

Great saphenous vein cannulation as venous access for cardiopulmonary bypass for minimally invasive cardiac surgery

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ABSTRACT

Minimally invasive cardiac surgery has seen the development of new techniques and modifications to achieve the goal. Arterial and venous cannulation is prime initial steps for establishing a good cardiopulmonary bypass to enable the main surgery. Usually, percutaneous cannulation is used but is costly; hence, most surgeons prefer an open surgical approach. Direct femoral venous cannulation is easy; however, if there is a tear in the femoral vein, usually on insertion or removal of the cannula, it can cause troublesome hemorrhage. A simple technique for venous cannulation with direct cannulation of the great saphenous vein has been described and does not require additional hardware and is expeditious. The method is safer, reliable, and repeatable and can be done easily even in emergency situations.

Key words: *Cannulation, Cardiac surgery, Peripheral CPB*

Minimally invasive cardiac surgery has become established as a standard method of approach for various cardiac surgical operations such as the closure of atrial septal defects, mitral valve surgery, and surgical myocardial revascularization. The mainstay of peripheral cardiopulmonary bypass is good cannulation without any complications and yet maintaining good perfusion flows. Good perfusion needs a good arterial outflow and good free venous access to allow a complete collapse of the heart if needed. Usually, the femoral artery and veins are used; however, there may be other choices such as subclavian or internal jugular access. There are various techniques of arterial and venous cannulation right from open technique to a totally percutaneous technique [1].

The open techniques need an incision and the percutaneous techniques need more hardware, which translate to more cost and sometimes have post-procedural leak complications. In the open technique for venous cannulation, rarely, there may be an inadvertent injury to the femoral vein during direct cannulation or while removal of the cannula giving rise to troublesome hemorrhage and blood loss. This is not desirable when the patient has just come off the cardiopulmonary bypass after undergoing major cardiac surgery. The paper focuses on a technical development that makes open peripheral cardiopulmonary bypass very efficient and bloodless and without any risk to the patient in terms of femoral vein injury or bleeding.

CASE REPORT

Between March 1, 2017, and March 30, 2020, I have performed 14 procedures using the technique described below. All the patients

were those who needed minimally invasive valve replacements or surgical closure of atrial septal defects. There were 10 male and four female patients. Some of the female patients who are for minimally invasive surgery are not deemed fit for the peripheral cardiopulmonary bypass as the femoral artery is very small in some of them due to their small body habitus.

Both the femoral artery and vein on both sides are studied with a vascular Doppler scan in the operation theater before surgical draping. Once the access is confirmed, the patient anesthetized, positioned, and surgically prepped before making a 2 cm incision in the groin. A vertical incision is preferred as it can be extended; however, it should be placed a trifle medial to the femoral artery so that the femoral vein is more under it. This allows access to the saphenofemoral junction. Alternatively, a transverse incision is also good. After exposure of the femoral artery in the femoral sheath, the common femoral artery is looped with a silastic loop or an umbilical tape. The distal part of the femoral artery is also looped. Cannulation of the femoral artery can be planned as either serial dilatation within a purse string of 4-0 polypropylene suture or by clamping and dividing the vessel and giving direct cannulation. Both of these techniques are good.

The femoral vein is exposed in its anterior surface only, and no additional dissection is done at the sides of the vein and no attempt is made to loop it. The saphenofemoral junction and the first 2 cm of the saphenous vein are dissected. Two black silk loops are placed around the saphenous vein (Fig. 1). Kindly note that the femoral vein is not looped not handled in any way and the dissection remains predominantly above the cribriform

fascia. I do not loop the femoral vein nor dissect it beyond the visualization of the saphenofemoral junction.

When the time is right for instituting the cardiopulmonary bypass, the patient receives systemic heparinization to keep the activated clotting time about 400. I usually perform the arterial cannulation first as during the venous cannulation; there can be atrial or ventricular extrasystoles due to the venous cannulation process itself, and it is incorrect not to be able to go on cardiopulmonary bypass (Fig. 2).

The two silk loops on the saphenous vein are both pulled up, and the saphenous vein is incised with a scissor (Fig. 3). A venous dilator-introducer is placed into this incision. A 0.38 inch guidewire is passed into the femoral vein and across the saphenous-femoral junction, and it pushed gently upward until it reaches the right atrium. This is done under the guidance of a transesophageal echocardiogram (TEE). The venous cannula is then passed over this guidewire and passed until the junction of inferior vena cava and the right atrium. As the saphenous vein enters the femoral vein at an acute angle, it is easy to deliver the cannula across the saphenofemoral junction. There is no need for

pre-dilatation, but if you are not confident in the initial stages, you could send a dilator across the guidewire just to get the feel of the cannulation. If the right atrium is not to be opened and there is no evidence of patent foramen ovale or atrial septal defect, the cannula can be manipulated further into the mouth of the superior vena cava. Then, after attaching the cannulae to the cardiopulmonary bypass circuit, the CPB can be started. Precisely speaking, I am using the great saphenous vein as a cannulation point rather than the femoral vein.

At the termination of CPB, once the patient has recovered the correct level of hemodynamics, the venous cannula is simply pulled out under TEE guidance, and the two silk loops are tied; and thus, the saphenous vein is occluded. There is no need for any extra sutures or hemoclips of any sort. There is no chance that the purse string on the femoral vein gets avulsed and one has to control the bleeding. Therefore, cannulation and decannulation are easier than any other technique, and the method is very fast.

Arterial decannulation is done after readministering all the extra blood in the reservoir of the oxygenator so that post-operative transfusion is not required. A protamine test dose is given, the rest of the volume in the reservoir is infused back to the patient and the arterial line is removed. The femoral artery is repaired if required, and then, the systemic heparin is reversed with protamine injection given slowly. We reverse the heparin only after the arterial cannula is also removed, as sometimes, we might have to clamp the femoral artery temporarily to take an extra suture or to close the arteriotomy if performed. The groin wound is then closed. All the patients had a good recovery and there was no incidence of seroma, wound sepsis, local bleeding nor deep vein thrombosis.

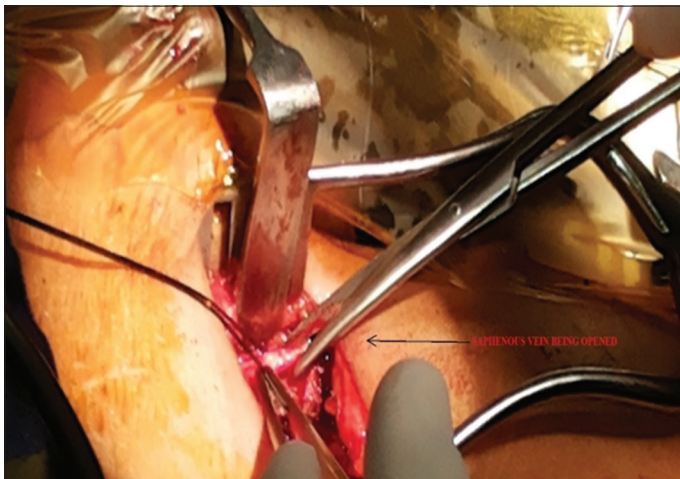


Figure 1: The Saphenous vein is pulled up between two silk slings and we are ready to make an oblique venotomy. (The arterial cannulation is done later for clarity)

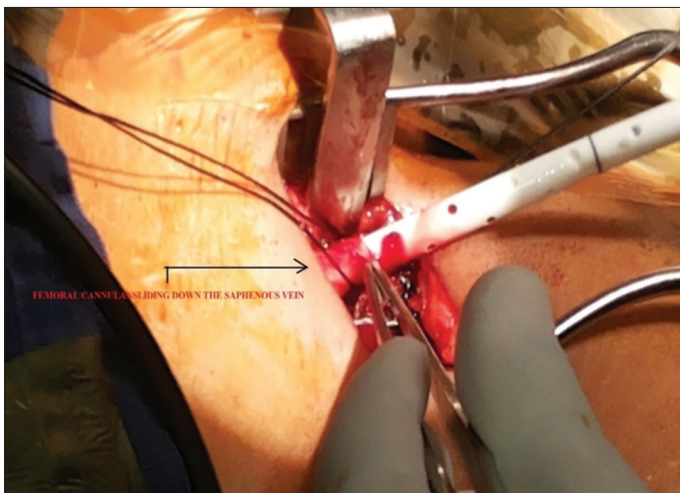


Figure 2: Cannulation in progress. The cannula just slides across the saphenofemoral junction

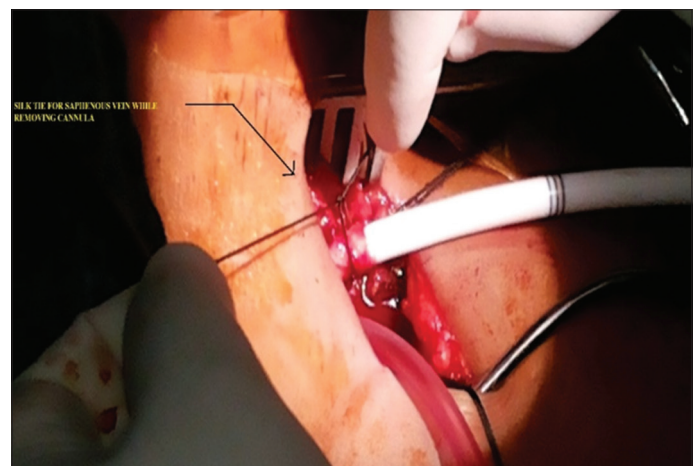


Figure 3: Tying of the silk suture before removing the cannula. Note that the femoral vein is not seen nor touched throughout

by Loulment and Carpentier) [2,3] is by achieving arterial and venous access from the femoral route, with additional cannulation of the superior vena cava if required. With the introduction of active vacuum-assisted drainage [1], additional cannulation is required only if the right atrium is to be opened.

Cannulation with the percutaneous method using the Seldinger technique [4] is definitely more superior to most other methods described. However, there is an increased cost in view of disposable dilators for serial dilatation [5]. Cost is a major factor in South Asian countries, where the per capita income is much lower than the West. Sometimes, there are variations in the vein positions that make cannulation difficult [6,7]. After the vein or artery is punctured and initial dilatation partially completed, then to convert to open technique is difficult and messy. This involves blood loss and failure to do the procedure of cannulation with ease and with speed.

Venous cannulation is usually done using a purse string and cannulation by the modified Seldinger technique. If there are cost constraints, the open technique is preferred as it is economical as we do not have to use disposable dilator and introducer sets. I have used a technique that simplifies femoral venous cannulation. This is simple, fast economical (only using silk sutures), and very easy to introduce the cannula. The major advantage is during decannulation as it becomes much easier and less messy than other techniques described so far. No other repair is required for the femoral vein. As there is no looping, there is no risk of retrovenous bleeding from variant branches from behind the common femoral vein. Purse strings on the venous side are prone to tear due to the thin nature of the veins; however, even if the purse strings do tear, we do not have too much bleeding due to the lower venous pressures. Nonetheless, it becomes very messy to manage. In my technique, purse strings are not used, so there is no risk of cut through. We do not require post-procedural repair work ever.

CONCLUSION

I have devised a very easy open technique for femoral venous cannulation for a cardiopulmonary bypass for minimally invasive cardiac surgery. The technique is devised using the natural position of great saphenous vein entering the femoral vein. This requires no repair of the native blood vessel, no looping, no purse strings, and no post-procedural repair work. This technique saves time and costs.

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