Melbourne
Heart Rhythm

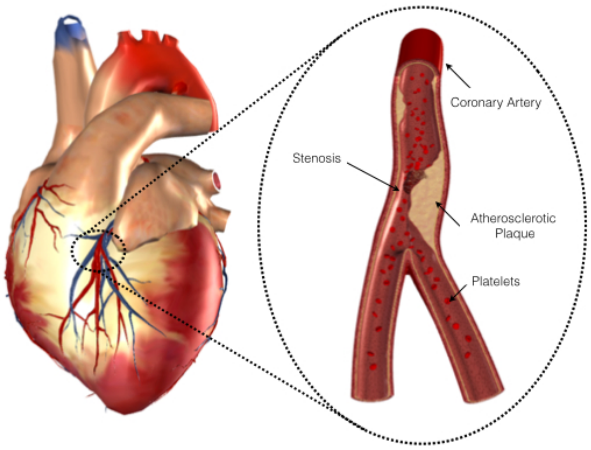
VT Ablation in Structural Heart Disease
Patient Information

Ventricular Tachycardia in Structural Heart Disease (VT-SHD)

Ventricular tachycardia (VT) is an abnormal rapid heart rhythm originating from the lower pumping chambers of the heart (ventricles). The normal heart usually beats between 60 and 100 times per minute, with the atria contracting first, followed by the ventricles in a synchronized fashion. In VT, the ventricles beat at a rapid rate, typically from 120 to 300 beats per minute, and are no longer coordinated with the atria.
The controlled contraction of the ventricles is important for the heart to pump blood to the brain and the rest of the body and to maintain a normal blood pressure. Abnormal and fast rhythms from the ventricle may impair the ability of the pump to supply blood to the brain and the rest of the body as a result of the rapid rate and weak contractions. This may result in palpitations (a feeling of rapid or abnormal heart beat), dizziness, lightheadedness, or syncope (loss of consciousness). If the heart rate increases to more than 300 beats per minute and becomes totally uncoordinated, this is usually called ventricular fibrillation (VF), which will cause sudden cardiac death.

VT occurs most commonly in patients with weakened heart muscle (cardiomyopathy) or when scar tissue develops in the heart. In patients with coronary artery disease (blockage of blood vessels on the surface of the heart), this scar is the result of a prior heart attack (myocardial infarction) when the muscle dies as a result of a blockage in blood flow. Scar, or fibrosis, can interfere with the normal electrical impulse in the heart, leading to a short-circuiting of the rhythm, called reentry. VT can also occur in patients with normal hearts by a different mechanism whereby the electric conduction is overly excitable, like a muscle twitch.

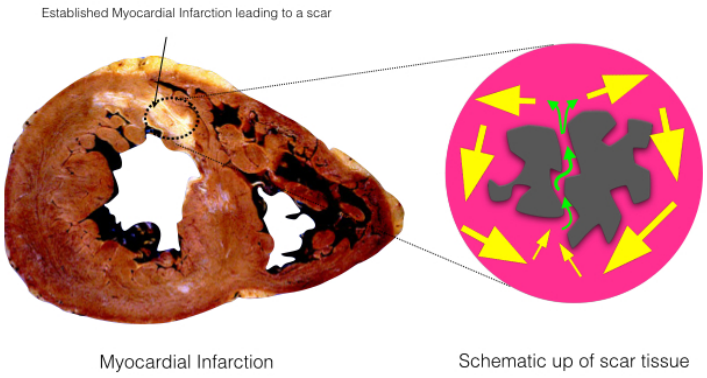
VT in Ischaemic Heart Disease



" A heart attack (myocardial infarct) is caused by a blockage of one of the coronary arteries that sit on the outside of the heart"

"Usually there is a slow build of cholesterol over time (atherosclerotic plaque) within the artery that leads to a narrowing (stenosis). If a blood clots blocks this narrowing acutely a myocardial infarction occurs."

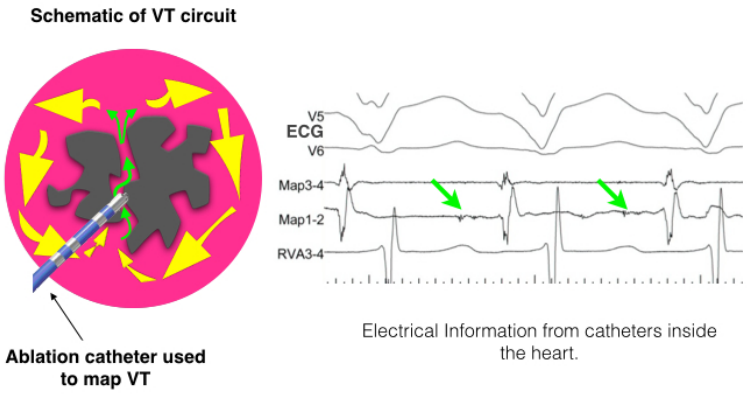
"If the artery is not opened up quickly with a stent, the heart muscle is permanently damaged leaving an area of scar within the heart"



"The scar can be quite large and can be of variable thickness.

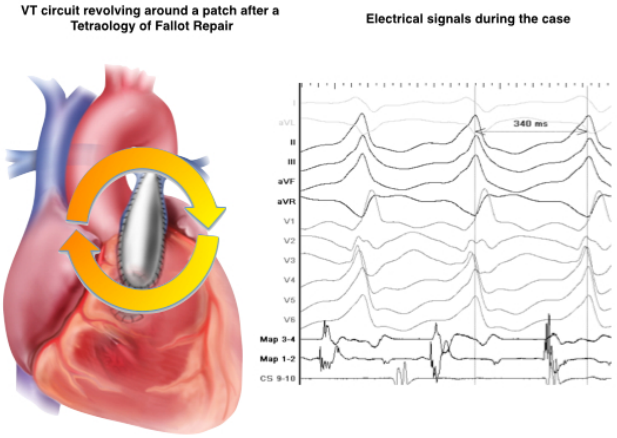
"The scar tissue is made up of a complex mix of areas of dead or scarred tissue (grey) and some surviving tissue(pink).

"It is the complex mix of islands of scar tissue and surviving tissue that forms VT circuits"



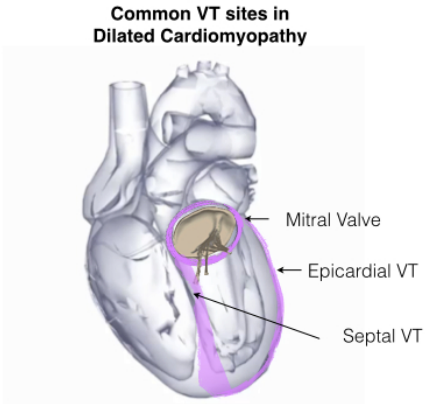
"VT is caused by large circuits revolving around islands of scar tissue (grey). The most important part of the VT circuit are the channels of surviving tissue (green arrows) separating islands of scar tissue"

"During a VT ablation we pass an ablation catheter from the leg to the left ventricles to find these critical channels."



"Patients with surgically corrected congenital heart disease can also develop problems with VT.

These circuits are often related to the the original surgery . Commonly they will involve reentry circuits revolving around either scar tissue, surgical suture lines or surgical patches."



"Patients with dilated cardiomyopathy develop ventricular tachcyardia.

The VT circuits in these patients tend to occur around the mitral valve, on the septum between the LV and RV and on the outside surface of the heart"

Risk of Sudden Cardiac Death

Sudden cardiac death causes about 450 000 fatalities each year in the United States alone. It is most commonly caused by VT deteriorating into VF, which is fatal within a few minutes if not defibrillated (shocked) back to a normal rhythm. Defibrillation may be accomplished by an automated external defibrillator or an implantable cardioverter-defibrillator (ICD). It is important to distinguish VT and VF, which are electric problems of the heart, from a heart attack, which is due to the sudden blockage of an artery. Heart attacks are treated with clot-busting drugs, balloon angioplasty, or stents. Sometimes, VT and VF are seen in that setting and are treated with electric shocks and drugs. The treatment of abnormal rhythms is discussed below.

What are the Treatment Options

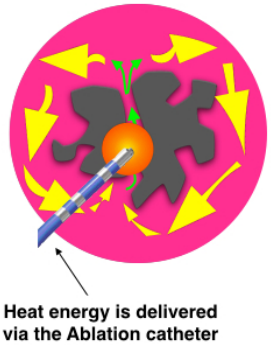
There are 3 treatment options for VT in patients with structural heart disease, although many patients require a combination: an ICD, antiarrhythmic medications, or catheter ablation. Many patients at risk for VT with structurally normal hearts are at risk of sudden cardiac death and as such are treated with an ICD. This is the most effective method of restoring a potentially life-threatening rhythm such as VT or VF back to a normal rhythm. However, an ICD does nothing to prevent the heart from going into VT. The ICD is a "safety net" and is like having an ambulance crew accompany you 24 hours a day.

Antiarrhythmic medications that modify the conduction of the electric impulse of the heart can be effective in suppressing VT. These medications can reduce the risk of recurrence by 75% but have potential side effects that include proarrhythmia, or worsening of the heart rhythm. For this reason, initiation of antiarrhythmic agents often requires close monitoring. Amiodarone, the most effective drug, has many side effects, which can involve toxicity to the vital organs like the liver, thyroid, lungs, eyes, and skin. Because of the discomfort associated with frequent ICD shocks and the side effects of antiarrhythmic drugs, catheter ablation is an important additional treatment option for many patients already using these therapies. The third treatment option is catheter ablation.

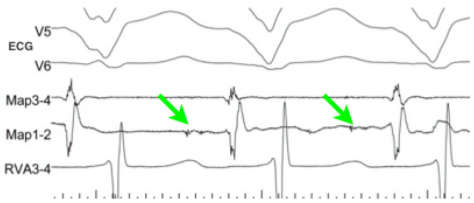
When Is Catheter Ablation an Appropriate Treatment?

Since radiofrequency catheter ablation was first described 20 years ago, it has played an increasing role in the treatment of ventricular arrhythmias. Initially used in the treatment of patients with multiple ICD shocks for VT (VT storm), it is now used more frequently and earlier in the management of VT, particularly in centers with a high volume of patients and experience. Catheter ablation is an excellent choice for patients when medications are not effective, tolerated, or preferred.

Catheter Ablation of VT



Heat energy is delivered via the Ablation catheter



Electrical Information from catheters in the heart. The green arrows show the electrical signal from the important channel causing this VT.

"We map the scar with the catheter to find the important muscle channels that are causing the VT. We then use heat energy to ablate (cauterise) the tissue to stop the circuits from re-forming"

"There will be often multiple VT circuits within the same heart that will require ablation"

The aim of this procedure is to target the origin of the VT by placing a long, thin wire or catheter into the heart chambers through the veins of the leg. When areas that are critical to the VT circuit are identified, radiofrequency energy is applied to a small area (4 to 5 mm in diameter) to destroy the abnormal tissue. The number of burns required to treat the VT varies among patients. In patients with scar tissue in the heart, ablations may be performed within the scar and around its perimeter to cauterize or ablate the abnormal electric circuit responsible for the VT.

What to Expect Before and After Ablation

You will may need to stop taking any medication that you have been prescribed for your abnormal heart rhythm 5 days prior to your procedure. We will discuss this with you. If you are taking anti-coagulation (blood thinning) medication eg warfarin then you will need to stop this for one week prior to your procedure. If this has not been discussed with you, or if you are unsure please call us.

You will be required to fast for at least six hours before the study. If your procedure is in the afternoon you may have a light early breakfast.
If your procedure is in the morning, **DO NOT EAT OR DRINK AFTER MIDNIGHT**, except for sips of water to help you swallow your pills.

What happens during a Radiofrequency Ablation Procedure?

You will be transferred to the Electrophysiology Laboratory (EP lab) from your ward. Usually before leaving your ward your groin will be shaved.

The EP lab has a patient table, X-Ray tube, ECG monitors and various equipment. The staff in the lab will all be dressed in hospital theater clothes and during the procedure will be wearing hats and masks.
Many ECG monitoring electrodes will be attached to your chest area and patches to your chest and back. These patches may momentarily feel cool on your skin.

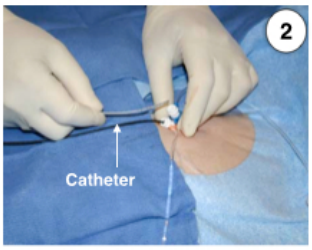
A nurse or doctor will insert an intravenous line usually into the back of your hand. This is needed as a reliable way to give you medications during the study without further injections. You will also be given further sedation if and as required. You will also have a blood-pressure cuff attached to your arm that will automatically inflate at various times throughout the procedure.

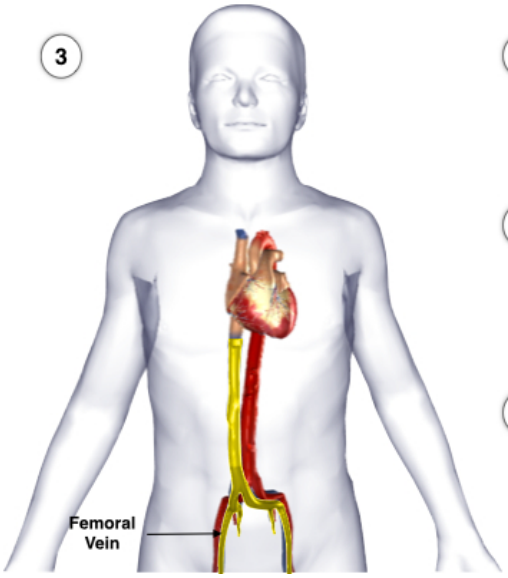
An anesthetist will be present for many procedures. The procedure may be performed under local anaesthetic with sedative medication or under full general anaesthetic. This will be discussed with you before the procedure.
If the procedure is performed under local anaesthetic, the doctor will inject the anaesthetic to the area in the groin where the catheters are to be placed. After that, you may feel pressure as the doctor inserts the catheters but you should not feel pain. If there is any discomfort you should tell the nursing staff so that more local anaesthetic and sedative medication can be given. Occasionally it is also necessary to place a catheter in a vein in the side of the neck.

How do we get access to the heart?

The catheters are positioned in your heart using X-Ray guidance. Once the catheters are in place you may feel your heart being stimulated and usually your abnormal heart rhythm will be induced. We will use a three-dimensional computer mapping system to guide the ablation procedure. This will help us move the catheters in your heart without the need for X-rays and also help us create an electrical map of the VT circuits. When the VT circuits have been identified and the abnormal tissue localized, the radiofrequency ablation will be applied to this spot. This may cause a transient warm discomfort in the chest. Radiofrequency ablation procedures are lengthy and the average duration is approximately 3 to 4hours.

How do we get access to the heart?...cont'





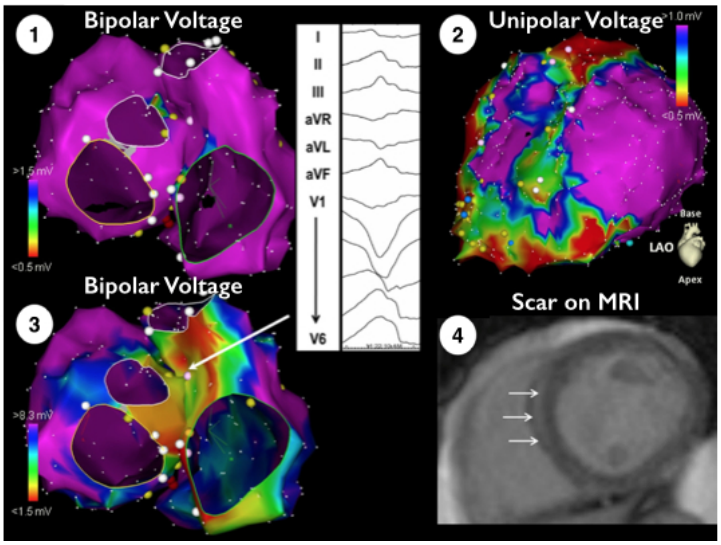
1 *"Vascular access is gain via the right or left femoral vein at the top of your leg. A small tube called a sheath is placed in the vein.*

2 *"All the catheters we use are passed via these sheaths in the leg. In some cases vascular access is obtained via a vein in the neck or via the femoral artery"*

3 *"The sheaths allow us pass the catheters up the veins straight into the right side of the heart. The sheaths are removed at the end of the case"*

Electrical Mapping of VT

The catheters are inserted through intravenous ports, or sheaths, placed in the veins in the groin and sometimes through a vein on the side of the neck. To access the left ventricle, a needle may be used to create a small puncture in the wall between the right and left sides of the heart under ultrasound guidance (called transseptal catheterization). Alternatively, a catheter can be inserted into the heart through an artery in the groin (similar to heart catheterization procedures). The ablation catheter is moved around the ventricle, and a virtual 3-dimensional image of the heart is created with a computer mapping system that acts like a navigation system . The location of the catheter is determined by use of fluoroscopy (x-ray) and this mapping system. Typically, the procedure lasts from 3 to 6 hours.



"We will use a 3D computer mapping system to create highly detailed electrical maps of the Ventricles to locate the VT circuits. "

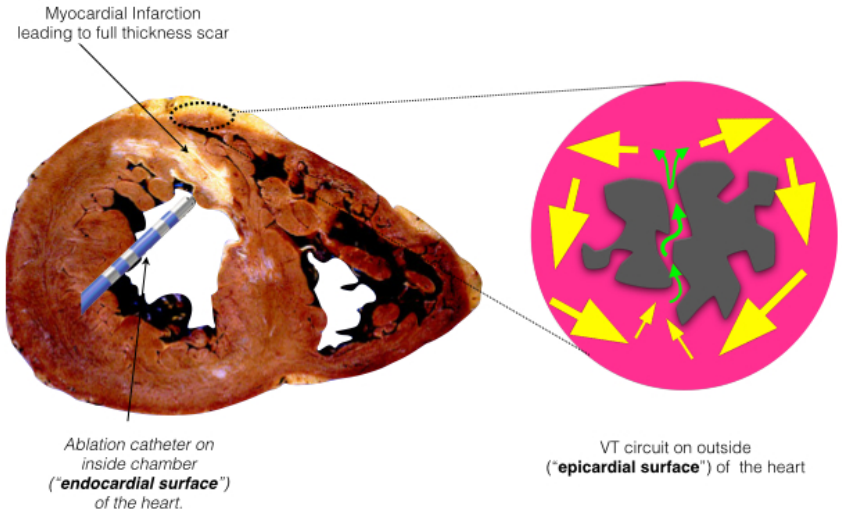
"Images one to three show examples of voltage map from a patient with VT. Areas in purple represent normal heart muscle with normal voltage. Areas in blue, green and red indicate progressively lower voltage indicate of scar. This is where the VT circuits can be found."

"Image four shows the same scar on an MRI. We will sometimes use a MRI to help us locate and define the scar prior to a VT ablation."

What is Epicardial VT ablation?

In some instances, the physician determines that the VT may originate from a circuit on the outer surface of the heart, or epicardium. If this is the case, a puncture into the sac, or pericardium, around the heart is performed just beneath the breastbone. This enables the ablation catheter to be inserted and maneuverer within the pericardium to determine whether the VT originates there. If a patient has a previous history of open heart surgery, a small surgical incision may be necessary to access the pericardium because of the presence of scar tissue, which can make the

pericardium stick to the heart. These procedures to access the epicardium are usually performed at highly experienced centers.

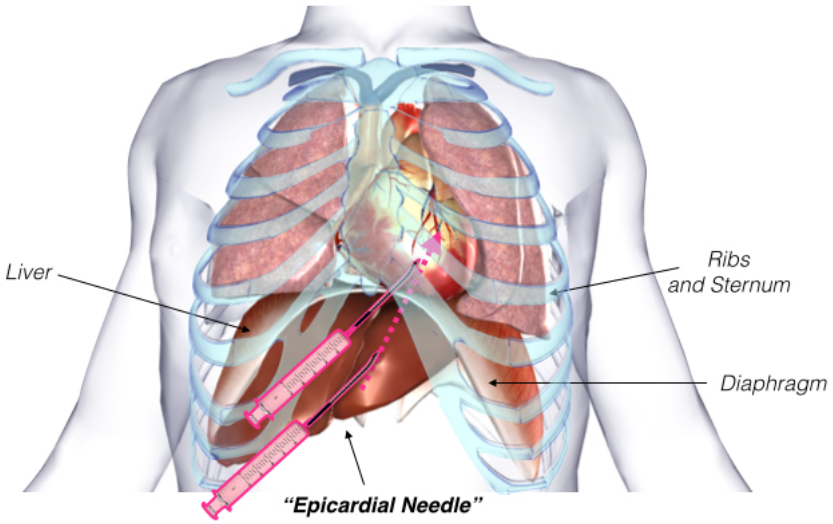


*"Some VT circuits are found on the outside surface (**"epicardial surface"**) of the heart rather than the inside"*

*"An ablation catheter mapping on the inside of the heart (**"endocardial surface")** cannot record or ablate the abnormal tissue as it is too far away"*

*"In these cases we gain access to the outside surface of the heart using a needle. This is technique is called **epicardial access.**"*

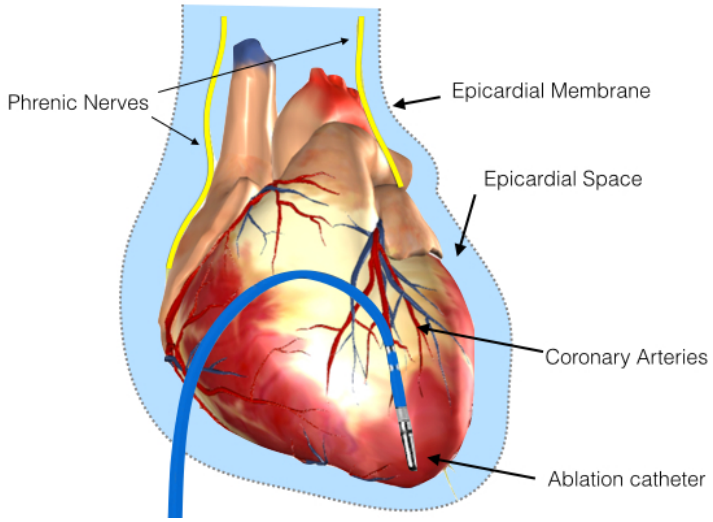
Epicardial Access for VT ablation



"To gain access to the outside surface of the heart, a small needle is advanced underneath the breast bone, under the ribs to gain access to the outside surface of the heart"

*"Once we have gained access, an ablation catheter is passed into the **epicardial space** surrounding the heart to map and ablate the VT circuit."*

Epicardial VT Mapping and Ablation



*The epicardial needle allows us to gain access into the **epicardial space** (highlighted blue) between the **epicardial membrane** surrounding the heart and the outside surface of the heart."*

*"Once the ablation catheter is in the **epicardial space**, we can map the entire outside surface of the heart."*

*"Before we perform any ablation we check the ablation catheter is safely away from the **coronary arteries** and the **phrenic nerves** which also sit on the outside of the heart."*

What happens after the VT ablation procedure?

Afterward, the catheters are removed, but the sheaths are left in until the blood thinner wears off. Typically, this requires the patient to lie still for several hours to prevent bleeding from the puncture sites. Slight discomfort and bruising in the groin area can occur, and some patients experience self-limited mild chest pain resulting from inflammation caused by the ablation lesions. When the procedure is successful, antiarrhythmic medications may be stopped at the discretion of the physician.

How successful is a VT ablation?

The success of VT ablation varies, depending on the patient's specific heart condition that caused VT. The procedure is most effective in patients with otherwise normal hearts, in whom the success rate exceeds 90%. In patients with structural heart disease resulting from scar or cardiomyopathy, success rates range between 50% and 75% at 6 to 12 months. In cases when a patient experiences a recurrence, 2 of 3 patients will still have less VT than before the initial ablation.

What Are the Risks From the Procedure?

The risk of any major complication for VT ablation in patients with structural heart disease (Ischemic and Non-ischaemic Cardiomyopathy) is approximately 6-8%.
The risk of major complications for VT ablation in patients with normal hearts (Idiopathic VT) is ~3%.

Major risks [1,2,3] of VT ablation in structural heart disease include but are not limited to:

- The peri-procedural risk of death during a VT ablation in patients with structural heart disease has been reported as low as 0.4% and up to 3%.
- The risk of major vascular complications (arteriovenous fistula, pseudo aneurysm, dissection) requiring surgery is 4% and minor vascular complications (hematoma in the leg) is 7%. Vascular complications are the most common major complication encountered during a VT ablation.
- The risk of stroke or transient ischemic attack is 1-2% .
- The risk of damage to the heart wall causing bleeding in the sac around the heart (cardiac tamponade) requiring drainage with another catheter or urgent cardiac surgery is 1% to 2%.
- Damage to a major artery (aorta) or heart valve (These complications may require urgent vascular or open heart surgery to correct).
- In patients with VT arising from the septum or near the fibers of the normal conducting system, there is a risk of heart block requiring permanent pacing.
- Acute exacerbation of heart failure can occur after VT ablation due to either fluid infused via the ablation catheter or "stunning effects" of the ablation itself.
- Deep vein thrombosis (DVT) at the site of vascular access can occur after the procedure but is minimized with routine prophylactic blood thinning medications in the postoperative period.

The risks of epicardial access and epicardial ablation include but are not limited to:

- Intra-abdominal or thoracic bleeding that can require surgery in less than 1% of procedures. Some patients may also need blood transfusion as a result of major bleeding.
- Damage to abdominal structures (liver, pancreas, bowel) or sub -diaphragmatic vessel as result of the epicardial needle has been described.
- Perforation and bleeding of the right ventricle during epicardial access which in some instances requires open-heart surgery.
- Damage to the coronary arteries or puncture of the lung (pneumothorax) as a result of the needle during epicardial access (rare).
- If ablation is performed on the epicardial surface, damage to the coronary arteries leading to an acute heart attack is possible. However, a coronary angiogram will always be performed prior to any epicardial ablation to make sure the ablation site is not close to a major coronary vessel.
- Damage of the phrenic nerve causing paralysis to one side of the diaphragm is possible if ablation is performed close to the nerve. Pacing is routinely performed from the tip of the ablation catheter to identify the course of the phrenic nerve to minimize the risk of phrenic nerve injury.

This has been adapted from "Catheter Ablation of Ventricular Tachycardia" by Tung et al Circulation 2010, 122, e389-391.

References:

1. *Tung et al Circulation 2010;122:389-391*
2. *Della Bella et al Circulation 2013;127:1359-1368*
3. *Koplan et al Heart Rhythm 2011;8:1661-1666*