ANGIOGRAPHIC STUDY OF CORONARY GRAFTS

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ABSTRACT

In last couple of decades, the number of 'graft study' cases in cath labs has increased due to increasing number of post coronary artery bypass surgery cases presenting with angina or ischemia. Coronary angiography in the setting of coronary artery bypass grafting (CABG) is an important diagnostic tool for the evaluation of graft patency in such patients[1]. Angiography in the setting of CABG is more complex and challenging than the conventional angiography, but with increasing experience, the procedure can be made easy, sleek and comfortable both for the patient and for the operator[2].

Pre-Requisite

Before the graft angiography is performed, it is very important to have the CABG report available. It will assist the operator to know the exact number and anatomical features of grafts. At least the types and number of vein grafts should be available before pursuing with an angiogram. It can substantially decrease radiation exposure, procedural time, contrast use and the risk to the patient[3]. For example, the knowledge about lack of internal mammary artery (IMA) as a bypass graft conduit will eliminate the need for left or right subclavian artery catheterization. Similarly, information about the number of grafts will eliminate the search for unknown number of grafts. Vein grafts to the right coronary arteries have usually right-sided take off from the aorta while left coronary grafts usually have an anterior take off[2,3]. Sequential vein grafts supplying two coronaries with one vein graft are not uncommon. Therefore, the knowledge about the presence of sequential vein grafts will aid the operator to avoid searching for additional non existing vein graft ostia[4].

Indications

The indications for performing graft angiography in patients with CABG surgery are similar to those without bypass surgery. Unstable or symptomatic patients who are candidates for coronary intervention, should undergo this procedure. Asymptomatic patients with a large area of ischemia documented on perfusion scans also benefit from angiography. Significant disease in native coronaries or in the grafts documented on CT angiogram is also an indication for graft study. CABG patients with new onset of left ventricular dysfunction, LBBB or congestive heart failure especially in the setting of diabetes mellitus are another group with potential benefit[4].

Limitations

Higher use of contrast and longer procedural time should be discussed with the patients and their family members. Other limitations of coronary angiography are similar to the patients undergoing native coronary angiography[5]. Patients with risk of bleeding, infection, peripheral vascular disease, renal failure, anemia, coagulopathy, congestive heart failure and significant co-morbid conditions are at higher risk for complications. Informed consent is necessary before the patient undergoes graft angiography[6].

Sequence

Usually, it is the native coronary angiogram which is performed before the graft study but there are no specific guidelines regarding this sequence. In addition to give the detailed anatomical information, performing native

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coronary angiography first has the advantage of visualizing distal graft insertion site for competitive flow/flash filling that suggests patent graft[7]. This is more helpful when the operator does not have accurate information about the numbers and types of vein grafts before performing angiography[8].

Arterial Access

Although majority of graft studies are performed by the femoral arterial site, but the radial arteries can be used for graft angiography. However, in the presence of left internal mammary artery (LIMA), left arm should be utilized in order to have easy access to the left IMA and vein grafts. For the presence of right IMA, right arm should be selected[9]. As in conventional angiogram, the radial access site is associated with a risk of thrombotic complication. Therefore, intra-arterial injection of 5000 units of heparin is routinely given after the sheath insertion. In addition, the radial artery is prone to develop spasm. Intra-arterial injections of nitroglycerin and/or verapamil after sheath insertion can abate this. Radial artery is small which cannot accumulate large sheath size. Usually a 5 or 6 French sheath is used. Once the sheath is inserted and flushed with saline solution, a diagnostic catheter is advanced over 0.035-inch J wire into the ascending aorta. After the removal of the wire, the catheter is connected to the manifold and double-flushed (aspirating blood followed by flushing with heparin saline) vigorously with the removal of all bubbles. Next, contrast is drawn into the injecting syringe and pressure is monitored during the entire procedure[10,11].

An Over-View of Location of Grafts

It is better to convince the surgeons to use tiny rings to help in marking the ostia of the vein grafts which can substantially aid the interventionist to localize the ostia during subsequent angiographic studies. The lack of markers increases the contrast use, procedure time and radiation particularly in patients without the knowledge of the types and number of vein grafts[12]. As mentioned earlier, right coronary grafts usually have a right sided take off from the aorta. Therefore, using the standard left anterior oblique (LAO) view, which is used for right coronary artery catheterization, is the view of choice. The catheter tip should be oriented in the same direction as in engaging the right coronary artery with a slightly higher search. However, the left sided grafts usually have an anterior take off[10,12]. Therefore, a right anterior oblique (RAO) view makes it easier to engage the left-sided vein graft ostia preventing fore shortening of the catheter tip. Using RAO, the catheter tip should be oriented to the right side of the screen. LAD vein graft ostia are usually closest grafts to the aortic valve if IMA is not used as graft conduit. This is followed by diagonal and then the circumflex grafts. Circumflex graft ostia usually have the highest take off from the aorta[13]. There are occasional cases with different take offs making vein graft angiography difficult. In such a situation, the angiography catheter has to be probed across the aorta in different level in order to engage the ostium. A non-selective strong contrast injection or aortogram using a pigtail catheter may be necessary to delineate the unusual take off of missing vein grafts or documenting total occlusion of missing vein grafts. Totally occluded vein grafts usually have a residual knob in the aorta that can be seen during angiography[14].

Appropriate views are selected to see the graft landing zone and the native coronary arteries distal to the insertion site of the grafts as that portion might be diseased. When the grafts ostia are engaged, the subsequent views depend upon the native vessel, i.e. the caudal views for LCX grafts and cranial views for the LAD grafts. Any additional views to complete the study and to define the anatomy should be taken[15]. It is important to watch for any damping or ventricularization of the aortic pressure. These signify a high grade ostial lesion or catheter touching the vessel wall. It is important to avoid injecting into the vessel wall as it can cause major dissection. Injection into the vein graft with a high grade

ostial lesion increases the risk of arrhythmias and sudden death[15].

Catheters For Vein Grafts

Regardless of the right or left coronary artery grafts, most of the vein grafts can successfully be engaged by a commonly used Judkin's right[4] (JR4) catheter. The JR4 is therefore the most commonly used catheter for graft study including the IMAs. However, many vein grafts have unusual take off requiring different catheters. Many right coronary vein grafts have steep inferior take off making the ostial engagement with JR4 difficult or impossible. In such a scenario, a multipurpose catheter which has a shallow angulation is the best choice. The second major challenge in engaging vein graft ostia, particularly vein grafts supplying the left coronary arteries, is the shape of the aorta[16].

A large aorta can make it very difficult for the JR4 catheter to reach the ostial vein grafts. In such a situation, Amplatz right (AR) and left (AL) catheters can be very helpful to reach the vein graft ostia. Amplatz catheters have a larger primary curve and have been used successfully in unusual superior take off of left coronary arteries or vein grafts and in large aorta. Amplatz catheters are available in different sizes (from smaller to larger curve: AR 1, AR2, AL 0.75, AL1, AL2 and AL3)[17]. Occasionally, a very superior take off of a vein graft requires specially designed bypass graft catheters. Amplatz catheters are also extremely helpful in engaging native right coronary ostium with a high anterior take off[17].

Arterial Graft Angiography

For left IMA angiography, the major challenge is the advancement of wire and catheter into the subclavian artery. Older age and peripheral vascular disease are the risk factors for tortuous anatomy. Subclavian stenosis is another cause of difficult subclavian catheterization[17,18]. In most instances, a JR4 catheter can be positioned into the subclavian artery ostium by counter-clockwise rotation and withdraw of the catheter after positioning it in the ascending aorta. Once the catheter is engaged in the subclavian artery ostium, any manipulation of the catheter has to be performed over the J tipped wire with extreme caution in order to avoid injury to the subclavian artery and embolism in the territory of vertebral artery. The later can cause posterior circulation stroke[18].

In case the IMA is not engaged, it is reasonable to inflate a blood pressure cuff in the left arm and perform a non-selective angiography of the left IMA. In the majority of cases, IMA opacification is satisfactory by manipulating the catheter 30-degree counter clock wise. However, for unsatisfactory opacification and when further detail of anatomical information of IMA is needed, a JR4 catheter needs to be exchanged to a left IMA catheter (LIMA seeker) using a long exchange J tip wire[10]. Exchange wire can also be used earlier after subclavian engagement particularly when a JR4 catheter cannot be advanced easily. In the majority of cases using left IMA catheter, excellent engagement and angiography of the left IMA can be performed. Again, it is important to avoid extreme manipulations of any catheters in the subclavian artery to avoid any vascular injury and embolism[18]. Contrast injection in the IMA can trigger severe pain in the arm. The patient needs to be warned and informed before injecting the contrast. If subclavian ostial engagement cannot be achieved with a JR4 catheter, a J-wire could be utilized and positioned into the subclavian artery followed by the left IMA or JR4 catheter advancement. There are rare instances when subclavian engagement cannot be achieved from femoral arterial route. In such a situation, using the left radial artery gives direct access into the left IMA ostia[17,19]. The technique for engaging right IMA is similar to the left IMA. However, right IMA angiography and engagement can be more difficult in dilated aortic root and abnormal steep take off of the right innominate artery. Similar to the left IMA, the right arm can be used in difficult cases. Aortogram and left ventriculography are usually performed using a pigtail catheter and power injector for the assessment of the left ventricular function, aortic

valve regurgitation or missing or occluded vein grafts with only a stub visible[20].

Special Issues Related To Vein Graft Angiography

- Higher contrast use with increasing risk of contrast induced nephropathy.
- Increased radiation exposure to the patients and angiographers.
- Longer procedural time.
- Higher risk for thromboembolism and aortic injury during additional catheter manipulations in the aorta.
- Risk of injury to the subclavian artery and aorta during IMA angiography.
- Difficulty in engaging angulated vein grafts take off and subclavian artery in some patients.

CONFLICT OF INTEREST

This study has no conflict of interest to declare by any author.

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