CASE REPORT

Double Posterior Descending Artery Arising from a Right Coronary Artery
A Post-Mortem Examination of Two Cases

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Summary
This paper presents two cases of human hearts (a 75-year-old woman and an 88-year-old man) with double posterior descending arteries (PDA) of various sizes originating from the right coronary artery, mainly supplying the interventricular septum as well as the posterior walls of both heart ventricles in a different scope. In the analysis of the arterial vasculature, a range of aspects were considered, such as the point of exit of the right coronary artery, the course of the vessel, the range of the blood supply of the interventricular septum and both ventricles, as well as selected morphometric parameters that were simultaneously compared with one another. These atypical changes presented based on the example of the analyzed cases will certainly constitute a valuable source of information for cardiac surgeons and interventional cardiologists in planning operations.

Key words: Anatomical variants, Heart vasculature, Morphometry, Autopsy study

This paper presents two cases of the occurrence of double posterior descending arteries (PDA) of various sizes originating from the right coronary artery (RCA). In the literature, this variability is observed in the range between 3% and 20% (Table). According to other authors, the incidence of multiple PDAs may be higher than 20%. Singha and Konar reported the presence of a single PDA in 74% and multiple PDAs in 26%, but it should be noted that the PDA origin in this analysis was not only from the right coronary artery. In another study, Lethe-Petracca reported that the PDA is a branch of the RCA in 90% of subjects, including in approximately 70% of which the PDA is a single branch, while the remaining 30% of cases have two or three smaller branches coursing in parallel interventricular sulcus. Observational studies were conducted at the Department of Anatomy of Jan Kochanowski University in Kielce during a routine autopsy performed for the purpose of education as part of the conscious body donation program. Hearts were collected from 45 human bodies and subjected to preservation in 10% formalin, which was followed by analysis of the arterial vasculature. From the collected material, two hearts (one female, one male) were used to analyze the interesting variability in the aspect of vascularization of the posterior wall of the heart. Selected morphometric elements of coronary artery vascularity were analyzed based on external diameters at the initial points of the arterial branches, which were measured using a digital caliper sensitive to 0.01 mm.

Case Reports

Case Report 1: We conducted an observational study of the heart of a 75-year-old woman. As a result of observation of the coronary vessels, an interesting course of two posterior descending arteries (PDA) running parallel to each other, as well as to a single posterolateral artery (PL), and an atrioventricular node (AV) artery were observed within the terminal segment of the distal right coronary artery (RCA) (Figure 1). In this case, the right distal coronary artery (RCA) dominates the coronary artery system, because of the accepted rule that dominance in coronary circulation is determined by the artery which forms the PDA - supplying the cardiac muscle in the lower third of the interventricular septum. Considering the selected morphometric parameters, in the case of the first posterior descending artery (PDA1), the point of exit of the RCA was located at a distance of 13.7 mm from the intersection of the interatrial septum and the interventricular septum on the posterior cardiac wall at the point of the cardiac crux (CC), while for the second posterior descending artery (PDA2) the distance from the same point (CC) was 4.9 mm. The distance between the observed vessels, or the PDA1 and PDA2 was 5.8 mm. In terms of the
course and length of these arteries, it should be noted that the PDA1 was clearly visible in the posterior interventricular foramen at a distance of 21.5 mm from the CC, and its end was at a distance of 23.4 mm from the cardiac apex (AC). The length of the observed artery was 86.3 mm, while the diameter of the PDA1 at the point of exit from the RCA was 4.4 mm. Referring to PDA2, it should be noted that it was half the length of the PDA1 (length 44.7 mm), and its diameter at the point of exit from the RCA was 3.2 mm; its course was also observed in the posterior interventricular foramen at a distance of 10.8 mm from the CC, while its end was recorded at a distance of 51.4 mm from the AC. Another important aspect of this anatomical variability is the number of septal perforator arteries originating from the PDA, which are responsible for direct vascularization of the posterior interventricular septum. In the analyzed artery system, in the case of PDA1, 7 perforator arteries, while in the case of the PDA2 - 5 arteries were observed.

**Case Report 2:** During observation of the coronary vessels of an 88-year-old man, a course of two posterior descending arteries (PDA) of various sizes, running parallel to each other, as well as to 6 posterolateral arteries (PL) and an atrioventricular node (AVN) artery, observed within the terminal segment of the distal right coronary artery (RCA). RV indicates right ventricle; LV, left ventricle; CC, cardiac crux; and CA, cardiac apex.

### Table. Incidence of Double Posterior Descending Artery Arising from a Right Coronary Artery - A Review Literature

| Authors                  | Year | Methods of research | Research population | Cases | Incidence |
|--------------------------|------|---------------------|---------------------|-------|-----------|
| Levin & Baltaxe          | 1972 | Arteriograms        | 200                 | 12    | 6%        |
| Nerantzis et al.         | 1998 | Corrosion castings  | 60                  | 2     | 3%        |
| Maasarany & Aboul-Enein  | 2009 | CT Imaging          | 20                   | 1     | 5%        |
| Sabnis                   | 2013 | Cadavers            | 108                 | 13    | 12%       |
| Atta-Alla et al.         | 2015 | Cadavers            | 30                  | 6     | 20%       |
| Reddy & Pusala           | 2016 | Cadavers            | 110                 | 22    | 20%       |
| Chaudhary, et al.        | 2017 | Cadavers            | 30                  | 1     | 3%        |

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**Figure 1.** A diaphragmatic surface of a cadaver specimen (a woman) revealing two posterior descending arteries (PDA1 and PDA2) running parallel to each other, as well as to a single posterolateral artery (PL) and an atrioventricular node (AVN) artery, observed within the terminal segment of the distal right coronary artery (RCA). RV indicates right ventricle; LV, left ventricle; CC, cardiac crux; and CA, cardiac apex.

**Figure 2.** A diaphragmatic surface of a cadaver specimen (a man) revealing two posterior descending arteries (PDA1 and PDA2) running parallel to each other, as well as to 6 posterolateral arteries (PL) and an atrioventricular node (AVN) artery, observed within the terminal segment of the distal right coronary artery (RCA). RV indicates right ventricle; LV, left ventricle; CC, cardiac crux; and CA, cardiac apex.
from the same point (CC) was 10.9 mm. The distance between the analyzed vessels, or the PDA1 and PDA2 was 7.6 mm. Considering the course and length of both arteries, the PDA1 revealed a course in 2/3 of its entire length in the posterior interventricular foramen, its distance from the CC was 36.2 mm, while its end was at a distance of 11.3 mm from the cardiac apex (AC), the length of the observed artery measured from the RCA was 107.8 mm, while its diameter at the point of exit from the RCA was 4.8 mm. In terms of the second artery (PDA2), its length was 5.8 mm, while its diameter at the point of exit from the RCA was 2.9 mm; the course of this vessel was also observed in the posterior interventricular foramen within a section at a distance of 23.4 mm from the CC, while its end was recorded at a distance of 32.2 mm from the AC. In the analysis of septal perforator arteries originating from the PDA, in the case of the PDA1 - 12 perforator arteries were observed, while in the case of the PDA2 - 5 perforator arteries were observed.

Discussion

The general anatomical variability in the cardiovascular system in angiographic examinations of computed tomography, and observational studies on human bodies is characterized by a high frequency. However, considering carefully the issue of difference in relation to the point of exit, course, extent of vascularity, and morphometry of coronary arteries, some cases are rare, for example the occurrence of a double posterior descending artery responsible partially for the vascularity of the posterior interventricular septum, and the posterior wall of the right ventricle. Variability in the cardiovascular system not only means the occurrence of additional arteries, but also the lack of typical arteries, e.g. the lack of a right coronary artery, which was observed in a 46-year-old woman, or the lack of a posterior descending artery as observed in a 79-year-old man. In the relevant literature, other cases of the absence of coronary arteries were described. Congenital anomalies were observed in approximately 1.3% of the study patients.

According to literature data, approximately 80% of anomalies are considered benign without significant clinical relevance, while the remaining 20% may potentially be a cause of clinical manifestations. In the present study, two cases are presented of the occurrence of double PDA arteries of various sizes originating from the right coronary artery, mainly supplying the interventricular septum, as well as the posterior walls of both heart ventricles in a different scope. According to literature data, the PDA is more often one of the main branches of the right coronary artery (RCA) than of the left coronary artery (LCA). The PDA length is in the range of 75 to 108 mm, while the diameters are between 2.8 and 4.8 mm. Regarding terminal PDA branches, the relative contribution of perforator arteries of the heart interventricular septum originating from the PDA (but also from LAD) is variable. According to literature data, perforator arteries of the heart interventricular septum in the interior part originate from the proximal segment of the LAD and are responsible for the vascularity of 2/3 of the upper part of the septum. They demonstrate a variability in their occurrence, ranging in number from 4 to 13, but the most frequent number is 8, and the length of these vessels varies from 40 to 80 mm. The first septal perforator artery originating from the LAD is usually the largest and the longest (from 4 to 6 cm), with an external diameter at its starting point being in the range of 1.0 mm to 2.35 mm. With respect to perforator arteries originating from the PDA, they supply the lower part of the interventricular septum with blood. They reveal a greater range of variability of their occurrence within a range of 6 mm to 20 mm, maintaining a maximum length not exceeding 15 mm, usually with a diameter of approximately 1 mm.

Variations in the duplication or multiples of PDA may be conditioned by increased blood supply to the interventricular septum by PDA at the expense of LAD, which may also be related to potential collateral circulation, due to the frequency (71%) of atherosclerotic lesions in LAD causing myocardial infarction. The benefits and drawbacks of cardiac vascular variability can vary. In the first case discussed, the presence of two PDA vessels with significant diameters was beneficial in the assessment of blood supply in the posterior part of the ventricular septum and posterior wall of the right ventricle, to which PDA1 vessels reached. In this anatomical variant, the occurrence of a single branch of PL was also observed, and it may condition poor vascularity of the posterior wall of the left ventricle by RCA, which results from the absence of vessels of LCA origin in this area. In clinical terms, this may be related to the patient’s disease history in which arterial hypertension was found, coronary atherosclerotic lesions mainly in vessels derived from LCA were observed, as well as failure of the left ventricle manifested by the occurrence of dyspnea and cough. The autopsy study in this case confirms at least in the morphological range that the failure of the left ventricle could also result from the anomaly of its vascularity, given the relatively poor supply of blood to the posterior wall of the left ventricle. The immediate cause of death in this case was ischemic stroke, and at the same time there was not enough evidence to show a relationship between left ventricular ischemia and ischemic stroke. Omar, et al. suggested that there is a potential relationship between the two pathologies, which should not be considered as a coincidence. In an earlier study, Hays, et al. showed that left ventricular dysfunction, even to a mild extent, is independently associated with an increased risk of ischemic stroke. The second presented case can be treated as an alternative in the vascularization of not only the posterior ventricular septum but also the posterior left ventricular wall, because the presence of 6 branches of PL significantly improves this area compared to the single PL observed in the first case. Regarding the clinical issue, referring to the patient’s medical history, there were no significant disorders that would affect the functioning of the heart and its coronary vessels. The patient survived 88 years without showing any health problems associated with the function of the heart, which in the light of the presented morphological analysis can be associated with the presence of a favorable anatomical variant in terms of variability of the coronary heart system.
Knowledge of variability in the vascular anatomy improves the quality of treatment, especially when considering angioplasty or bypass. Anomalies or changes in the anatomy of the arteries may have an impact on the blood supply of the area, clinical presentation as well as prognosis of its diseases, and even on the development and location of atherosclerosis. In the case of coronary angioplasty, the risk of myocardial exposure should be assessed in terms of planned surgical intervention, another important aspect of the knowledge of the existence of clinical coronary anomalies is, for example, prevention of coronary artery damage during ventriculotomy, coronary artery bypass grafting, or revascularization.28,29) These atypical changes presented based on the example of the analyzed cases will certainly constitute a valuable source of information for cardiac surgeons and interventional cardiologists in planning operations.

Disclosures

Conflicts of interest: None.

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