

THE CHOICE OF ANESTHESIA IN CARDIAC DISEASE*

STANTON BELINKOFF, M.D.

New York, N. Y.

INTRODUCTION

THE choice of anesthesia for patients suffering from moderate or severe cardiac disease has always been a problem since these people usually belong to the older age group and, with their impaired cardiac status, are considered poor anesthetic and surgical risks. A major operative procedure together with its anesthetic is often more than they can tolerate. With modern anesthesia, it is not enough for the anesthetist to keep the patient alive during the operation and the trip back to his room, but if possible he should not do anything that might lessen the chance for recovery. Deaths occurring in the first postoperative days are often attributable wholly or in part to the anesthetic since the deleterious effects upon the patient, while not severe enough to cause collapse on the table, may so weaken him that his downhill progress is accentuated and culminates in his death.

If possible, the anesthesia, while providing suitable working conditions for the surgeon, should also be physiologically selected to meet and perhaps help remedy the cardiac deficiency. Such anesthetics vary with the different cardiac conditions, and an attempt will be made to consider the more common diseases and a rationale for the selection of certain anesthetic procedures.

In many instances of minor surgery, the anesthesia of choice which produces the least change in the patient is local infiltration or regional field block with procaine hydrochloride or a similar agent. Often, however, this method proves impractical, especially for major intra-abdominal surgery, and the choice usually lies between spinal and inhalation anesthesia. It is the selection of anesthesia in this type of case that will be discussed. Not all cardiac diseases will be mentioned, but rather those which are most commonly encountered, such as coronary artery insufficiency, cardiac decompensation and hypertension.

CORONARY ARTERY DISEASE

The group with coronary artery disease is so labeled because of a history of a previous occlusion or infarction, sometimes substantiated by electrocardiographic findings, or a history of anginal, precordial or substernal pain. Usually the patients belong to the older age group and are apprehensive about their heart and its ability to withstand the strain of a surgical procedure. They keep repeating to the surgeon

* Prize-winning essay in contest sponsored by The American Society of Anesthesiologists, Inc., 1945.

and anesthetist that they have a "bad heart." In these cases, reassurance and stressing of the lack of harmful effects from the contemplated anesthetic and operative procedure are most important in the preoperative preparation of the patient. Fear and apprehension must be allayed.

Too much stress cannot be placed upon preoperative sedation, and if error is to be made, it is better to be slightly on the side of an overdose. Each case must be individualized and separately evaluated, and enough sedation given to render the patient euphoric and sleepy. A combination of morphine and scopolamine in the ratio of 25:1 is best for this purpose. The inclusion of this class of patient in a group which receives routine preoperative orders, a practice that is prevalent in some institutions, is a grave error.

There are four chief dangers to be avoided in the administration of an anesthetic to a patient with real or potential insufficiency of the coronary circulation. Anoxia of the cardiac muscle is to be feared and is prevented by avoidance of a fall in the diastolic blood pressure, since it is upon the diastolic pressure that the coronary arteries depend for their supply of blood. Second, there must be maintenance of a high oxygen intake, using only those agents which permit a high percentage of oxygen to be administered while at the same time producing suitable anesthesia. Third, the excitement stage with its violent muscular exertion and consequent imposition of great strain upon the cardiac musculature may precipitate a coronary spasm and occlusion or myocardial infarction. This is avoided by the use of rapid-acting agents. Fourth, overloading of the circulation by large amounts of intravenous fluids may put too great a strain upon the heart and lead to cardiac failure.

In most instances, spinal anesthesia is contraindicated because of its tendency to produce a drop, often precipitous in nature, in both the systolic and diastolic blood pressures. With the use of vasopressor drugs, the blood pressure can often be maintained at or near its preoperative level, and inhalations of 100 per cent oxygen can maintain an adequate cardiac oxygenation. However, a form of general anesthesia is to be desired since at times a sudden, severe drop in blood pressure can produce disastrous results before it is remedied.

Several agents are available for the production of general anesthesia. In minor and extraperitoneal procedures not requiring any great degree of relaxation, intravenous sodium pentothal in a 2-3 per cent solution combined with inhalations of 100 per cent oxygen is the method of choice. Its advantages are pleasant induction and awakening with no excitement stage and a high oxygen intake which eliminates the possibility of anoxia during the procedure. This oxygen administration might well be continued into the postoperative period until the patient has completely reacted from the anesthetic. There is little or no change in the blood pressure.

In intra-abdominal procedures, sodium pentothal, when given in safe doses, does not provide sufficient relaxation to allow satisfactory operating conditions. Inhalation anesthesia is the method of choice, given by means of the carbon dioxide absorption technic. Of the various agents available, a combination of cyclopropane with ether and oxygen has proved most satisfactory. Nitrous oxide and ethylene may be dismissed as not providing sufficient oxygenation when given in concentrations high enough to produce surgical anesthesia.

The frequency of cardiac arrhythmias with cyclopropane-oxygen has led to the addition of ether to the mixture. Although irregularities in rhythm are never to be desired, they are more dangerous in the patient with preexisting coronary artery disease and may lead to ventricular fibrillation, cardiac arrest, or cardiac failure. It has, therefore, proved best to use cyclopropane for induction because of its rapidity of action, short or absent excitement stage, and high percentage of oxygen in the mixture. After the stage of surgical anesthesia is reached, ether is added to the mixture for its stabilizing effect on the cardiac rhythm. The concentration of cyclopropane is now reduced, and the anesthesia maintained with a mixture of cyclopropane, oxygen and ether. This arrangement allows for good relaxation, high oxygenation, and the least possible toxic effects upon the heart muscle during the operative procedure. Cyclopropane is depended upon to produce the larger part of the anesthesia, just enough ether being added to stabilize the heart rhythm. Usually only a trace is sufficient.

This type of case is ideally suited to the use of a balanced anesthesia, using some form of local or regional anesthesia combined with the general anesthetic agent. If the operative site is in the upper abdomen, intercostal block, as described by Bartlett (1), may be of inestimable value.

Intercostal block may be used in combination with sodium pentothal, as described by Evans (2), or with any of the inhalation agents, as described by Belinkoff (3). The amount of general anesthetic needed is greatly lessened, and the benefit to the patient is therefore large. The agent for production of the block is procaine 2 per cent, without adrenalin. Special care must be taken to insure the preparation of a solution without adrenalin since the usual routine is to include it when preparing procaine for local anesthesia. The presence of adrenalin may precipitate a coronary occlusion.

If the procedure is to be in the lower abdomen, an abdominal wall field block may help provide relaxation. The same precautions in regard to adrenalin must be observed here. It is wise to include a barbiturate in the preoperative sedation since this has a tendency to lessen the toxicity of the cocaine derivatives. The limits of safety in quantity of procaine that can be used should be remembered, 50 cc. being considered the maximum for 2 per cent procaine.

Aminophylline has seemed of value in this group of patients and is

now used routinely. Two cubic centimeters containing $7\frac{1}{2}$ grains are given intramuscularly about fifteen minutes before the start of the anesthetic. This is done to take advantage of the ability of the drug to produce coronary dilatation and bronchial relaxation.

DECOMPENSATION

The physiologic etiology of pulmonary edema and cardiac decompensation is controversial, groups favoring both the forward failure and backward failure theories. Anatomically, the etiology may be interference with the filling of the left ventricle as in mitral stenosis or inability of the left ventricle to empty itself adequately with each contraction or heart failure produced by hypertension, coronary artery disease, aortic insufficiency and aortic stenosis. Valvular lesions can usually be traced to a previous episode of rheumatic fever.

For the purpose of this discussion, patients will be considered on the basis of their symptomatology and physical findings regardless of the etiologic factors involved. Our primary consideration is alleviation of the symptoms or at least avoiding aggravation of those already present. In this group are included those with the signs and symptoms of cardiac decompensation, a history of such an episode, and those who show the findings which suggest that an episode of decompensation might occur if the cardiac system were subjected to an extra load. The predominant symptoms of this group are dyspnea on exertion, orthopnea and ankle edema. Basal rales are often found on examination. A history of rheumatic fever with the presence of a valvular lesion also automatically includes the patient.

The anesthesia of choice in this group of patients is spinal. This conclusion is based upon the physiology of cardiac decompensation and spinal anesthesia, the work of Sarnoff and Farr (4) in using spinal anesthesia for the treatment of cardiac decompensation, and clinical experience with the use of both spinal and inhalation anesthesia in this type of case.

Sarnoff and Farr have used spinal anesthesia in the treatment of patients admitted to the hospital presenting the picture of severe cardiac failure, with pulmonary edema the predominant symptom causing distress. They assumed that spinal anesthesia would cause peripheral dilatation and muscular relaxation in the caudad portion of the body and trap some blood there, so reducing the circulating blood volume and the load on the heart. The reduced return flow to the right heart would help correct the imbalance between the right and left heart and aid in the return of the fluid in the lungs to the general circulation, relieving the pulmonary congestion. The anesthesia thus acts as a bloodless phlebotomy in essentially the same manner as applying tourniquets to the extremities. In their cases it was not used as the sole method of treatment but was employed in conjunction with other accepted medical means. It relieved the acute symptom of pulmonary

edema with its impairment of respiratory function and anoxia which signaled impending disaster and allowed the drugs administered a chance to exert their full effect.

This theory is sound, and its application to clinical anesthesia naturally follows. Whenever the operative site is to be below the diaphragm, spinal anesthesia is the method of choice, and if the procedure is to require any prolonged time, the continuous method described by Lemmon (5) should be used.

In some instances it is desirable to put the patient to sleep, as when there are stimuli from mesenteric traction, uncontrollable nausea or emotional instability. The best method is a continuous pentothal drip as in a venoclysis of a 0.5 per cent solution combined with a 50 per cent mixture of nitrous oxide and oxygen, this providing the most nearly physiologic sleep without undue depression and with high oxygenation. The use of a carbon dioxide absorption technic for the nitrous oxide-oxygen mixture also provides a rebreathing bag where the depth of respirations can be observed, and any signs of respiratory depression quickly noted and remedied.

An attempt to produce relaxation and good surgical anesthesia in this type of cardiac patient with a form of inhalation anesthesia has in several instances precipitated a severe form of cardiac failure, with pulmonary edema. In some cases the heart failure is not evident during or immediately following the operation but begins to show and progress during the first and second postoperative days. The anesthesia can still be considered a contributing factor in these cases.

Even when the patient does not have a history of an episode of severe cardiac decompensation but has had ankle edema and dyspnea or orthopnea, he should be considered a poor risk and not subjected to a deep inhalation anesthesia. In one case, the patient had residual valvular lesions following rheumatic fever but no signs or symptoms of decompensation. She developed acute pulmonary edema on the operating table on two successive instances when an operative procedure was being done under inhalation anesthesia. This indicates the necessity for vigilance before selecting general anesthesia for this type of apparently normal but potentially poor risk patient.

If the operation is an elective one and the patient presents some of the signs and symptoms of failure, an effort to digitalize him should be made in the preoperative period. In the case of emergency surgery, however, a test dose of ouabain should be given and more held in readiness to be administered at the first sign of decompensation. Once these people go into cardiac failure, it is very difficult to return them to their normal state since superimposed upon the diseased heart is the insult of a major surgical procedure.

A high concentration of oxygen should be administered throughout the operative procedure. As soon as the spinal anesthetic has been given, an oxygen mask should be placed upon the patient's face and

100 per cent oxygen given until the end of the procedure. Oxygen administration should be continued in the postoperative period for twenty-four hours with nasal catheters or by B.L.B. or some other suitable mask if a concentration higher than 50 per cent is desired.

The routine use of a pressor drug prior to the administration of a spinal anesthetic should be continued here to maintain the blood pressure. Neosynephrin hydrochloride is the drug of choice. Its advantages are that as a rule it produces a bradycardia, increases the stroke output, does not cause arrhythmias and does not have any effect upon the central nervous system. Pitressin particularly is to be avoided since, while raising the blood pressure, it is also a potent coronary vasoconstrictor.

Venoclysis should be started before the operative procedure begins and run as slowly as possible, chiefly to provide a patent and readily accessible vein for the immediate administration of any drugs or blood or plasma should they become necessary in an emergency.

HYPERTENSIVE HEART DISEASE

Patients with hypertension can be divided into two groups; those with elevation of only the systolic blood pressure and those with elevation of both the systolic and diastolic pressures. The diastolic elevation is the most significant since it is upon the diastolic pressure that the coronary arteries depend for their blood supply. When the coronaries have been accustomed to a rapid flow of blood under high pressure to supply an enlarged heart doing a greater amount of work, a sudden, severe fall may so embarrass the heart muscle through anoxia that it might be unable to carry on its work. In the group with a very high diastolic pressure, spinal anesthesia is contraindicated for any intra-abdominal procedure that may be associated with a sharp fall in blood pressure. However, it can safely be used for perineal procedures, operations upon the vagina or rectum where the anesthesia can be limited to the "saddle" area with small doses of the anesthetic agent and negligible drop in blood pressure. It is wise to give 100 per cent oxygen during the procedure to guard against possible anoxia.

Many minor operations on superficial parts of the body in which relaxation is not required may safely be done with intravenous sodium pentothal combined with 100 per cent oxygen. The ease of induction and pleasant recovery period make it a desirable method.

For all major procedures, however, inhalation anesthesia is the method of choice, with cyclopropane-oxygen as the agent most desirable. This produces less systemic change than any of the other inhalation agents which are capable of producing muscular relaxation sufficient for intra-abdominal surgery. It maintains the blood pressure fairly well with no precipitous drops. Its disadvantage of predisposing to cardiac arrhythmias may be counteracted by the addition of small quantities of ether to the anesthetic mixture as a cardiac stabi-

lizing agent. This arrangement, while providing acceptable operating conditions for the surgeon, provides the patient with an assured coronary blood flow with a high oxygen concentration.

When a severe amount of kidney damage is present, the anesthesia of choice is spinal. If, however, the diastolic pressure is also markedly elevated and spinal anesthesia is contraindicated, then cyclopropane should be used since it is the least toxic to the kidneys of any of the other agents. All patients with hypertension should have urinalysis and blood chemistry studies done.

If hypertensive heart disease is combined with arteriosclerotic heart disease, inhalation anesthesia with cyclopropane with or without the addition of small quantities of ether is again the method of choice, for here, even more than before, a severe drop in blood pressure may be disastrous. The coronary vessels are sclerotic and unable to compensate for this drop in blood pressure and heart failure would result in a short time.

COMMENT

The tendency of many of the older surgeons is to demand open drop ether as the anesthetic of choice when they have a seriously ill patient or one with a severe cardiac disease, and they have instilled this idea in the younger men whom they have trained. This thought originated and gained strength some years ago when anesthesia as we know it today was in its infancy. The present carbon dioxide absorption technic was not available then, the value of inhalations of high concentrations of oxygen was not fully appreciated, and spinal anesthesia was new, erratic, and undependable. At the present time, with the highly developed methods of anesthesia available, the proper technic should be chosen depending upon the individual patient and the picture he presents. The only time open drop ether is indicated is when a trained anesthetist is not available and either a layman or someone not acquainted with anesthesia must be called upon to anesthetize the patient as best he can under the direction of the surgeon. Even then, if any means of administering oxygen is available, it should be used along with the ether. The practice of some surgeons of demanding open drop ether anesthesia because "the patient is too sick or too bad a risk" is to be strongly condemned.

The surgeons are not solely to blame. Medical men called in on consultation to evaluate the patient's cardiac status and estimate the risk are often responsible for selection of open drop ether anesthesia. This is usually owing to ignorance on their part, and their feeling that as long as they suggest open drop ether they would be safe, since it is the oldest anesthetic agent, is the best known, and the safest in untrained hands. The anesthetist in charge should be consulted by the cardiologist and a decision made after a discussion of all the available methods.

Anesthesia produced by local infiltration can at times be dangerous. When such an anesthesia is incomplete and the patient feels pain, the resultant straining, especially in intra-abdominal procedures, rapidly produces shock. The mental strain and worry along with the pain may precipitate a coronary occlusion or a cerebral hemorrhage in patients already predisposed toward these complications. Unless the local infiltration will provide complete anesthesia, it is best to arrange for another method.

If there is available an anesthetist well trained in all the branches and methods of anesthesia available, then the anesthetic should be chosen along the lines already described. However, in some instances the person called upon to administer the anesthetic may be very adept at one form and not very good at the others, as some men almost always use general anesthesia, some spinal, some pentothal. In this case, rather than have the anesthetist try to use a method with which he is unfamiliar, it is better to use that to which he is accustomed since in his particular hands this will prove to be the better method. Instances are common in which a man is compelled to give an unfamiliar anesthetic agent for an operative procedure because it has been shown to be good for this particular type of patient in someone else's hands. This practice has often led to tragic results. Along with the individual patient, the capabilities and training of the individual anesthetist must be considered.

This has not been a discussion of all types of cardiac disease. Many pathologic states have been purposely omitted, since they are uncommon and do not frequently arise as problems. Anesthesia for operations upon the heart itself belongs in the realm of anesthesia for thoracic surgery and will not be taken up here.

CONCLUSION

The most common types of cardiac disease have been discussed and the rationale for the anesthetic of choice given when a surgical procedure is contemplated. Each case must be considered individually, and a careful evaluation made of the patient's condition, the proposed operation and the skill of the anesthetist before the anesthetic is selected. If possible, this should be done by joint consultation of the physician, surgeon and anesthetist.

111 East 76 St.

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