CORONARY BLOOD FLOW
AND
ANAESTHESIA
FOR PATIENTS WITH
CORONARY ISCHAEMIA

THESIS

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I N D E X

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INTRODUCTION

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Since the earliest days of anaesthesia, the effect of anaesthetic agents on the heart and the ability of the diseased heart to withstand the combined assault of anaesthesia and surgery have been matters for concern.

Sudden cardiac failure has engaged the attention of the anaesthetists since the introduction of chloroform. Since then, avoidence of cardiovascular depression has been considered of utmost importance by the anaesthetists and leads to the appearance of cardiac monitoring.

This study deals with coronary blood flow and anaesthesia for patients with coronary ischaemia. Coronary artery disease is widely distributed among elderly patients. While the frequency of coronary artery disease is very high, the disease may not be clinically apparent unless several vessels are severely narrowed or obstructed.

The patient who has coronary ischaemia is an overt anaesthetic risk, with a great possibility of infarction or reinfarction in the perioperative period. Presence of coronary artery disease causes a two- to three- fold increase of perioperative mortality and a ten-fold increase in coronary occlusion after surgery (Foex P.,1981)

Good assessment of the patient, better anaethetic management, extensive patient monitoring and proper postoperative care have reduced the frequency of reinfarction.

This work reviews the coronary blood flow through its anatomical and physiological background. The aim of the work is to study the assessment, preparation, anaesthetic management, as well as post-operative care for the ischaemic cardiac patient undergoing non-cardiac surgery .

ANATOMY

ANATOMY OF THE CORONARY CIRCULATION

THE CORONARY ARTERIES:

The coronary arteries emerge, one on each side, from behind the pulmonary trunk. They run in the atrioventricular grooves. The right coronary artery runs down over the front of the heart, while the left coronary artery runs down over the back of the heart.

The right coronary artery arises from the anterior aortic sinus and runs forward between the pulmonary trunk and the right auricle. It descends in the right atrioventricular groove, giving branches to the right atrium and the right venrticle. At the inferior border of the heart it continues posteriorly along the atrioventricular groove to anastomose with the left coronary artery in the posterior interventricular groove. It gives off a marginal branch, wich supplies the right ventricle, and a posterior interventricular branch, which supplies both ventricles.
The posterior interventricular branch anastomoses with the anterior interventricular branch of the left coronary artery.

The left coronary artery arises from the left posterior aortic sinus and passes forward between the pulmonary trunk and the left auricle. It then enters the atrioventricular groove, winds around the left margin of the heart, and ends by anastomosing with the right coronary artery. It gives off a large branch, the anterior interventricular artery, which runs downwards to the apex of the heart in the anterior interventricular groove, supplying both ventricles on its way, it then passes around the apex to anastomose with the posterior interventricular branch of the right coronary artery.

Although anastomoses between the terminal branches of the coronary arteries do occur, they are not large enough to provide an adequate supply of blood to the cardiac muscle, should one of the larger branches becomes blocked by disease. (Ellis, H. and McLarty, M. 1969).

VENOUS DRAINAGE OF THE HEART:

Most of the blood from the heart wall drains into the right atrium by means of the coronary sinus. The coronary sinus lies in the posterior part of the atrioventricular groove and is a continuation of the great cardiac vein. It opens into the right atrium to the left of the vena cava. The small cardiac vein and the middle cardiac vein are tributaries of the coronary sinus. The remainder of the blood is returned to the right atrium by the anterior cardiac vein and also by small veins that open directly into the heart chambers. (Last R. J., 1978).

PHYSIOLOGY

PHYSIOLOGY OF CORONARY CIRCULATION

Normal Coronary Blood Flow and its Variation

Physiological anatomy of the coronary blood supply:

The main coronary arteries lie on the surface of the heart, and small arteries penetrate into the cardiac muscle mass. It is almost entirely through these arteries that the heart receives its nutritive blood supply. Only the inner 75 to 100 microns of the endocardial surface can obtain significant amounts of nutrition directly from the blood in the cardiac chambers.

The left coronary artery supplies mainly the anterior part of the left ventricle, while the right coronary artery supplies most of the right ventricle as well as the posterior part of the left ventricle in 80 to 90 percent of all persons.

In about 50 percent of all human beings, more blood flows through the right coronary artery than through the left. In about 30 percent the arteries are about equal, and in 20 percent the left artery predominates.

Most of the venous blood flow from the left ventricle leaves by way of the coronary sinus which is about 75 percent of the total coronary blood flow, and most of the venous blood from the right ventricle flows from the small anterior cardiac veins, which empty directly into the right atrium and are not connected with the coronary sinus. A small amount of coronary blood flows back into the heart through thebsian veins, which empty directly into all chambers of the heart. (Ganong, W. F., 1981).

Normal coronary blood flow

The resting coronary blood flow in the human being averages approximately 250 mL. per minute, which is about 0.7 to 0.8 mL./gram of heart muscle, or 4 to 5 percent of the total cardiac output.

In sternous exercise the heart increases its cardiac output by 4 to 6 fold, and it pumps the blood against a pressure which is higher than the normal pressure. Consequently the work output of the heart is increased by 6 to 8 fold. The coronary blood flow increases 4 to to 5 fold to supply the extra nutrients needed by the heart. But this increase in coronary blood flow is not quite as much as the increase in work load. This means that the ratio of coronary blood flow to energy expenditure by the heart decreases. However, the "efficiency" of cardiac utilization of energy increases to make up for this relative deficiency of blood supply.

Phasic changes in coronary blood flow

Effect of cardiac muscle compression:

During systole, blood flow through the capillaries in the left ventricular wall falls to a low value, which is opposite to the flow in other vascular beds of the body. This is because of the strong compression of the left ventricular muscle around the intramuscular vessels. During diastole, the cardiac muscle relaxes completely, allowing the blood to flow rapidly in the intramuscular vessels. Blood flow through coronary capillaries of the right ventricle undergoes phasic changes similar to those in the coronary capillarires of the left ventricle. But because the force of contraction of the right ventricle is far less than that of the left ventricle, these phasic changes are relatively milder than those of the left ventricle. (Guyton A. C., 1981).

Effect of intramyocardial pressure:

During cardiac contraction all the cardiac muscle squeezes towards the centers of the ventricles, so that each muscle layer squeezes the underlying layer. Therefore during systole, a gradient of intramyocardial pressure develops, with the pressure in the subendocardial muscle having a pressure almost as great as the pressure inside the ventricle, while the pressure in the outer layer of heart muscle is only slightly above atmospheric pressure. During systole, blood flow through the subendocrdial plexus of the left ventricle falls almost to zero because of the very great contractile force of the muscle. To compensate for this almost total lack of flow during systole, the subendocardial arteries are much larger than the nutrient arteries in the middle and outer layers of the heart. Therefore, blood flows in subendocardial arteries during diastole is considerably greater than the flow in the outermost arteries. This peculiar difference in flow between epicardial and subendocardial arteries plays an important role in certain types of coronary ischaemia such as subendocardial myocardial ischaemia , which must be expected when the diastolic arterial pressure is very low as occurs in cases of aortic regurgitation and patent ductus arteriosus. (Guyton A. C., 1981).

Control of coronary blood flow

A- Local metabolism as the primary controller of coronary flow:

Blood flow through the coronary system is regulated almost entirely by intrinsic vascular response to the local needs of the cardiac musculature for nutrition. This mechanism works equally well wether the nerves to the heart are intact or are removed.

Oxygen demand as a major factor in local blood flow regulation

Blood flow in coronaries is regulated almost exactly in proportion to oxygen need by cardiac musculature and to oxygen consumption by the heart. Yet, the exact means by which increased oxygen consumption causes coronary dilatation has not been determined.
It is speculated that a decrease in oxygen concentration in the heart causes a vasodilator substance to be released from the muscle cell, causing dilatation of arterioles. The substance with the greatest vasodilator propensity is adenosine. But, adenosine is not only the vasodilator substance that has been identifed, others include potassium ions, carbon dioxide, bradykinin and possibly prostaglandins. Yet, difficulties still exist with the vasodilator hypothesis. For one, infusion of maximal amounts of adenosine into the coronary arteries does not dilate these vasseles as much as does maximal increase in cardiac muscle metabolism. Second, agents that block or partially block the vasodilator effect of adenosine do not prevent coronary vasodilatation in response to increased muscle activity. Therefore, another theory to explain the coronary artery