PBLD TABLE #8

Why are you ruining my EP study?

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Objectives:

1. Review the management of common pediatric arrhythmias presenting for electrophysiology (EP) study and ablation

2. Discuss the advantages/disadvantages and the factors affecting the choice of anesthetic technique (general vs. sedation)

3. Review the effects of inhalational agents and intravenous anesthetics on cardiac electrophysiology and a successful ablation

4. Discuss the risks/complications related to a cardiac electrophysiology study and ablation

Case History:

A 12-year-old male has a history of recurrent palpitations/SVT over the past 5 years. He has had >20 emergency room visits with 8 emergency room admissions over the past year. These episodes were not controlled with Atenolol and vagal maneuvers. He was recently hospitalized one week ago for five days to initiate flecainide. His current medications now include flecainide and digoxin. He had an episode of SVT last night. His family contacted his cardiologist who instructed them to give him four tablets of his digoxin.

Recent ECG: NSR; no evidence of pre-excitation

Recent echocardiogram: normal structural anatomy with normal biventricular function

HR 74 BP 123/65 O_2 sat 99% RR 20 T 36.4°C 109 kg 175 cm

Questions:

How is SVT defined? What are the current medical treatment recommendations? What are the current indications/contraindications for EP study and possible ablation? Wasn't he supposed to have held his cardiac medications prior to the EP study? What is the mechanism of action for flecainide? Will his overnight increase in digoxin administration interfere with his study? Should he be cancelled?

You proceed with the case as scheduled.

Questions:

What does an EP study entail? Does it require the presence of an anesthesiologist? What is the optimal anesthetic plan for this patient's EP study and possible ablation?

The cardiologist requests no general anesthesia because it will interfere with his EP study.

Questions:

Do you agree? Is there evidence-based literature to support his statement? Are you concerned this patient's BMI is 35.6?

You proceed with the plan for mild to moderate sedation using a propofol infusion and oxygen via face mask. As the procedure begins with obtaining vascular access, the patient moves and moans in pain despite the local anesthetic administered by the cardiologist. Despite a bolus of alfentanil and increasing the propofol infusion, the patient still continues to move in response to obvious discomfort.

Questions:

What are the ASA defined levels of sedation and recommendations regarding monitoring? What should be done next? Is it reasonable to convert to a general anesthetic?

You continue to increase the propofol infusion, which is now running at 250 mcg/kg/min and still giving additional alfentanil boluses. The patient begins to snore heavily but is able to maintain an adequate oxygen saturation. The cardiologist states his catheters are now in place and he is ready to begin testing.

Questions:

Where are the EP catheters usually placed? How is testing performed? How long do you expect this procedure to last?

The cardiologist communicates to you that he is having difficulty inducing this patient's arrhythmia. He inquires how "deep" is the patient at this time. He also informs you that he will be starting isoproterenol.

Questions:

How do you reply? Should you have placed a BIS monitor on this patient planned for sedation? Would that make a difference? Why isoproterenol? What is the usual dose to be given?

The cardiologist is able to induce the patient's arrhythmia and has it mapped. He is now ready to ablate, however he states the catheter keeps moving too much because of the patient's abdominal wall motion. Can't you do something about it?

Questions:

Is it time now for conversion to a general anesthetic? Do you think the patient is hypercarbic? Will hypercarbia affect the EP study?

You decide to simply give boluses of propofol making the patient apneic intermittently during the ablation. During the follow-up EP study following the ablation, the cardiologist states he has found another pathway that needs to ablated as well. You have now been in the cath lab for this study for four hours thus far.

Questions:

Will you consider a change in anesthetic plan now? Are you worried about personal radiation exposure? What are the recommendations for limiting radiation exposure as the anesthesiologist?

After the second pathway has been ablated, the follow-up EP study shows no further issues. The cardiologist states he is done. You stop the propofol. The patient begins to awaken and you transport to the recovery area. Approximately 45 minutes after you leave the patient, the recovery nurse calls you because the patient has persistent hypotension.

Questions:

What are the complications associated with an EP study/ablation? Could you have prevented this cardiac perforation?

Case Discussion:

Supraventricular tachycardia (SVT) is the most clinically significant pediatric arrhythmia. SVT is characterized by a narrow QRS complex, although a widened QRS complex can occur secondary to aberrancy in the right or left bundle branches. There are two general types of SVT: automatic and reentry. Reentry is the more common of the two types. Medical management of SVT depends on the patient's clinical status, type of tachyarrhythmia and its mechanism.

The purpose of an electrophysiology (EP) study is to identify the arrhythmia, its mechanism and map foci for ablation. In the pediatric population, successful ablation of SVT occurs in approximately 91-95% of patients, with a recurrence rate of 23%. Most children presenting for SVT ablation are otherwise healthy and have structurally normal hearts. The indications for catheter ablation of SVT include: failure of medical treatment (i.e. frequent recurrences of arrhythmia on medications), risk of sudden death, intolerance of side effects related to anti-arrhythmic medications, and patient preference for ablation as possible curative treatment rather than long-term therapy with anti-arrhythmics.

Anti-arrhythmic agents are usually stopped two to three days prior to the scheduled electrophysiology (EP) study. An EP study begins with obtaining vascular access, usually via the femoral veins and right internal jugular vein. Typical catheter positions include the high right atrium to evaluate sinoatrial (SA) node function and atrioventricular (AV) conduction, the right ventricular apex to assess ventricular activity and provide pacing capability, across the tricuspid valve to assess the bundle of His, and in the coronary sinus to capture left atrial activity. After a baseline study is performed and recorded, pacing is performed. Burst pacing and

programmed electrical stimulation is initiated, sometimes accompanied by a catecholamine infusion such as isoproterenol. Isoproterenol increases the SA rate, speeds AV conduction, reduces refractory periods and increases automaticity of other myocardial contractile tissue. Programmed electrical stimulation utilizes a number of stimuli delivered at fixed cycle lengths followed by a premature beat. The premature beat is moved increasingly earlier, until the refractory period of the area being tested is reached. This technique promotes the triggering of supraventricular arrhythmias and allows for establishing diagnosis of the mechanism. Cardiac mapping during the EP study identifies the temporal and spatial distributions of electrical potentials during normal and abnormal rhythms. This process allows evaluation of the spread of activation from its commencement to its completion within an area of interest. Cardiac mapping is useful in identifying the site of origin or a critical site of arrhythmia conduction for which to target during radiofrequency ablation.

The choice of anesthetic technique depends on a number of factors. The primary considerations when choosing the type of anesthetic to provide should take into account the patient age, patient co-morbidities, type of procedure, and anticipated length of procedure. The anesthetic technique should provide for patient comfort during the procedure, minimal effect on atrioventricular conduction, and the ability to afford for immobility to facilitate accurate cardiac mapping and safety during particular times such as trans-septal puncture to the left atrium and during ablation. When utilizing sedation techniques, airway obstruction can lead to excessive chest and abdominal wall movement which can lead to undue intracardiac catheter movement interfering with cardiac mapping, as well as causing loss of catheter contact with the intended ablation site which is important for lesion quality. General anesthesia with either laryngeal mask airway or intubation can alleviate such issues.

A number of anesthetic agents have been studied to delineate their effect on normal atrioventricular conduction. Volatile agents can affect SA node automaticity, shorten cardiac action potential, and prolong AV conduction time. However, multiple clinical studies in the pediatric population have shown that the use of isoflurane, sevoflurane and desflurane during EP testing and ablation have minimal effects on the ability to elicit tachyarrhythmias and do not interfere with accessory conduction pathways. Intravenous agents such as fentanyl, alfentanil, sufentanil, midazolam and propofol are all considered acceptable for use during EP testing and ablation. Propofol has been noted in one pediatric study for its effect on ectopic atrial tachycardia with an automatic mechanism. Its use was felt to interfere with inducibility of the arrhythmia and therefore successful ablation in this particular subgroup. There are only published animal studies investigating the electrophysiologic effects of ketamine. Two intravenous agents that are currently considered to be contraindicated during EP testing and ablation are remifentanil and dexmedetomidine. Remifentanil has been demonstrated in two pediatric ablation studies to slow SA and AV nodal function and decrease SA node automaticity when used in conjunction with a propofol infusion. Dexmedetomidine,

an α-2 agonist, in a study involving 12 pediatric patients undergoing EP evaluation and ablation for SVT demonstrated depression of SA and AV nodal function. Monitoring of AV nodal function is of importance due to the risk of complete heart block related to misleading measurements and subsequent ablation, especially if atrioventricular nodal reentrant tachycardia (AVNRT) is the arrhythmia of concern. The use of muscle relaxants should also be avoided during periods of pacing to enable the cardiologist to assess phrenic nerve function in order to avoid possible injury.

The most common complication related to radiofrequency catheter ablation are vascular access injuries such as bleeding, hematoma and infection in approximately 3-4% of patients. Other less frequent complications are cardiac perforation and/or tamponade, complete heart block requiring permanent pacemaker placement and phrenic nerve injury. Identification of cardiac perforation and/or tamponade usually manifests as hypotension. The diagnosis can be confirmed via fluoroscopy if still in the EP suite or echocardiography if in the recovery area.

The demand for anesthesiologists in the EP suite due the increasing numbers of ablations for various tachyarrhythmias in both adult and pediatric patients continues to grow. In comparison to operating room cases, the delivery of anesthesia in remote locations such as the EP laboratory has been associated with a higher proportion of death primarily related to an adverse respiratory event with monitored anesthesia care/sedation. The choice of anesthetic technique for EP testing and ablation depends on more than just the cardiologist's preference, but also patient safety.

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