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Coronary arteries morphometry and their vascular territories

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ABSTRACT
Our study was performed on a total of 24 angioCT's by each coronary artery executed on a GE LightSpeed VCT64 Slice CT Scanner. To assess the type of vascularization (coronary dominance) we used also dissection on fresh and formalin preserved hearts, injection of contrast substance followed by radiography and plastic mass injection followed by corrosion. Left coronary artery from origin I found a diameter of between 4.1 to 5.8 mm, the length of the left main coronary artery until its branching (bi or trifurcation) ranging from 3 to 11.8 mm. The diameter of the anterior interventricular artery, was between 1.8 to 3.4 mm, and when the anterior interventricular artery branched off a left marginal artery, it was less voluminous than the case when the marginal artery origin by trifurcation of coronary artery, with 1.8-2.5 mm. Anterior interventricular artery detach left anterior ventricular branches with a diameter of 1.2-2.2 mm. Circumflex artery present a diameter of 2.1 to 4.2 mm at the left aspect of the heart circumflex artery has a diameter of 2.1 to 3.4 mm. On the posterior surface of left ventricle from circumflex artery branches come off with 1.2 to 2.4 mm in diameter. Left marginal artery, when originate from the left coronary artery had a diameter of 2.1 to 2.8 mm. The right coronary artery presents at origin a diameter of 3.1 to 5.4 mm, from the coronary right for the anterior aspect of the right ventricle unhooking the branches with a diameter of 2.2 to 4.2 mm. To the posterior of the right ventricle right coronary artery gave branches with a diameter of 1.6 to 2.6 mm. Right marginal artery had a diameter of 1.6-2.2 mm, and in one case (4.17% from cases) had a diameter of 3.4 mm (when the right coronary origin was 5.4 mm). From right the coronary atrial branches detaches with a caliber of 0.6-2 mm. Regarding the coronary dominance, we found on a number of 88 hearts that in 29.54% of cases there is predominance of right coronary artery in 25% of cases there is a predominance of the left coronary artery, and in 45.46% of cases there is a balance between the territories of the vascularity of the two coronary arteries.

Keywords: coronary artery, morphometry, segmentation territories

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Introduction

The heart is vascularized by two arteries, one left and one right, arising from the origin of the ascending aorta above the corresponding semilunar valves. Arterial trunks cross the atrio-ventricular grooves, making a crown around the base of the heart, where their names, the coronary arteries. The two loops overlap the arterial crown, one antero-inferior, located anterior and inferior the interventricular groove, and the other the postero-superior, less important and less stable [1], which is located in the inter-atrial grooves. From the crown and loops, arterial branches arise for different cardiac segments. Practically the cardiac

areas does not receive a homogenous vascularity, being preferential areas for coronary system, where the arteries have a characteristic appearance [1]. Variants of origin, caliber trajectory and collateral branching of the coronary arteries are numerous. In surgical practice, which has gained an impressive development in the last decades, knowledge of these variations is very important, since they may confuse the surgeon, with unpleasant consequences. There is no dividing line between the ventricular distribution territories of the coronary arteries. Dominant coronary arterial system is one that gives rise to the posterior interventricular artery [2].

Materials and methods

Determining the diameter of coronary arteries and their collateral branches have been established in a number of 24 angioCT for each coronary artery executed in Pozimed Diagnostic Center Constanta, on a GE LightSpeed VCT64 Slice CT Scanner. To assess the type of vascularization (coronary dominance) we used also dissection on fresh and formalin preserved hearts, injection of contrast substance followed by radiography and plastic injection followed by corrosion.

Results

Left coronary artery at origin we found a diameter of between 4.1 to 5.8 mm in 14 cases (58.33% of cases), in 10 cases (41.67% of cases) with a diameter of 5-5.8 mm. Left main coronary artery length until branches off (bi or trifurcation), we found it between 3 to 11.8 mm, in 9 cases (37.50% of cases) being 3-5,5 mm, in 12 cases (50% from cases) is of 6-10 mm, and in 3 cases (12.5% of the cases) the length ranged from 10.4 to 11.8 mm. Anterior interventricular artery diameter, we found it between 1.8 to 3.4 mm, most commonly with 2.4 to 3 mm in 16 cases (66.67% of cases), in 5 cases (20.83 % from cases) with 1.8 to 2.3 mm, and in 3 cases (12.5% of the cases) 3.1-3.4 mm. When from anterior interventricular artery branched off a left marginal artery, it was less voluminous than the marginal artery originated by trifurcation of coronary artery, with 1.8 to 2.5 mm. From anterior interventricular artery detaches left anterior ventricular branches (diagonal arteries) who had a diameter of 1.2-2.2 mm. Circumflex artery present a diameter of 2.1 to 4.2 mm, most frequently in 14 cases (58.33% of cases), having a diameter of 2,5-3,2 mm, in 4 cases (16.67% from cases) was 2.1 to 2.4 mm, in 6 cases (25% from cases) was 3.4-4.2 mm in diameter, in one case with 4.2 mm, and in other cases is up to 3.8 mm diameter. On the left aspect of the heart circumflex artery, have a diameter of 2.1 to 3.4 mm. On the posterior surface of left ventricle from circumflex artery arterial branches come off with 1.2 to 2.4 mm in diameter. Left marginal artery, when originate from the coronary artery have a diameter of 2.1 to 2.8 mm, and when had the origin from the circumflex artery was 1.1 to 2.4 mm diameter.

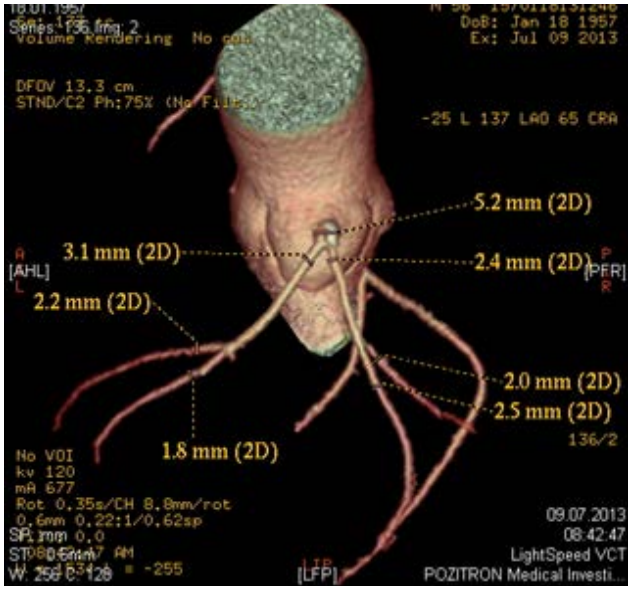

Figure 1 - The diameters of the left coronary artery and its collateral and terminal branches.

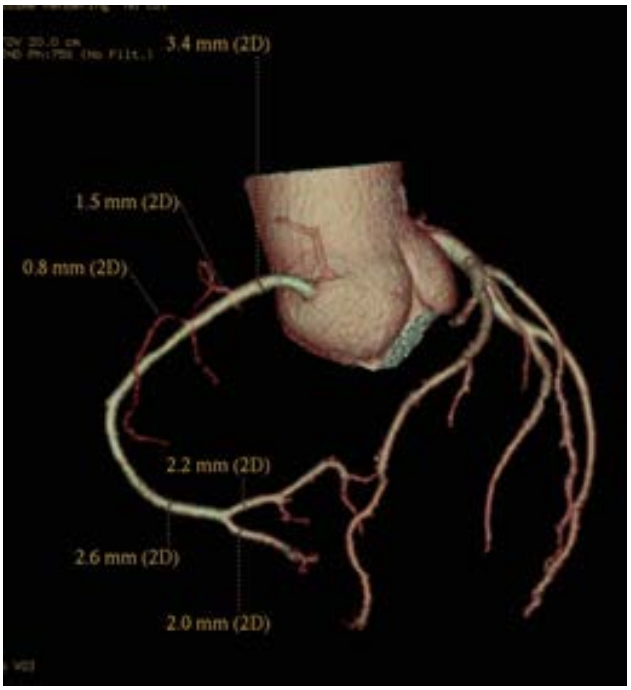

Figure 2 - Diameters of the right coronary artery and its collateral and terminal branches.

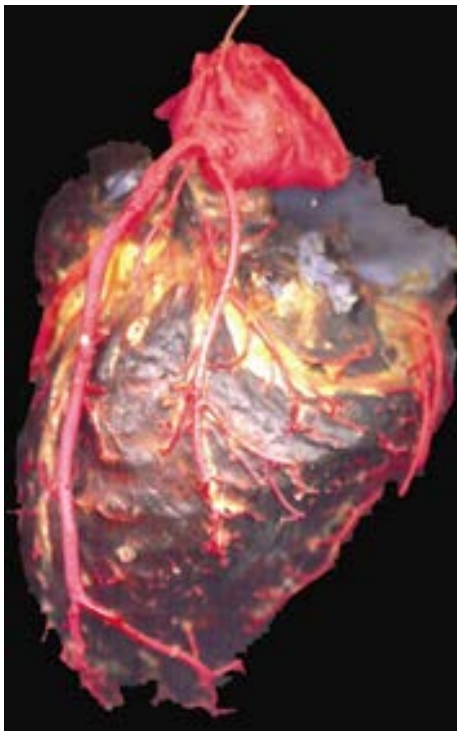

Figure 3 - Right coronary dominance, left coronary artery with a reduced blood supply territory

Right coronary artery origin presents a diameter of 3.1 to 5.4 mm, in 14 cases (58.33% of cases) with a diameter of 3.1 to 3.8 mm, in 9 cases (37.50% from cases) was from 4 to 4.8 mm, and in one case (4.17% from cases) was 5.4 mm. For the anterior aspect of the right ventricle, from the right coronary artery detaches branches with a diameter of 2.2 to 4.2 mm, in 13 cases (54.17% of cases) with 2.2 to 2.8 mm, in 10 cases (41.17% from cases) with 3-3.3 mm and in one case (4.17% from cases) was 4.2 mm. For the posterior of the right ventricle right coronary artery gave branches with a diameter of 1.6 to 2.6 mm, in 15 cases (62.5% of cases) these branches had a diameter of 1.6 to 2 mm. Right marginal artery had a diameter of 1.6-2.2 mm, in one case (4.17% from cases) having 3.4 mm diameter (when the right the coronary origin was 5.4 mm). At the level of the posterior interventricular artery, coronary artery had a diameter of 1.4 to 2.5 mm, and on the case with voluminous right coronary artery having 2.9 mm. From the right coronary artery branches with a caliber of 0.6-2 mm detaches.

Figure 4 – Left coronary dominance, circumflex artery ending as a posterior interventricular artery

Regarding the dominance coronary, we found on 88 hearts that in 26 cases (29.54% of cases) are predominant right coronary artery, in 22 cases (25% of cases) there is a predominance of coronary artery left, and in 40 cases (45.46% of cases) there is a balance between the vascularity territories of the two coronary arteries.

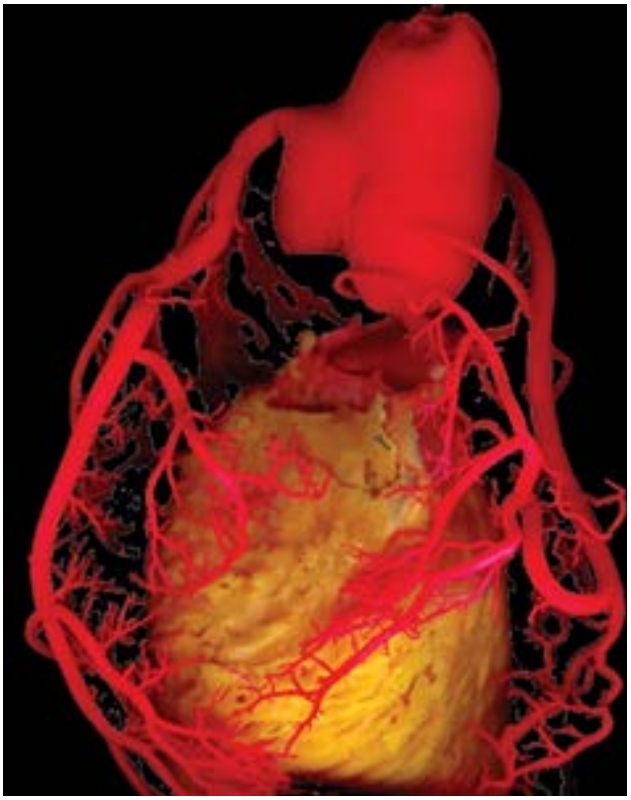

Figure 5 - Co-balanced dominance

Discussions

Normal caliber of the coronary arteries of the myocardium provides good functionality, ensuring the necessary quantities of nutrients and oxygen, both at rest and in activity. Irregularities in size downward from normal size in relation to age, sex or morphological type of the individual, can lead to problems sometimes incompatible with the survival. Although in literature morphometric differences do not differ much from one author to another, however there are contradictions between the vascularity territories of the two coronary arteries.

Table I - The diameters of the origin of the coronary arteries

Author	Right coronary artery	Left coronary artery
Christide	4-5 mm	5 mm
Bouchet	3.5-5.5 mm	4-5 mm
Kamina	3-5 mm	3-5 mm
Gray	1.5-5.5 mm	1.5-5.5 mm
www.scritube.com	4 mm	3.5-4.5 mm
Personal research	3.1-5.4 mm	4.1-5.8 mm

In relation to the consulted literature the minimum right coronary diameters found by us are lower by 0.9 mm compared to [1] and [3] and lower by 0.4 mm than [4], but higher with 0.1 mm to [5] and above 1.6 mm to [6]. The maximum diameter found by us is higher by 1.4 mm compared to [3], 0.4 mm to [1] and [5] and lower only 0.1 mm to [4] and [6]. In the left coronary artery our results about minimum values are 0.1 mm greater than those mentioned by [4], 0.6 mm by [3], 1.1 mm greater than [5] and 2.6 mm higher than [6], but smaller with 0.9 mm than [1]. The maximum values found by us are higher than all the authors we refer to, being larger with 0.3 mm than those mentioned by [6], with 0.8 mm than [1], [4] and [5] and greater with 1.3 mm than [3]. According to [5], the left coronary artery is thicker than the right one in 60% cases, and we find it that the diameter of the left coronary artery is greater than the right one with 0.2 to 1.8 mm.

Right coronary artery dominance we met more frequently than [2] and [8] with 14.54% and 9.54% compared to [7], but lower than [9] with 18.05%, than [1] with 28.06% and [6] with 31.06%. Left coronary artery dominance was met more frequently than most authors quoted, and is higher by 10% compared to [8], by 15% [2] and [1], 7% higher than [9] and 8% than [6], but with 35% less then [7]. Balanced type of coronary vascularization we met more than [7] with 25.46%, than [6] with 22.46%, with 13.46% [1] and

Table II - Coronary dominance

Author	Right coronary dominance	Left coronary dominance	Co-balanced dominance
Christide	58%	10%	32%
Gray	60%	17%	23%
Barry	48%	18%	34%
Moore	15%	10%	10%
Schünke	15%	15%	70%
www.mymed.ro	20%	60%	20%
Personal research	29.54%	25%	45.46%

higher by 11.46 % than [9], but reduced by 24.54% than [8] and by 29.54% than [2]. According to [10], the left coronary artery supplies, most frequently, 60-80% of the heart.

Conclusions

There is a correlation between coronary artery calibers; this correlation was more obvious between the right coronary and the anterior interventricular arteries. The more anterior interventricular artery size increases, higher the caliber of the right coronary artery [9].

Following [8], although there are many individual variations in the distribution of the coronary arteries, one thing is precise: there isn't vessel only for half right or half left of the heart. The two coronary arteries supply both halves of each heart and this is more obvious for ventricular segment than for atriums. Also the left coronary artery supply the majority of the left ventricle and interventricular septum, while the right coronary artery supply most of the right ventricle, inter-atrial septum, all right atrium and part of the left atrium. In the ventricles, the line of separation is obvious on the anterior aspect of the heart and less obvious on the underside; arterial variations that can be observed in the distribution system affects mainly coronary branches for the underside of the ventricles, than the other side. This line goes anteriorly from the middle infundibulum, descend to the anterior aspect of the right ventricle, following parallel, at 1 cm, the anterior interventricular groove, crosses the right edge of the heart 2 cm from the tip, touches the posterior surface of the right ventricle, then crosses the posterior interventricular groove , at a variable level depending the extent of the left coronary artery territory as well as according to the extent of the underside of the left ventricle, reaching finally, through a convex curve to the right, the middle portion of the interatrial - left posterior ventricular groove [Brocq and Mouchet, quoted by 11]. Territorial particularities of blood supply the heart, makes [12] to talk about cardiac vascular segments in the human heart..

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