EDITORIAL/REVIEW

Surgery for Wolff-Parkinson-White Syndrome and the Role of the Perfusionist

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Key words: Wolff-Parkinson-White, cryoablation, epicardial approach, endocardial approach

Abstract

Surgical treatment of Wolff-Parkinson-White (WPW) is increasing dramatically and perfusionists should be familiar with the methods used in this procedure. Cardiac surgeons are being trained in this procedure in increasing numbers and hospitals are rapidly starting programs of surgery for certain arrhythmias. The success of the operation over the past 20 years has ensured that the number of procedures will increase as results continue to improve. In view of the safety and gratifying long-term results achieved in patients with a variety of supraventricular dysrhythmias, it has become apparent that early surgical intervention is generally preferable to chronic pharmacological therapy (1).

Surgery for WPW syndrome requires team work even more than other cardiac procedures. The surgical procedures used require either cardiopulmonary bypass (CPB) or immediate standby in case of complications. In addition, operation of the cryoablation machine used in some procedures is most appropriately delegated to the perfusion team. The perfusionist must be thoroughly familiar with the techniques used and the varying aspects of each procedure.

Introduction

Normal conduction of the heart begins in the right atrium at the sinoatrial (SA) node, which is located near the superior vena cava. The impulse moves across the atrium to the atrioventricular (AV) node and then to the His bundle. The His bundle conducts the current from the atria to the ventricles by penetrating the annulus fibrosis, and continues down through the membranous interventricular septum. The bundle then divides into three tracts. The right goes around the right ventricle to the apex where depolarization occurs. The left has two branches. The main left bundle goes across the superior interventricular septum to an area near the aortic valve. There, it divides into the left posterior and left anterior divisions conducting to the interventricular septum and basilar portions of the left ventricle, respectively (2).

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Conduction in WPW

WPW is a cardiac arrythmia resulting from an accessory pathway of the atrial-ventricular (AV) electrical conduction system. The existence of an accessory tract results in an accelerated AV conduction with the affected ventricle becoming prematurely excited. These tracts, called Kent bundles, invariably connect the atrium to the ventricle with a band of myocardial tissue that lies in the fat pad of the AV groove. Transmission of electrical impulses across the Kent bundle is much faster than conduction across the normal AV node. Episodes of supraventricular tachycardia occur when conduction follows the normal tract across the AV node, but returns to the atrium by a retrograde route along the accessory tract causing the atrium to contract again. There are four main areas that are affected by the accessory conduction: the left ventricular free wall (50%), the right ventricular free wall (25%), posterior septal wall (25%) and a small number affect the anterior septal wall.

Clinical Presentation

The EKG demonstrates a shortened P-R interval with a delta wave (a sloped QR line) on the QRS complex indicating ventricular pre-excitation.

Patients selected for the operation are generally young and in otherwise good health. In one recent study, the patients had a mean age of 30 and this should be expected to decrease even more as the operation becomes more prevalent. Ebstein's anomaly is present in about 6% of the affected individuals. Many of these patients had experienced episodes of dizziness and loss of consciousness and most were deemed to be incapable of being managed with medical therapy (4). Some were operated on as an alternative to long-term drug therapy and this option would seem to be increasing as the efficacy of the operation is disseminated. Hopefully, younger patients will enjoy a life free of disabling arrythmias and the side effects of medications.

Preoperative Evaluation

Preoperative electrophysiological evaluation is completed to establish the presence of WPW. The cardiologists study the arrythmias. The locations of the accessory pathways are determined using right atrial and coronary sinus mapping while

stimulating the heart. The cardiologist is actively involved in all aspects of the operation.

Anesthesia Considerations

The patient is monitored upon arrival in the operating room with a seven lead surface EKG along with ST segment analysis. Central venous access is recommended for all patients undergoing CPB and some patients may require a pulmonary artery catheter for measuring filling pressures and cardiac output. In placing invasive monitoring, care must be taken to reduce atrial and ventricular dysrhythmias.

The goal of the anesthesiologist is to prevent sympathetic stimulation causing tachyarrhythmias and to maintain hemodynamic stability (5). Induction agents may include thiopental, narcotic, vecuronium, pancuronium and a nitrous oxide-oxygen 2:1 mixture. Usually, no side effects on the accessory pathways are seen with nitrous oxide, thiopental, or pancuronium (6).

The use of atropine in WPW syndrome patients is controversial since it can cause tachycardia as well as normalize AV conduction with resolution of the delta wave on the surface EKG (7). At the present time, atracurium or vecuronium seem to be the best muscle relaxants to use in patients with WPW syndrome since they have no effect on conduction (8). Deep anesthesia using inhalation agents has been advocated (7, 9), and halothane has been shown to slow conduction in the AV node, His-Perkinje system, and ventricular myocardium, while enflurane has been shown to slow AV nodal conduction (10, 11). Although anesthetic agents may interfere with the mapping by altering AV and accessory pathway conduction properties, clinical management must be centered on maintaining hemodynamic stability.

Procedure

The surgical procedure begins with a median sternotomy regardless of the suspected location of the aberrant pathway. Electrodes used for both pacing and sensing are sewn onto one of the atria and one of the ventricles. These electrodes are then used to identify the precise location of the Kent bundle by a process called intraoperative mapping.

Antegrade mapping involves measuring the amount of time taken for an impulse arising in the atrium, to reach the ventricle, while retrograde mapping measures the time taken for a ventricular impulse to reach the atrium. A handheld electrode is positioned on either the atrial or ventricular side of the AV fat pad as the heart is being paced by the previously placed electrodes. The probe is positioned first at the base of the right atrial appendage while the ventricle is being paced by the cardiologist. The amount of time required for the ventricular impulses to reach the atrium is measured and the handheld probe is moved approximately 2 cm. around the AV groove for the next measurement. This is done around the entire heart as sequential measurements are taken and the process is repeated with the handheld probe on the ventricular side of the fat pad while the atrium is placed. The result is a series of measurements showing where the point of fastest transmission occurs. As mentioned above, the Kent bundles transmit impulses faster than the normal conduction system, so this point of fastest activation corresponds to the location of the abnormal accessory tract.

Mapping the right side and inferior surface of the heart does not require much manipulation, but to position the handheld probe on the left side of the heart requires lifting the heart out of the pericardial well, which usually produces unacceptable hypotension. Because of this, it is often necessary to institute CPB to allow safe mapping of the left side. Aortic cannulation is routine, and two single stage venous cannulae are most often used to obtain venous return. The venous cannulae are placed well away from the AV groove in order to avoid damaging the tract, which could invalidate mapping, and to keep the cannulae away from a potential area requiring surgical dissection.

In general, there are two approaches to WPW surgery; the endocardial approach and the epicardial approach. Both are based on the same principle of completely dissecting the AV fat pad in the region of the Kent bundle. Anatomic studies unequivocally show that the accessory tracts lie somewhere in this fat pad, so a complete dissection of the fat pad necessarily destroys the Kent bundle and eliminates abnormal conduction.

The endocardial approach has been the traditional technique used to eliminate Kent bundles. It is based on an incision into the endocardium 2 mm. away from either the tricuspid annulus or the mitral annulus, depending on the location of the accessory tract. The incision is several centimeters in length and is carried down on the surface of the ventricle until the epicardial reflection is reached. Since exposure of the endocardium is required, the patient must be on CPB. Most surgeons use moderate systemic hypothermia along with aortic cross-clamping and cardioplegia for the approach.

The epicardial approach has been championed primarily by Guiraudon as an alternative to endocardial dissections and does not require opening the heart and so can often be done without placing the patient on CPB. With this approach, an incision is made into the epicardium at the level of the AV fat pad overlying the atrium. Using a wide advance, the dissection is carried down along the atrial surface until the tricuspid or mitral annulus is reached. One of the advantages of the epicardial approach is that the cardiologists can tell immediately when the pathway is eliminated. Right free wall and posteroseptal pathways can be eliminated without circulatory support, but left free wall pathways invariably require normothermic CPB. After the dissection has been completed, cryoablation is used as an adjunct to eliminate any microscopic pathways that may not be apparent.

The responsibility for operation of the cryoprobe falls to the perfusionist, thereby making complete familiarity with this device a necessity. The cryoprobe is applied to the atrial wall overlapping the annulus and carried down to -60° centigrade for two minutes. After the two minutes, the unit is switched to the defrost mode in order to prevent tearing of tissue that may adhere to a frozen probe.

Both approaches, then, dissect the AV fat pad from the valve annulus to the epicardial reflection. Epicardial dissections do

this from the outside of the heart along the atrial wall, while endocardial dissections do the same except from the inside of the heart along the ventricular wall. Regardless of the type of approach, remapping is carried out after dissection in order to ensure that the pathway has been eliminated (12-18).

The Cryomachine

The cryomachine is very simple to use and the only problem we have encountered is the exhausting force of the nitrous oxide gas utilized by the machine. The exhaust outlet must be connected to a powerful vacuum source in order to prevent the exhaust line from being blown off, causing a sudden rush of gas and a frightening sound. We have eliminated this need for a powerful vacuum source, which we do not have, by running our exhaust line outside the operating room and having the vacuum line at the outlet but not connected. This allows the gas to be scavenged without overpressurizing the line. Another safety concern is the necessity of the pressure gauge on the cryomachine reading zero before the cryoprobe line itself is disconnected at the termination of the procedure in order to prevent a dangerous release of pressurized gas.

The prevention of accidental complete AV block is a major consideration of cryoablation. At our institution, the individual operating the cryomachine is instructed to immediately begin defrosting if the cardiologists detect unintentional block. Seconds are critical and the involvement of all team members is important.

CPB Considerations

CPB may be necessary at any time during the operation, including mapping as the heart may become irritable and fibrillate. For that reason, we have a primed pump in the operating room. Attempting to bring a pump into the room and prime it would be time consuming and dangerous due to the presence of the large amount of equipment that the cardiologists utilize. Lidocaine is not added to our prime due to the antiarrhythmic effects of the drug. The drug works by increasing the electrical stimulation threshold of the ventricle, and thus it may serve to mask the aberrant pathway. Heparinization during normothermic bypass must be carefully monitored due to the increased metabolism of heparin when the patient is warm. The initial heparin dose, which is administered directly into the right atrium, is 300 units per kilogram. Activated clotting times are kept at 480 or greater, and are monitored every 15 minutes. At our institution, we also use a Hepcon machine to determine heparin levels and for protamine reversal dosages.

Oxygenation is carefully monitored. Again, due to the lack of systemic cooling for long periods, oxygen utilization may increase. We utilize a Bentley OxySat meter and a Cardiovascular Devices 300 in-line gas monitoring system to assess our management of perfusion in conjunction with our samples sent to the lab. Blood flows are kept at a 2.4 index during normothermia.

Results

Complications of this surgery include tearing of the coronary sinus or atrium. These are usually easily repaired. Permanent AV block may also occur, requiring a permanent AV pacemaker. Mortality is one percent. However, the success rate of the operation as a whole is 98% as measured by the lack of recurrences of ventricular tachycardia or fibrillation without drugs or with drugs that previously have been ineffective (14). These patients are able to enjoy normal, active lives without the syncope and dizziness often associated with WPW. They are also spared the life-threatening episodes of atrial fibrillation with a rapid ventricular response.

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