Branching of Main Trunk of Left Coronary Artery and Importance of Her Diagonal Branch in Cases of Coronary Insuficiency

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Abstract

Proficiency in the anatomy of coronary arteries and their variations is significant for proper interpretation of the coronary angiographies, assessment of the complexity and result of the coronary insufficiency as well as surgical myocardium revascularization. The objective of this study is anatomy-radiology research of the methods of branching the main trunk of left coronary artery and to prove importance of the diagonal branch (ramus diagonalis) existence in the conditions of coronary insufficiency. In this study we have analyzed 100 coronary angiographies done at the Clinic for Heart Diseases and Rheumatism of the Clinic Center of University of Sarajevo and dissected 20 human hearts from the Institute of Anatomy. In our study we have come upon two methods of branching of main trunk of left coronary artery (bifurcation and trifurcation). By the method of the angiography we have found the bifurcation in 71% of cases while 65% of cases were proved by the dissection method. Trifurcation has been discovered in 29% of cases of analyzed angiographies i.e. 35% of cases of dissected hearts. We believe that third terminal branch of the left coronary artery should be marked as ramus diagonalis. This branch, including its anastomoses, presents important pattern of the collateral blood flow, which has special meaning, under conditions of coronary insufficiency.

KEY WORDS: main trunk, left coronary artery, ramus diagonalis

Introduction

Human heart in the most cases possess right and left coronary artery (a. coronaria dextra et a. coronaria sinistra), and in certain number of cases (5%) there are supernumerary heart arteries. We call them coronary because, they like a wreath encircle heart in particular groove. A.coronaria dextra originates from the right aorta sinus (sinus Valsavae dexter), headed from top toward frontal part and externally and emerges at the frontal part of heart. It passes through coronary groove and arrives at the back part of heart, where in the most cases ends at its back interventricularis groove (sulcus interventricularis posterior). A.coronaria sinistra originates from the left aorta sinus (sinus Valsavae sinister). Its main branch, after it passes by between the branches of pulmonary arteries and left aurikula, emerges at the frontal part of heart. When magisterial type of cases, here at this spot it splits on ramus interventricularis anterior and ramus circumflexus. However, there are numerous variations at the beginning, in the course and the method of branching of the heart arteries, and they appear in the most cases with left coronary artery. (2). Some hearts have the main trunk of left coronary artery containing three terminal branches. This occurrence is called trifurcation. The third branch flows on the frontal wall of left atrium and it is marked ramus diagonalis. Its vascular area is partially overlap with the area of vascularisation of ramus interventricularis anterior, and sometimes with the ramus circumflexus(3). Diagonal branch (ramus diagonalis) is significant for collateral coronary blood flow because it anastomoses to other branches of left heart artery with its sprigs. (4). Its importance is particularly expressed under conditions of insufficiency of ramus interventricularis anterior (5). Rarely, left coronary artery might have four or more terminal branches but then medium branches are having shorter flow than in case of trifurcation of the main trunk (6). Proficiency in anatomy of coronary arteries and their variations is significant for proper interpretation of the coronary angiographies, assessment of the complexity and result of the coronary insufficiency as well as surgical myocardium revascularization (2).

Objective

The objective of this study is anatomy-radiology research of the methods of branching of the main trunk of left coronary artery and to prove importance of the diagonal branch (ramus diagonalis) existence under conditions of coronary insufficiency.

Material and Methods

As supporting material, we have used in this study 100 coronary angiographies taken at the Clinic for Heart Diseases and Rheumatism of the Clinic Center of University of Sarajevo and 20 human hearts taken from the Institute of Anatomy. In our work, we used the method of coronary angiography and dissection method. All research described in submitted publication involving human subjects and material derived from human subjects complied with principles outlined in Helsinki Declaration. The method of **coronary agiography**, as well as use of appropriate contrast substance enabled that we were capable to visualize the heart blood vessels. Judkins left catheter was introduced through a.femoralis for left coronary artery and Judkins right catheter for right coronary artery. These catheters are thin, elastic and it is possible to introduce them through huge blood vessels to the heart. Blood pressures, content of gasses in the blood had been measured and iodine non-ion contrast substance was introduced that provides the image of blood vessels and heart cavities. Recording was done in **LAO** projection (left frontal projection) and in **RAO** projection (right frontal inclined projection). During the same act, the ventriculography of the left heart ventricle has been done allowing us to monitor its function, ejection capability and eventual disorder of its kinetics. The method itself lasts about half an hour; it is painless for patient who cooperates during the act with the team that perform the catheter process. During the process of the analysis of coronary angiographies, special attention was drawn to the method of branching of the main trunk of left coronary artery. In the analysis of statistic data, the percentage of representation of different methods of division of main trunk of left coronary artery has been determined and results had been compared depending to the gender of patients. In cases of simultaneous presence of ramus diagonalis and insufficiency ramus interventricularis anterior, the presence of homocollateral as well as the function of left ventricle was monitored. Functional state of left ventricle was assessed based on the value of ejected fraction (EF). **The dissection method** enabled the image of heart blood vessels as well as monitoring of their flow and branching. The heart samples were as fresh as possible; they were conserved from 3 to 5 days in 10% solution of formaldehyde. Upon this, fat tissue was removed and by careful dissection arterial blood vessels were prepared. The method of branching of the main trunk of left coronary artery was monitored as well as the course of terminal branches.

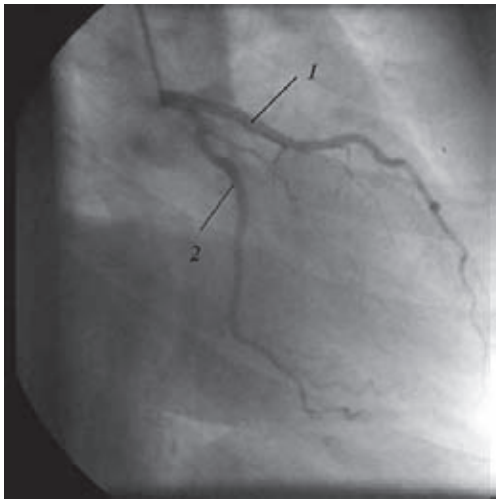

FIGURE 1. Angiography of left coronary artery in RAO projection presents bifurcation of the main trunk.

1-ramus interventricularis anterior
2-ramus circumflexus

RESULTS

We have analyzed 100 coronary angiographies in our work out of which 60 angiographies belonged to male persons while 40 angiographies belonged to female persons. On the angiographies taken in LAO and RAO projections, we monitored carefully the spots where coronary arteries were split as well as their course and division. There has been a presence of main trunk of the left coronary artery on all analyzed angiographies and we did not have any occurrence of independent emerging of ramus interventricularis anterior and ramus circumflexus from left sinus aorta. Also, we did not notice any other anomalies of emerging of these arteries' branches. We have noticed on the analyzed angiographies two methods of branching of the main trunk of left coronary artery: on two branches (**bifurcation**) and on three branches (**trifurcation**). Bifurcation, i.e. branching of the main trunk of left coronary artery on two terminal branches (ramus interventricularis anterior and ramus circumflexus) has been found in 71% of tested cases (Figure1). Out of 60 analyzed angiographies of male persons, bifurcation has been found in 73,33% of cases while remaining 40 analyzed angiographies of female persons bifurcation was present in 67,5% of cases (Table 1). Branching of the main trunk of left coronary artery on three terminal branches has been stated in 29% of cases

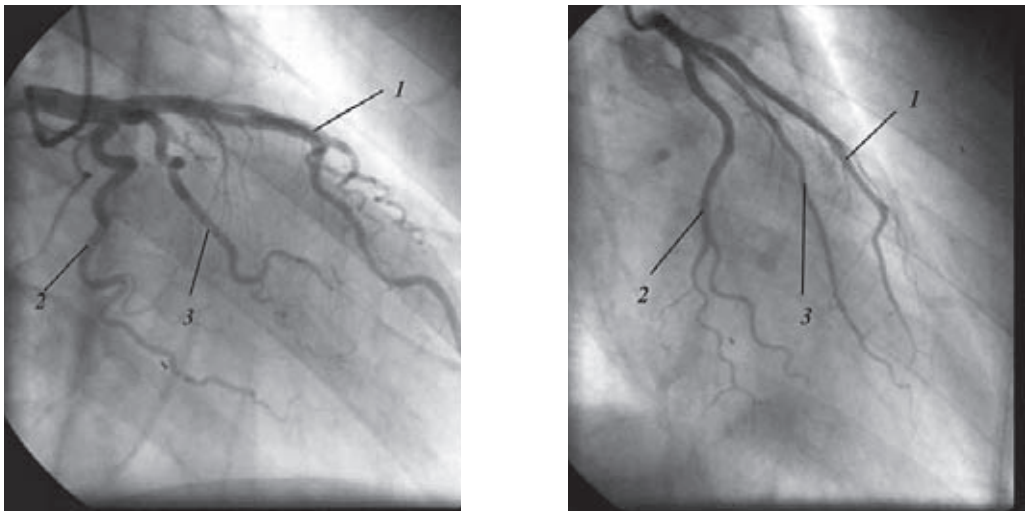

FIGURE 2a and 2b. Angiographies of left coronary artery in RAO projection (branching of the main trunk on three terminal branches)

1-ramus intervenrtricularis anterior; 2- ramus circumflexus; 3- ramus diagonalis

GENGER	BIFURCATION	TRIFURCATION	TOTAL
FEMALE	67,5%	32,5%	100%
MALE	73,33%	26,67%	100%

TABLE 1. Presentation of appropriate ramification methods of left coronary artery depending on gender (in percentages)

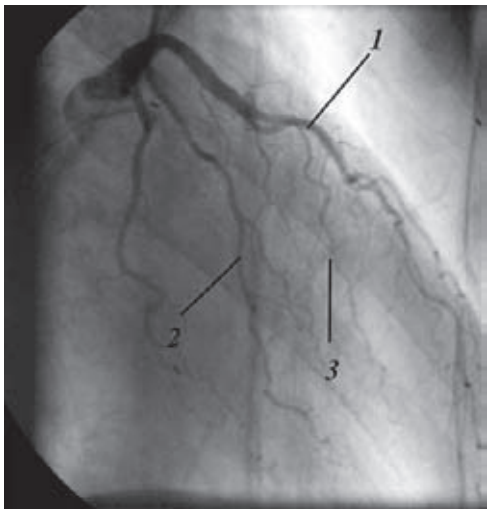

FIGURE 3. Angiographies of left coronary artery in RAO projection

1-ramus interventricularis anterior; 2- ramus diagonalis; 3-intraartery anastomozes

FIGURE 4. Human heart (dissected sulpha)
Bifurcation of main trunk of left coronary artery
1. ramus interventricularis anterior
2. ramus circumflexus

out of total number (100) of analyzed angiographies (Figure 2a and 2b). Trifurcation is common with female persons (32,5%), while 23, 75% with male persons. Not single analyzed coronary angiographies presented branching of the main trunk of left coronary artery on four or more terminal branches. Regarding changes on the ramus interventricularis anterior that cause its insufficiency, we have found strong collateral connections (Figure 3) with sprigs of ramus diagonalis, that resulted with good function of left ventricul (ejected fraction >50%). By the dissection method we were able to determine the presence of the main trunk of left coronary artery in all examined cases. Its average length is 16 mm (range from 5 to 22 mm).

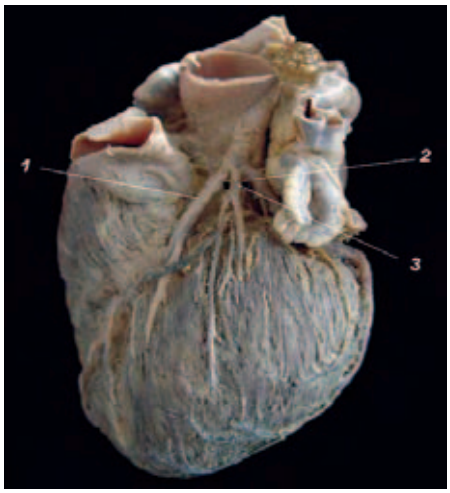

FIGURE 5. Human heart (dissected sulpha)
Trifurcation of main trunk of left coronary artery
1. ramus interventricularis anterior
2. ramus circumflexus
3. ramus diadonalis

Discussion

Numerous authors studied the method of branching of the coronary arteries and their variations: Angelini (1), Hadžiselimović (4), James (6), Džavahisvili, Komahidze (7) and other. As the left coronary artery, quite often we find variations in the source, in the course and method of branching than it is the case of right coronary artery (2). James (6) emphasis that left coronary artery in most of cases is divided on two branches, and rarely there is bigger number of terminal branches. If left coronary artery is divided on two branches than we deal with magisterial type of artery, but if it ends with bigger number of terminal branches then we deal with diffusive type of artery (4). Reig (8) used dissection of 100 samples of hearts; he discovered that bifurcation of main trunk of left coronary artery is presented in 65% of cases, trifurcation was presented in 31% of cases and squarefurcation in 4% of cases. Cavalcanti (2), Džavahivisvili (7), Šećerov (9), Surucu (10), Wieloposh (11) and others reached approximate results in their researches. The frequency of the trifurcation of main trunk of left coronary artery determined during our researches confirmed results achieved by the above mentioned authors. We could not find division of left coronary artery into 4 or more branches with the dissection method or by analyzes of the coronary angiographies.

In the studies done by Garg (12) and Yamanaka (13), it is pointed out that some persons (1%) do not have main trunk of left coronary artery and ramus interventricularis anterior and ramus circumflexus have independent beginning originating from left aortic sinus (sinus Valsavae sinister). We have not found any of such cases in our studies as well as some other anomalies originated in left coronary artery and its branches. We faced with different names for third terminal branch of the main trunk of left coronary artery in the literature. Some authors mark it as ramus diagonalis (4,3), other call it medium left artery (10) or ramus intermedius (14). We think that the most appropriate name for this branch is ramus diagonalis. Ramus diagonalis flows over frontal wall of left ventricul and its vascular area is partially covered with the vascular area of ramus interventricularis anterior. Due to this reason, in cases of occlusion of the anterior interventricular branch or its lateral sprigs, diagonal branch softens ishemia of anterior wall of left ventricul (3,10). This is realized by collateral blood flow i.e. anastomoses of sprigs of anterior interventricular branch (ramus interventricularis anterior), with sprigs of diagonal branch, and sometimes with sprigs of arch branch (4,10,15). The importance of this inter artery connections under conditions of the coronary insufficiency are stressed by other researchers (5,16). This has been confirmed in our researches because in cases of the simultaneous presence of ramus diagonalis and insufficiency ramus interventricularis anterior, we noticed developped inter artery connections and good function of left ventricul.

Conclusions

- We found two methods of branching of main trunk of the left coronary artery in the researches we have conducted (bifurcation and trifurcation).
- The bifurcation has been found by method of angiography in 71% of cases while it has been proved by dissection method in 65% of cases.
- Trifurcation has been declared on 29% of analyzed angiographies i.e. 35% of dissected samples of heart.
- We found higher percentage of trifurcation of the left coronary artery with females (32,5%), while 26,67% with males.
- Considering the branching from the main trunk of the left coronary artery, we find that the most appropriate name for its third branch would be ramus diagonalis.
- Diagonal branch with its anastomoses present an important way of coronary collateral blood flow under conditions of coronary insufficiency.

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