PREOPERATIVE PREPARATION OF THE
PATIENT WITH CORONARY ARTERY DISEASE

SAMUEL BELLET, M.D.

THE PROBLEMS

The problems involved in operative procedures on the patient with coronary artery disease have in recent years assumed increasing importance. Many factors contribute to this increased interest: the recent improvement in surgical procedures, pre- and postoperative care, wider use of antibiotics, advances in anesthesia, and the increasing percentage of older people in the general population, and therefore a larger percentage of older individuals who are now being subjected to operative procedures. Many of these subjects would ordinarily be considered to be poor surgical risks. It is a matter of common knowledge that such patients often make an uneventful recovery even after a relatively major and prolonged operative procedure. Because of the increasing incidence of complications during surgery, the preoperative study and management of such patients has assumed increasing importance.

For purposes of preoperative management, these subjects may be divided into the following groups: (1) older people who are relatively symptom free, (2) those with the anginal syndrome (coronary insufficiency), (3) patients with previously healed infarction, (4) patients with recent infarction (in the previous two weeks or few months), (5) those with arrhythmias, and (6) subjects with congestive failure.

Prior to operation the following problems confront the internist: (1) establishment of the presence, type and severity of coronary artery disease and any complications which may exist, (2) in the presence of an acute emergency, the consideration of the various acute abdominal conditions that may simulate an acute myocardial infarction, and vice versa, (3) is the operation mandatory to save life? (4) what is the increased hazard of surgery? and (5) what can be done to minimize this risk?

DIAGNOSIS OF CORONARY ARTERY DISEASE

The diagnosis of coronary artery disease is in most cases relatively simple. However, there is a large number of borderline cases where the differential diagnosis between conditions that simulate it are difficult to make.

Accepted for publication January 31, 1956. Dr. Bellet is Director of the Division of Cardiology, Philadelphia General Hospital, and Division of Cardiovascular Disease, Graduate Hospital and the Robinette Foundation of the University of Pennsylvania, Philadelphia, Pa. The work was aided by a grant from the Foundation of Cardiovascular Research and the Eli Lilly Company, Indianapolis, Indiana. The paper was read before the annual meeting of the American Society of Anesthesiologists, Inc. in Boston, Massachusetts, November 1, 1955.
The diagnostic features of coronary artery disease are as follows:

1. There is a history of attacks of the anginal syndrome or episodes of coronary occlusion.

2. The symptoms are principally those of precordial or substernal pain, or both. Chest pain is considered to be cardiac in origin if it was induced by effort or excitement, if its location was substernal with or without radiation to the left shoulder or arm, or if it is constrictive or oppressive in type. Chest pain of extracardiac origin frequently manifests the following characteristics: it occurs at rest, it may occur anywhere in the left chest (often without radiation), it has an aching quality, and is of relatively long duration.

3. The physical signs are as follows: The heart may be normal in size, but it is often enlarged, hypertension is often observed, and diffuse and peripheral arteriosclerosis are frequently associated. Dyspnea and/or cyanosis at rest is observed in advanced cases.
   a. Cardiac asthma or pulmonary edema may occur spontaneously or following physical effort or excitement.
   b. Ectopic rhythms (particularly ventricular tachycardia) may occur during an episode of coronary insufficiency or may appear more or less frequently during the course of coronary disease.
   c. Congestive heart failure is present.
   d. Adams-Stokes seizures may appear during the transitional stage from normal rhythm or partial atrioventricular block to complete atrioventricular heart block, or during the continuance of established complete A–V heart block.

4. Roentgenologic study often shows evidence of cardiac enlargement, and occasionally left ventricular aneurysm, calcification of the aorta or coronary arteries, or both.

5. Electrocardiographic studies show changes in the T wave, ST segment, and QRS complex, varying degrees of A–V heart block, bundle branch block and the presence of various arrhythmias.

6. Ballistocardiography often shows various abnormalities, such as early M pattern, late M pattern and deterioration of complexes. These changes are usually exaggerated by exercise and smoking.

7. Electrokymography may show diminution of ventricular pulsations localized to the region of the left ventricle, thereby confirming the diagnosis of left ventricular aneurysm.

8. Exercise tolerance tests will frequently reproduce the episodes of chest pain and may show characteristic ST and T wave changes in the electrocardiogram.

9. Anoxemia test: The inhalation of gas mixtures, with diminished oxygen tension, for example, 10 per cent oxygen will reproduce the episodes of precordial or substernal pain and result in alterations in the ST and T wave segment of the electrocardiogram suggestive of ischemia.
10. Chemical findings in blood: These patients often show an increase in cholesterol and uric acid and alterations in the lipoprotein patterns of the blood.

Although not all of these studies are required in each case, in borderline cases the differential diagnosis between coronary artery disease or other simulating conditions may be made only after thorough investigation.

**CONDITIONS SIMULATING ACUTE MYOCARDIAL INFARCTION**

The following problems confront the internist or cardiologist in the presence of an acute surgical emergency: (1) He must confirm the diagnosis of a surgical condition in a doubtful case. This is important in an elderly person when the symptoms and signs are localized to the mid-epigastrium, upper part of the abdomen, and lower part of the chest. Because of its location and severity the clinical picture may simulate that of an acute abdominal emergency. The diagnosis of an acute surgical condition often involves the differential diagnosis of the following: (1) acute coronary occlusion, (2) acute pericarditis, (3) dissecting aneurysm of the aorta, (4) gallbladder disease, (5) acute pancreatitis, (6) ruptured peptic ulcer, and occasionally (7), sudden distension of the liver accompanying congestive failure may simulate an acute gallbladder or other acute state localized to the abdomen.

The electrocardiogram, although quite helpful in differential diagnosis, in these conditions often presents difficulties. In the presence of coronary occlusion with shock, the electrocardiographic diagnosis is almost always clear cut. In many subjects however development of a characteristic pattern is delayed for twenty-four to thirty-six hours or even longer. The diagnosis of acute infarction may be difficult to make in cases with previous electrocardiographic abnormalities, particularly in the presence of bundle branch block digitalis effects and auricular fibrillation. Moreover, certain abdominal conditions, particularly those associated with vomiting and diarrhea (for example, bowel obstruction and acute pancreatitis), may, because of associated electrolyte change, produce T wave and ST segment changes which closely resemble those of an acute myocardial process. Shock-like states may also show electrocardiographic changes which may resemble those of myocardial ischemia. It is therefore important to obtain all of the available data and evaluate the case as a whole before deciding upon operation.

**GLUTAMIC OXALACETIC TRANSAMINASE (SGO-T) TEST**

Recently a valuable test has been developed which is helpful in the diagnosis of myocardial infarction, namely estimation of SGO-T in the serum (6, 18, 19). Glutamic oxalacetic transaminase (SGO-T) is present normally in all serum. The enzyme is found in highest
concentrations in the heart, skeletal muscle, brain, liver and kidney, in decreasing order. Following myocardial infarction, this enzyme rises 2 to 20 times the normal value from six to twenty-six hours after infarction. The height of the rise of the enzyme in the serum, as well as the duration of the rise, is roughly proportional to the amount of acutely infarcted tissue. In the presence of a suggestive clinical picture and equivocal electrocardiographic signs, the rise in serum SGO-T is important confirmatory evidence of acute infarction. Other factors which also cause a rise that must be ruled out are acute damage to skeletal muscle, liver, brain and kidney.

In experimental studies on dogs, a significant rise in transaminase was evident within five hours, and the peak level ranged from nine to twenty-three hours after the coronary artery occlusion. Similar observations have been made in the human subject. To be of significance in ruling out myocardial infarction, the transaminase activity should therefore be determined no less than five or six hours after the episode of precordial pain.

Differential Diagnosis Between Myocardial Infarction and Acute Abdominal Emergency

The following cases illustrate the difficulty in differential diagnosis which occasionally occurs:

Case 1. F. R., a 52 year old man, was admitted to the hospital complaining of severe pain in the lower chest, epigastrium and right upper quadrant. Although he gave a history of chest pain in the past suggestive of the anginal syndrome, an electrocardiogram taken on his admission showed only slight ST segment depressions in the precordial leads. Because of the doubtful cardiac findings and since the clinical picture was suggestive of acute gallbladder disease or some other acute abdominal emergency, surgery was decided upon. At operation, the gallbladder was found to be normal. No evidence of pathology was discovered after thorough abdominal exploration. On the following day, because of the continuance of the chest pain, another electrocardiogram was taken which disclosed a full-blown posterolateral infarction. This patient made an uneventful recovery.

This case illustrates the difficulty in differential diagnosis between a myocardial infarction and an acute abdominal condition. Because operation during an acute myocardial infarction involves a significantly added risk, this condition should be ruled out prior to operation, and the estimation of the SGO-T would be of considerable help.

Case 2. S. B., a male aged 42, gave a long standing history of mild hypertension. The heart was moderately enlarged. Because of symptoms of dyspnea and swelling of the ankles towards evening, he had in addition to other therapy received digitalis for several years. He was admitted to the hospital on Oct. 5, 1948 because of the sudden development of severe pain in the upper abdomen and a slight fever (102 F.) The differential diagnosis rested between an acute
abdominal condition (acute appendicitis or gallbladder disease) and an acute myocardial infarction. The electrocardiogram, which had always showed a deep Q wave in Lead III because of a high diaphragm, showed a depression of RST segments in Lead I, elevation in Lead III, and AVF and a depression of the ST segments in the precordial leads. It was impossible from the electrocardiographic findings to differentiate an acute inferior infarction from the ST segment changes resulting from digitalis effects in a transversely placed heart. At operation an acute appendix was removed.

The lesson to be learned from this case is that the electrocardiogram in a digitalized patient may give suggestive evidence of inferior, posterior or subendocardial infarction. The suspicion of an acute myocardial infarction might sway one to postpone operation when it is indicated.

Is the Operation Elective or Mandatory to Save Life?

The severity of the heart condition, with its resultant effect on anticipation of the life span, and the discomfort of the condition requiring surgery should all be weighed in determining whether the operative procedure should be performed. In the presence of an acute abdominal emergency such as perforated ulcer, ruptured gallbladder, or acute intestinal obstruction, one is warranted in taking the extra risk. On the other hand, the performance of an elective operation like herniorrhaphy or a pelvic repair may not be indicated if the anticipated life span is relatively short, that is, only one or two years.

Before deciding against operation the following point requires emphasis. Recent reports indicate that relatively long periods of survival are often observed following coronary occlusion. In a series of 100 consecutive patients (8), 66 survived over a period of 10 years. At the end of the next 10 years, only 16 were known to be alive, 16 were known to be dead, and 15 were lost to the follow-up. Additional reports (9, 10, 11, 15) show long periods of survival with a complete return to the previous occupation. Because of these factors and the lowered mortality rate of operation in such cases, operation should not necessarily be withheld in many of the cases.

Increased Hazard of Surgery in Patients with Coronary Artery Disease

Patients with coronary artery disease present an increased risk for surgery as opposed to those with normal hearts. However, the mortality statistics in the older literature must be revised in the light of modern anesthesia and surgery. Many subjects with even severe coronary artery disease may be operated upon without mortality. However, in a general way it may be said that the presence of coronary artery disease increases the mortality rate above that anticipated in those with normal hearts. The outcome in the individual case is often
difficult to predict, as are the complications that may develop and the patient's response to these complications.

There are relatively few available reports in the recent literature defining the actual risk of operation in cases of coronary artery disease. Sprague (1) (1929) reported an operative mortality of 21.8 per cent in 170 cases. Butler and Feeley (2) (1930) reported a mortality of 12.1 per cent in 414 cases; Hickman et al., (3) (1935) 7.7 per cent in 8 cases; Brumm and Williams (4) (1939) 4.3 per cent in 259 cases; Morrison (5) (1948) 9.9 per cent in 311 cases; and Hannigan et al. (1951) 5.2 per cent in 58 cases. Lochhead et al. (13) (1954) performed 51 surgical procedures on 32 patients; 30 operations were performed on 17 patients with one or more episodes of myocardial infarction, and 21 operations were performed on 13 patients with angina pectoris. The most recent report, that of Baker, Grover and Wise (17) (1955), is that of patients with healed myocardial infarction. In 70 cases involving 111 operative procedures (72 major and 39 minor), the operative mortality was 5.7 per cent for the 70 patients and 3.6 per cent for the 111 procedures. It is apparent from these figures that the operative mortality has dropped considerably in recent years. The point is of considerable importance in the final decision regarding the performance of a surgical procedure in these patients.

Few data are available relative to the effect of major operation on patients during the acute stage (necrosis) of myocardial infarction. In the uncomplicated case of myocardial infarction, necrotic changes are present for one to two weeks following the infarct and are replaced by granulation tissue by the third week. Operation should be postponed for at least six to eight weeks, and preferably for three to six months following the infarction. Butler and Feeley (2) (1930) observed four deaths in 5 patients who were subjected to surgery during the acute stage. I have observed two deaths which occurred immediately following operation, and within two weeks in a third. However, in three other cases, there were no observable effects of the operation or of the course of the acute infarction. When the surgeon is confronted with an urgent surgical indication during the stage of acute infarction, the decision is indeed a difficult one. The use of anticoagulants entails an added complication. In the case of heparin, the problem is relatively simple since the clotting time will return to normal in a few hours after cessation of bleeding. If Dicumarol® has been administered, the problem is more complicated. The administration of vitamin K, and in the case of Danilone®, of vitamin K oxide, will usually result in a return of the prothrombin time to normal in a matter of hours.

Preoperative Management

If surgery has been decided upon, one should determine the means by which the risk can be reduced during or after surgery. The follow-
Preparation in Coronary Artery Disease

...ing conditions require attention: (1) Anemia, if present, should be corrected by transfusion. If due to other causes than blood loss, treatment should be directed to the cause. (2) Polycythemia increases the operative hazard because of the tendency to develop vascular thromboses, especially of the coronary vessels. In such cases, one should especially guard against anoxia, hypotension and shock. (3) Patients should be in optimum electrolyte balance, particularly in the presence of fluid loss due to vomiting and diarrhea. The heart suffers appreciably during electrolyte imbalance. Hypopotassemia increases the tendency toward the development of ectopic rhythms and may be a factor in precipitating sudden heart and circulatory failure. Hyperpotassemia, on the other hand, which often occurs in association with dehydration and acidosis, results in cardiac slowing and may predispose the patient to the development of cardiac arrest.

Drug Therapy. Sedation should be accompanied by barbiturates or mild opiates. Morphine is a respiratory depressant and should be used with caution in this group.

Digitalis. Patients should not be digitalized routinely. This drug decreases cardiac irritability in combination with the depressant effect of anesthesia, anoxia and acidosis and may lead to the development of serious cardiac arrhythmias. Digitalis is indicated in the presence of heart failure in subjects susceptible to the development of auricular tachycardia and in the presence of auricular fibrillation to maintain a slow ventricular rate during and in the immediate postoperative period.

Anti-arrhythmic Drugs. Patients with ectopic beats preoperatively manifest a tendency to develop auricular or ventricular tachycardia and/or fibrillation during surgery. In the presence of extrasystoles prior to operation, quinidine or Pronestyl® may be given to prevent their increase during operation. The presence of auricular fibrillation entails an added hazard because of the tendency to develop heart failure and embolic phenomena. Finkbeiner et al. (14) (1955) reported an operative mortality of 5 per cent in 60 patients with cardiovascular disease associated with chronic auricular fibrillation. They emphasized the importance of complete digitalization and proper preoperative preparation. They feel that a patient with chronic auricular fibrillation is probably no greater an operative risk than a non-fibrillating patient with equal cardiac damage, providing the patient is adequately prepared preoperatively. Subjects with partial atrophicventricular heart block may develop increasing degrees of A-V heart block or cardiac arrest because the diseased conductive tissue can poorly withstand the effects of anoxia. Subjects with the Wolff-Parkinson-White syndrome, because of the tendency to develop rapid ectopic rhythms, should receive prophylactic digitalis, quinidine, or Pronestyl®. These drugs may be given orally or intramuscularly at selected time intervals preoperatively so that they will manifest their effect during the operative procedure. The patient should be watched with the
cardioscope during the procedure so that additional doses may be given in amounts sufficient to abolish the ectopic beats.

**Estimation of Surgical Risk**. The operative risk is often difficult to determine exactly. However, most of the patients withstand the operative procedure quite well. The intangible factors which are difficult to determine are the length of the operation, development of arrhythmias, hypotension, occurrence of shock, hemorrhage, and the patient's response to these complications. The following are important in the evaluation: (1) the presence of a metabolic disorder, whether particularly angina pectoris, myocardial infarction, syncope, arrhythmias, hypertension, or a tendency to develop sudden left heart failure or thrombo-embolic phenomena.

Probably the most important factor is the ability of the heart to respond to effort. If the patient has been able to carry on ordinary duties, the heart can probably withstand the usual load of an operative procedure. This does not, however, apply to the development of certain arrhythmias, shock, or circulatory collapse. It is therefore difficult to estimate the functional capacity of the myocardium in a specific individual subject to a specific operation. The more serious the coronary artery disease and the more serious the operative condition, the greater is the required skill of the surgeon and anesthetist.

**Psychological Preparation**. The psychological factors and nervous makeup of the patient are important, particularly in the presence of cardiovascular disease. Not only does anxiety increase cardiac work, but it is a factor in producing ectopic rhythms and vasospasm of the peripheral vessels. Such subjects have been living in constant fear of more or less serious complications, and the added hazard of operation accentuates their anxiety. Reassurance and the use of sedatives and tranquilizing drugs are of help in this record. The establishment of rapport between the patient and the anesthetist can be accomplished by preoperative visits and evaluation. Such visits are extremely helpful in dissipating and removing the fears of the patient for the unknowns of surgery and the operating room.

**Summary**

The preoperative preparation of the patient with coronary artery disease is a problem that has assumed increasing importance in recent years. Many problems are involved in the preoperative preparation. These include: (1) Diagnosis of coronary artery disease and determining its type and evaluating its severity. Has the patient had a previous myocardial infarction? After complete examination one may endeavor to determine the coronary reserve, that is to say, the extent of coronary involvement. This is frequently difficult to determine exactly. (2) In the presence of an acute emergency, one is frequently called to make a differential diagnosis between some acute abdominal condition
and a condition in the chest. The following problems then arise: (a)
is the operation mandatory to save life or is it elective? (b) what is
the risk of surgery? and (c) what can be done to minimize this risk?

The value of the electrocardiogram and the recently developed test,
serum glutamic oxalacetic transaminase, is discussed.

Operation should rarely be performed in the presence of acute
infarction and this only in the presence of an acute emergency. Prior
to operation the following often require attention: anemia, sedation,
digitalization, and the use of anti-arrhythmic drugs. Finally, the psy-
chological preparation of the patient is discussed.

REFERENCES

2. Butler, S., and Feeney, N.: Patient with Heart Disease as a Surgical Risk, J.A.M.A. 85:
85 (July 12) 1930.
3. Hiekmann, J., Livingstone, H., and Davies, M. E.: Surgical and Anesthetic Risk in Heart
Disease, Arch. Surg. 31: 917 (Dec.) 1935.
4. Brumm, H. J., and Willius, F. A.: Surgical Risk in Patients with Coronary Disease,
J.A.M.A. 112: 2377 (June 10) 1939.
1953.
9. Master, A. M., and Daek, S.: Rehabilitation Following Acute Coronary Artery Occlusion,
J.A.M.A. 118: 828 (Sept. 7) 1940.
cardiographic Features of Acute Myocardial Infarction, Arch. Int. Med. 68: 1215 (Dec.)
1941.
41: 323 (March) 1951.
12. Wasserman, F., Bellet, S., Saichek, R. P.: Postoperative Myocardial Infarction, New En-
16. Master, A. M., Jaffe, H. L., and Perdy, L.: Cardiac and Non-Cardiac Chest Pain: Statis-
Oxalacetic Transaminase (SGOT-T) Activity Following Graded Myocardial Infaracts in