

MYOCARDIAL INFARCTION
WITH
NORMAL CORONARY ARTERIES

THESIS

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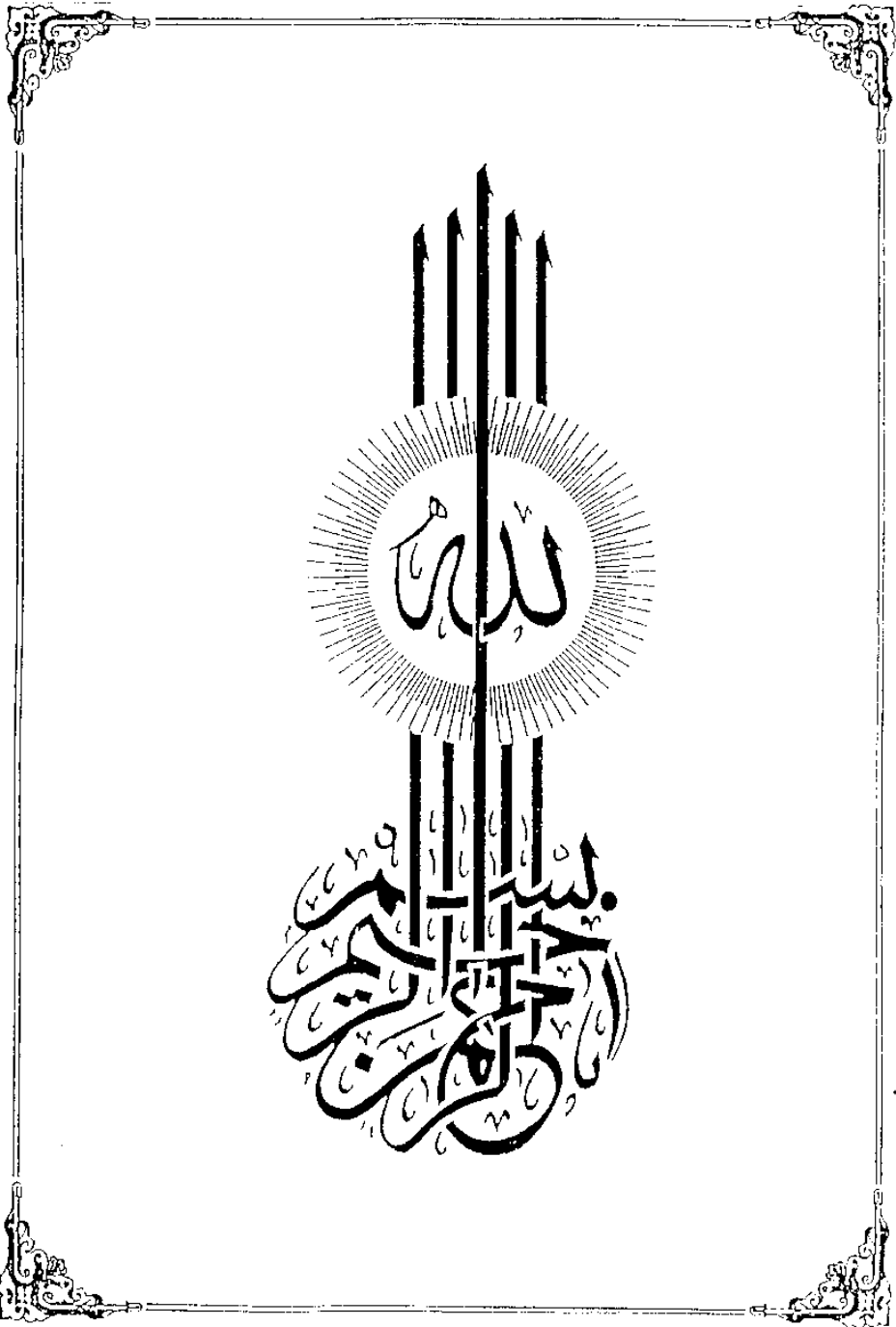
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*Anatomy of coronary
circulation*

ANATOMY OF THE CORONARY CIRCULATION

Although the anatomy of the coronary arteries aroused the curiosity of Vieussens 350 years ago, it was only after a relation between disease of the coronary arteries and chest pain was established in this century that knowing about these vessels assumed more than academic importance. In recent years the rapid advances in cardiac surgery and coronary angiography have stimulated further interest in the coronary arteries (Hurst, 1982).

THE SINUSES OF VALSALVA:

The root of the aorta has three pockets of dilatation lying behind each of the respective valve cusps. These sinuses, which act as miniature reservoirs, exhibit marked eddies and whorls with completely turbulent flow under normal conditions. This arrangement probably plays a role in the maintenance of uniform coronary inflow. The right sinus gives rise to the right coronary artery, while the left coronary sinus gives rise to the left coronary artery. The non-coronary cusp lies posteriorly (Gorlin, 1976).

THE LEFT CORONARY ARTERY:

It arises from a single ostium located in the middle of the upper half of the left coronary sinus of the aorta

which protrudes between the main pulmonary artery and the body of the left atrium (Hurst, 1982).

The diameter of the artery is 0.4 - 1 cm under normal conditions and its length varies from an almost immediate postostial bifurcation to a trunk as long as 2-4 cm. (Abrams and Adams, 1976).

The vessel then usually forms two major channels;

- * The anterior descending artery.
- * The circumflex artery.

The anterior descending artery:

It follows the anterior interventricular groove and has a variable length, following short of, or in some situations passing around the apex of the heart to supply the inferior surface of the left ventricle as well.

The anterior descending artery gives off:

- (1) Diagonal branches of highly varying numbers (one to three in number), and subsequent bifurcations often covering the entire anterior and much of the lateral wall of the left ventricle.

(2) Septal branches also of highly varying numbers (three to five in different hearts, (Hurst, 1982), they begin near its origin and continue to its termination at or beyond the apex. The septal branches differ from all other branches of the anterior descending system in that, they are intramyocardial, while the other vessels are epicardial in distribution.

An exception to this rule is that, the left anterior descending artery itself which on occasion may lie within the myocardial substance for its entire length or may course in serpentine fashion, periodically dipping below the epicardial surface. The presence of surrounding myocardium greatly influences the pattern of flow in the vessels, both with respect to their ability to serve as part of a collateral network and with respect to their ordinary flow transmission.

(3) There are smaller branches leading to the right ventricle, some of which meet branches coming from the right coronary artery to form the ring of Vieussens. The network of right ventricular branches will figure prominently as a source of collateral interatrial pathways.

The left anterior descending artery can supply blood to as much as 50-70% of the left ventricular myocardium (Gorlin, 1976).

The left circumflex artery:

It arises at an angle nearly perpendicular to the left main coronary artery. It lies beneath the left atrial appendage and advances in the atrioventricular groove for a highly variable distance. In a minority of cases this artery may follow the atrioventricular groove all the way to the crux and give off the posterior descending artery lying in the posterior interventricular sulcus. At the other extreme, it may give rise to only a single marginal branch. In the majority of cases, however, the left circumflex artery terminates at or just beyond the obtuse margin of the heart. There are many anatomical variations and branches in the circumflex artery, but the number of branches will always be in direct reciprocal relationship to the extension of the right coronary artery on the posterolateral surface of the left ventricle. Similarly the distribution of the marginal branches will reciprocate with the number and extent of the diagonal branches of the left anterior descending system (Gorlin, 1976).

The circumflex system may give rise to numerous atrial branches, among them:

- 1- The left atrial circumflex artery.
- 2- The sinus node artery (in about 45% of human hearts) (Hurst, 1982).
- 3- The AV node-artery (in 10% of cases), (Hurst, 1982).

The posterior descending portion of the circumflex artery may on occasion originate from the right coronary artery or sinus as a separate division distinct from marginal circumflex arteries arising from the left coronary artery.

THE RIGHT CORONARY ARTERY :

The right coronary artery exits anteriorly from the right or anterior coronary sinus, runs directly inferiorly in the right atrioventricular groove beneath the right atrial appendage and passes around the acute margin of the right ventricle into the posterior right atrioventricular sulcus (Hurst, 1982) to the crux of the heart.

The right coronary artery provides an extensive distribution to the left ventricle because the vessel

gives rise to the posterior descending artery running in the interventricular groove in the majority of cases and supplies a variable portion of the inferior and posterior surfaces of the left ventricle and usually a segment of the postero-inferior portion of the interventricular septum. The inferior surface of the heart is supplied by the right coronary artery in approximately 90% of all cases and by the left circumflex system in the remaining 10% (Gorlin, 1976).

The right coronary artery gives off:

- 1- A conus branch which runs anteriorly to complete the ring of Vieussens at the level of the pulmonary valves.

In approximately half of the population, the conus artery may actually arise from an orifice in the anterior sinus separate from the main right coronary artery (Gorlin, 1976).

When the conus artery does not arise from the aorta directly, it is the first branch of the main right coronary artery (Hurst, 1982).

- 2- Right ventricular marginal branches which generally are perpendicular to the main trunk. Those from the right atrioventricular sulcus to the anterior wall of the right ventricle have a loop exit as

they emerge from their deep position in fat (Hurst, 1982).

In certain anatomical variations, right ventricular blood supply may be subserved by a bifurcation of the right coronary artery with

- Anterior branch serving the anterior portion,
- Posterior branch supplying the residual component of the circulation to the right and left ventricles.

- 3- The sinus node artery that originates about equally from the left circumflex and right coronary arteries.
- 4- The AV node artery usually arises from the right coronary artery because it so much more frequently reaches the crux than the left circumflex (James, 1961).

ARTERIAL DOMINANCE:

It is the reciprocal lengths of the right coronary and left circumflex arteries in the posterior atrio-ventricular sulci-one being longer as the other is shorter-which led Bianchi and Spalteholz (Hurst, 1982), to classify coronary distribution in this region, as right or left predominant. Thus if the right coronary artery crossed the crux of the heart (as it does in 90% of human beings), it predominated, while the left

circumflex did so in only 10%. They did not intend this classification to refer to arterial supply of the entire heart which is the unfortunate way the classification is now commonly used.

Regardless of which artery reaches the crux, at least 70% of the left ventricular myocardium is supplied by branches of the left coronary artery and one should actually refer to the degree of left dominance in a given case (Hurst, 1982).

SIZE OF THE NORMAL CORONARY ARTERY:

This vessel can not be arbitrarily defined in terms of its caliber, because under normal conditions the caliber is directly related to the extent of perfused myocardial mass and the number of secondary, tertiary and quaternary branches which will arise from this vessel.

This creates one of the intrinsic problems in quantifying the severity of an arterial obstruction because the standards are not absolute. The cross-sectional diameter of a normal vessel is so highly variable.

The normal caliber may range from as much as 10 mm in a large main left coronary artery to as little

as 1 mm in a typical mid-portion of a left anterior descending or circumflex coronary artery (Gorlin, 1976).

SITES OF PREDILECTION FOR CORONARY ATHEROSCLEROSIS:

The major curves of the right coronary and left circumflex arteries are particularly prone to atheromatous lesions, as are the several bifurcations such as the junctions of the left main coronary artery with its two major branches.

The divisions of the left anterior descending artery into the first septal and first diagonal branches are uncommonly susceptible sites. The first diagonal branch is particularly susceptible because not only is there branching of two or three vessels within a short space but the left anterior descending artery is held in position by the penetrating septal branches. Conversely, vessels are often spared segmental lesions in the portion of artery beyond the major bifurcations. This is seen for example in the posterior descending artery, in the distal branches of the left anterior descending artery and its terminal diagonal branches and also in the left circumflex marginal systems.

If the marginal branches are single and straight, they are often free of atheromata, but if on the other hand they tend to branch early, then these sites of branching will also exhibit evidence of disease at the tertiary branch bifurcation (Gorlin, 1976).

CORONARY VENOUS SYSTEM:

There are systems of veins in the human heart:

1- The heart has a large patulous structure called the coronary sinus which lies in the posterior atrioventricular groove following in general the course of the circumflex artery from left to right. This sinus receives venous drainage via:

- 1- The anterior interventricular vein which generally follows the left anterior descending system.
- 2- The lateral marginal veins.
- 3- Occasionally, the posterior interventricular vein which may have a separate orifice adjacent to that of the coronary sinus.
- 4- Series of atrial veins entering the coronary sinus in variable fashion.

Blood supply reaching the coronary sinus represents essentially drainage from left ventricular myocardium, while that from the posterior interventricular vein is a mixture from right and left ventricular muscle.