werner G, Ferrar M, Betge S, Gastmann O, Richartz B, Figulla H. Collateral function in chronic total coronary occlusions is related to regional myocardial function and duration of occlusion. *Circulation* 2001; 104: 2784.

6. Celano C, Peters RW, Fisher ML. Coronary collateral blood flow in a patient with angiographically normal coronaries. *Cathet Cardiovasc Diagn* 1987;13:325–326.
7. Linsemeyer GJ III, Schneider JF. Angiographically visible intercoronary collateral circulation in the absence of obstructive coronary artery disease. *Am J Cardiol* 1984;53: 954–6.
8. Lefèvre T, Bernard A. Intercoronary anastomoses of congenital origin. A propos of case. *Arch Mal Coeur Vaiss* 1989;82: 949–52.

## **KLINIČKI ZNAČAJ KOLATERALNIH KRVNIH SUDOVA - PRIKAZ SLUČAJA**

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### **Sažetak**

**U posebnim kliničkim uslovima, srce stvara kolateralne krvne sudove, kao što su ishemija i hipertrofija miokarda, hipertenzija ili ateroskleroza.**

**Cilj rada bio je pokazati važnost kolateralnih krvnih sudova u kliničkoj praksi, naročito u rehabilitaciji kardioloških bolesnika.**

**Bolesnik star 62 godine, anesteziolog po zanimanju, žali se na bol u ramenu, nelagodnost u grudima i brzi zamor sa osećajem nedostatka daha. Pre navedenih tegoba, bio je veoma fizički aktivan (obrađivao je skoro 3 hektara zemlje svakodnevno).**

**Submaksimalni test opterećenja bio je negativan, dok nalaz na koronarografiji ukazuje na 100% zakrčenja desne koronarne arterije (DKA), leva koronarna arterija urednog nalaza, uz registrovane dobro razvijene kolateralne krvne sudove. Faktori rizika: aktivni pušač, povišen nivo holesterola, dislipidemija, pozitivan hereditet. Drugi faktori rizika: izloženost stresu, fizička aktivnost, normalna uhranjenost. Deset godina kasnije, žali se na brže zamaranje i aritmije. Stres test pokazuje bigeminiju. Koronarografija ukazuje na 100% perzistiranje okluzije DKA, sa 30% suženjem leve. Ehokardiografski nalaz uredan.**

**U hipoksičnim uslovima, kada stenozna krvnog suda mora biti barem 70% pod uticajem adenzina, dolazi do razvoja angiogeneze, koja je, pak, pod uticajem endotelnog faktora relaksacije. Kolateralni krvni sudovi su jako bitni u prognozi koronarne bolesti i infarkta miokarda (IM). Zahvaljujući njima, iste promene u angiogramu velikih krvnih sudova ne daju isti elektrokardiografski nalaz i kliničku sliku. Dobro razvijena kolateralna cirkulacija sprečava nastajanje nekroze i uništavanja kolagena posle IM. Brzina i stepen njihovog nastajanja zavisi od stepena stenozne i vremena izloženosti ishemiji. Razvoj kolateralnih krvnih sudova verovatno je genetski predisponiran.**

**Ključne reči:** kolateralni krvni sudovi, hipoksija, rehabilitacija kardiovaskularnih bolesnika