

# ANATOMY OF HUMAN CORONARY CIRCULATION

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## ABSTRACT

**Objectives:** To study the coronary blood supply and its anatomical variations in a population of Khyber Pakhtunkhwa in Pakistan.

**Material and Methods:** A retrospective analysis of cardiac patients registered for treatment at Peshawar Institute of Medical Sciences, Hayatabad, Peshawar was conducted. The angiographic reports were made by consultant radiologists and consultant interventional cardiologists. Data from the reports were recorded on specially designed registers and analyzed using SPSS (version 18.0).

**Results:** Angiographs of 197 patients were analyzed of which 123 were males and 74 females. In 62% (n=122.14) the blood supply of heart was right side dominant. Regarding the anatomy of the coronary arteries 11% (n=21.67) of patients showed normal anatomical variants, while anomalous arteries were observed in 2% (n=3.94) cases.

**Conclusion:** This study demonstrates that there is no significant difference regarding the normal anatomical variations of coronary arteries and its anomalies between males and females. The arterial supply of the heart of the population studied is very similar as reported in the literature. It is recommended that similar studies should be conducted in order to understand the anatomy of the coronary arteries, as well as other structures, in different local populations to assist in evaluation and determination of invasive procedures.

**Key Words:** Coronary Artery Circulation, Normal Variation, Anatomy, Anomalies.

## INTRODUCTION

The coronary arteries arise from the ascending aorta at its anterior (right coronary artery) and left posterior (left coronary artery) aortic sinuses. The calibre of the arteries is based on measurements taken from arterial casts or angiograms and ranges between 1.5 and 5.5mm at their origins. The diameters may increase upto 3.3% per year<sup>1</sup>. Variations in the anatomy and course of the coronary arteries are important as they can affect the blood supply to the diaphragmatic surface of ventricles. These variations are commonly found associated with the origin, size, and distribution of the posterior interventricular artery. In the right side dominance, the posterior interventricular artery is the largest branch of the right coronary artery, being present in 90% of the individuals. In left side dominance the posterior interventricular artery is a branch of the circumflex branch of left coronary artery: it occurs in 10% of the population<sup>2</sup>.

The branches of the coronary arteries are generally considered to be the end arteries, i.e. arteries that lack adequate anastomoses with other large branches to maintain viability of the myocardium in cases of occlu-

sion. However anastomoses do exist between branches of the coronary arteries, sub-epicardial or myocardial, and between these arteries and extracardiac vessels such as the thoracic vessels. An anastomoses also exists between the terminations of the right and the left coronary arteries in the atrioventricular groove as well as between the interventricular (IV) branches around the apex of the heart in approximately 10% of normal hearts<sup>3</sup>.

Anastomoses between branches of the coronary arteries provide a collateral circulation, but in most cases they are not sufficient to provide an adequate blood supply to the myocardium when a branch becomes blocked in a cardiac pathology, such as myocardial infarction, resulting in necrosis of myocardium<sup>4</sup>. Nevertheless, these anastomoses can provide alternate pathways, for blood to reach a given area of myocardium<sup>5</sup>.

Coronary anomalies comprise several different entities, which a few have consistent clinical manifestations. Most reported cases require a specific and critical review because of the association of anatomical abnormalities as the clinical events might well be non-casual rather than casual, i.e. indirect rather than direct<sup>6</sup>.

Since cardiac diseases are the leading cause of death in the world, with most of these deaths being related to pathology of the coronary arteries, knowledge of the anatomy of coronary arteries is important. In order to prevent cardiac diseases and to design new treatment modalities there is a need to appreciate and understand the coronary circulation anatomy in the

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local population. Although several studies regarding the anatomy of the coronary arteries, as well as the collateral coronary circulation, have been conducted in Western countries there is a lack of data in the developing countries, particularly in the province of Khyber Pakhtunkhwa, Pakistan. The aims of this research were (i) to establish the anatomy of the coronary blood supply in a population of Khyber Pakhtunkhwa and (ii) to determine the prevalence of collateral coronary blood vessels in this population.

## MATERIAL AND METHODS

Angiogram of cardiac patients registered for treatment at Peshawar Institute of Medical Sciences, Hayatabad, Peshawar was conducted to establish the anatomy of the coronary blood supply in the population of Peshawar and the adjoining areas of Khyber Pakhtunkhwa, Pakistan. This center was selected as it has a large catchment area, as well as providing diagnostic and treatment facilities to a large number of cardiac patients of the province. The study population included all patients who attended the hospital for angiography between January 2010 to December 2012. The angiographies were assessed by consultant radiologists and consultant cardiologists. The results of the angiographic data were recorded on specially designed registers, which also included socio-demographic characteristics, presence and duration of symptoms and details of coronary anatomy, including origins of the left and right coronary arteries. The data were collected by team members and reviewed by the lead cardiologist and anatomist.

Data was abstracted from the registers and entered using Epi data. Strong data validity checks were used for data entry. Data quality assurance was achieved by double data entry and cross-checking a random sample of records (10%) systematically with the paper forms. Data management and cleaning were then conducted and clean data was exported to SPSS version 18.0 for analysis. For continuous variables summary statistics were calculated. Frequencies were calculated for categorical variables.

## RESULTS

A total of 197 patients who underwent diagnostic coronary artery catheterization in Peshawar Institute of Medical Sciences, Hayatabad, Peshawar were included in the study: 123 (62.43%) males and 74 (37.86%) females. Patient's age ranged from 25 to 85 years with a mean age of 55 years: 112 (56.85%) patients were aged between 41 and 60 years, as shown below in Table, and in Figures 1, 2 & 3.

In 62.43% (n=123) cases the blood supply of heart was right side dominant, with a co-dominant supply was observed in 14.21% (n=28) and the left

side dominant supply in 23.35% (n=46). The coronary arteries were observed to be normal in 87% (n=171) of cases, with 11% (n=22) having normal anatomical variants: anomalous arteries were found in 2% (n=3.94) of patients. 22.14 (11%) showed anatomical variations of the coronary arteries, in these the left main stem was either very short or very long, while the left anterior descending artery was found to be rudimentary, super dominant and very long, very tortuous, very ectatic with the circumflex arteries originating separately from the left coronary cusp as separate origins, while in some it arises from the right coronary cusp or a non-coronary cusp in few cases: In one case it was from the right coronary artery (RCA), as shown below in Table, and in Figures 1, 2 & 3.

**Table 1: Characteristics of patients (n= 197) underwent cardiac, Angiography at Peshawar Institute of Medical Sciences, Hayatabad**

Characteristics	Frequency (%)
<b>Sex</b>	
Male	123 (62.4 %)
Female	74 (37.5%)
<b>Age</b>	
<40	85 (43.15)
>40	112 (56.85%)
<b>Variations of coronary arteries</b>	
Left dominance	46 (23.35%)
Right dominance	123 (62.43%)
Normal anatomical variation	22 (11.17%)
Anomalous coronary arteries	4 (2.03%)

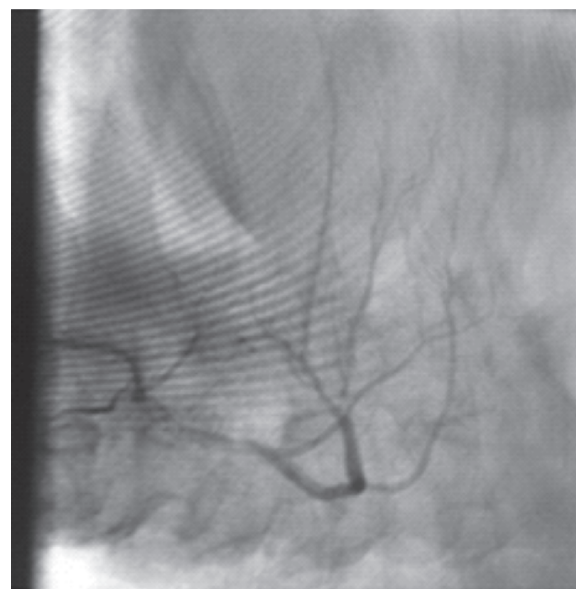


Figure 1: Angiogram: Dominant right side coronary artery

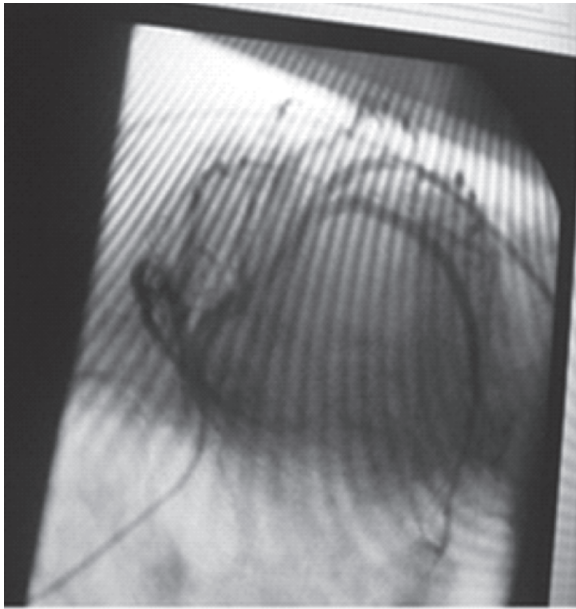


Figure 2: Angiogram: Spider view appearance of the proximal left coronary artery and left anterior descending artery

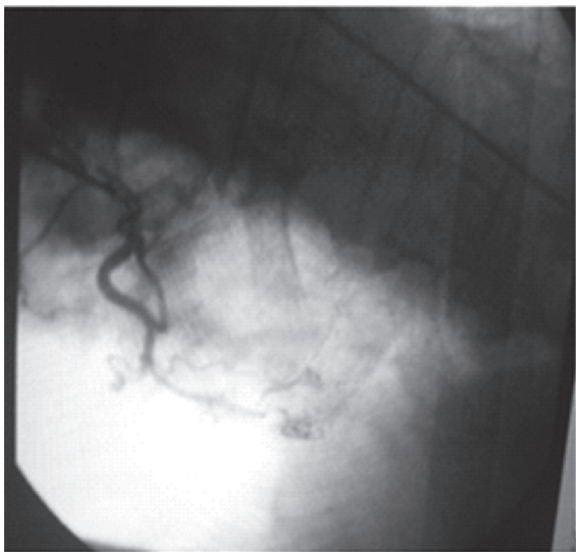


Figure 3: Angiogram: Right coronary artery blocked in the middle

## DISCUSSION

Normal variations were found in 11.17% patients while Altai et al reported that it occurred in 6% patients<sup>6</sup>. This included tortuous anterior descending (left anterior interventricular) artery while left main stem was either very short or very long.

Anomalous arteries occurred in 2.03% (n=4) of patients in the present series while Altai et al found that it occurred in 1% patients<sup>6</sup>. This finding is important as it may assist in different invasive procedures, such as PCI (Percutaneous Coronary Intervention). Such knowledge may help in catheter selection and also account

for the difficulties that may be encountered during the procedure. The importance of anomalous origins of the coronary vessels would inform the approach that should be opted for intervention, such as PCI and which type of catheters should we use to engage it.

It has been hypothesised that coronary tortuosity leads to flow alterations which result in a reduction in coronary pressure distal to the tortuous segment of the coronary artery, subsequently leading to ischemia<sup>7</sup>.

Some coronary artery anomalies are difficult to visualize at angiography: even if they are visualized their course may not be delineated accurately. Hence multimodular imaging should be considered in cases with signs of myocardial ischaemia or unexplained syncope in young individuals, where no other aetiology is evident<sup>8</sup>. Anomalous origin of the right coronary artery is a rare congenital anomaly that was first described in 1948 by White and Edwards<sup>9</sup>.

Circumflex arteries originated from the left coronary cusp in 19% (n=39) of cases, from right coronary cusp in 18% (n=36) and from both the left and right coronary cusp in 13% (n=27). The right coronary artery (RCA) can have an anomalous origin, mainly posteriorly between the right and non-coronary cusp, but in few cases from the left coronary cusp and in some cases from the left main stem (LMS). This anomaly is rare but it can lead to myocardial ischaemia and sudden death<sup>10</sup>.

In 62.43% (n=123) of cases the blood supply to the heart was right side dominant while a co-dominant supply was observed in 14.21% (n=28), with left side dominant only in 23.35% (n=46). Kosar et al concluded right dominant in 76%, co-dominant in 14.8% and left dominant in 9.1% cases<sup>11</sup>. The terms "right side dominant" and "left side dominant" are used in a topographical sense to designate which coronary artery gives rise to the posterior interventricular (descending) artery. In the balanced type, each artery gives a separate posterior interventricular artery<sup>12</sup>. The artery that gives the posterior descending artery (PDA) and the posterolateral branch determines the coronary dominance<sup>13</sup>. The importance of dominance is that it decides which site to address during various surgical procedures such as PCI: similarly it can also give an indication of the size of an infarction, as this is related the size of vessel affected and the area it supplies. For example, a large Myocardial Infarction (MI) in a right side dominant heart would arise because of the posterior descending artery. In contrast, in a non-dominant system would give rise to a smaller infarct due to the smaller area supplied.

## CONCLUSION

This study demonstrates that there is no significant difference regarding the normal anatomical variations of coronary arteries anomalies between males and females and the arterial supply of the heart of the population studied is very similar as reported in the literature. It is recommended that similar studies should

be conducted in order to understand the anatomy of the coronary arteries, as well as other structures, in different local populations to assist in evaluation and determination of invasive procedures.

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### **AUTHOR'S CONTRIBUTION**

Following authors have made substantial contributions to the manuscript as under:

**Badshah M:** Idea, collection of data.

**Qadir M:** Data analysis.

**Hasnain J:** Statistics.

**Soamer R:** Bibliography.

**Iqbal Z:** Followup.

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