Spiral CT of Non-Graft Post Cardiac Surgery Complications: A Pictorial Essay

Spiral CT is a rapidly growing method for noninvasive visualization of post-operative complications, including post-operative complications in CABG (coronary artery bypass graft). In the recent years, several different, yet more efficient types have been introduced with progressive improvement in the diagnostic accuracy in the detection of post-operative complications. The introduction of 64-slice technology, which allows high resolution as well as reconstructed images, has resulted in further progress in the diagnostic process. This kind of diagnostic equipment will spread rapidly in the world. Although studies with large numbers of patients regarding spiral CT as a routine diagnostic method have not been reported, there is great need for it all over the world. In this article, we intend to review the spiral CT findings of non-graft complications in patients after cardiac surgery.

Keywords: Spiral CT Scan, Cardiac Surgery, Diagnosis, Complication, Non-Invasive Method

Introduction

Coronary artery bypass graft (CABG) is a major surgery with a mortality of 3.1%. Intrathoracic complications are the etiology of death in some patients. Thoracic complications may affect presternal (cellulitis, sinus tract), sternal (osteomyelitis, dehiscence), retrosternal (hematoma, mediastinitis and abscess), or cardiothoracic (pericarditis, pseudoaneurysm/dissection, pulmonary emboli) compartments. For presternal complications, there is no need for imaging most cases. Spiral CT plays an integral role in the diagnosis of other postoperative complications. In this article, we review the spiral CT findings of non-graft complications in patients after cardiac surgery. Furthermore we have mentioned recommended CT protocols for each complication, normal postoperative thoracic findings and complications.

Patients and Methods

CT Protocols

For routine postoperative CT scanning of the chest, we used 3-5 mm slice thickness reconstructed every 5 mm, 120-140 Kv and 240 mAs. Sternal complications (osteomyelitis and dehiscence) may be evaluated by plain CT with bone window and 3D reconstructed images. For mediastinal and pericardial complications, CT with and without contrast administration are preferred. For contrast enhanced CT, 1 ml/Kg of nonionic iodinated contrast is injected in the antecubital vein. Pseudoaneurysm and pulmonary emboli are evaluated by CT angiography. Typically, a bolus of 100-150 ml contrast material at a rate of 4-5 ml/sec provides adequate opacification. Bolus tracking software provides the optimal scan delay for evaluation of ascending aorta.
(in case of aortic pseudo aneurysm) or pulmonary artery (in case of pulmonary emboli).

**Normal postoperative appearance**

Soft tissue infiltration and edema, blood in pre-ter nal and retrosternal compartments (Fig. 1) and focal air bubbles are normal postoperative changes which may persist for 2-3 weeks.

Most patients have abnormalities in the sternum; sternal gaps (max 4 mm wide), impaction of sternal halves, and step-off of sternal tables are normal postoperative findings (Fig. 2). Even 6 months after CABG, only half the patients show complete healing of the sternum. Complete healing may take 1 year time after surgery.²

**Postoperative complications**

Unbearable pain and tenderness in the sternum, erythema, fever and bloody or purulent discharge are clinical manifestations of postoperative complications. Elevated leukocyte count and erythrocyte sedimentation rate (ESR) may also be detected. All these manifestations are nonspecific and it is impossible to determine the severity of infection based on these manifestations. Pulmonary emboli may manifest as shortness of breath, pleural chest pain and tachypnea. Appropriate CT study can help in the diagnosis of most of these complications. We discuss postoperative complications from the sternum to the lungs.

**Sternal osteomyelitis and dehiscence**

The incidence of postoperative sternal osteomyelitis is 1.7%. The time of diagnose is 15-19 days after surgery in most cases.³ Early stages of the disease are difficult to distinguish, but periosteal reaction, bone destruction or sclerosis and soft tissue swelling help in equivocal cases.² Obesity, insulin dependent diabetes and bilateral internal mammary grafting increase the risk of sternal infection. IV antibiotic therapy and debridement are its treatment. Excessive debridement may lead to sternal dehiscence. CT findings of dehiscence include displaced sternal wires and progressive widening of the incisional gap. Rarely in advanced infections, sternectomy is necessary (Figs. 3-5).

**Mediastinitis**

Mediastinitis is a rare but disastrous complication of CABG. Its incidence is 1% with up to 14% mortality. Fever, elevated ESR, wound discharge and sternal pain are its clinical manifestations. Obesity, insulin dependent diabetes, tracheostomy and leg wound infection are associated risk factors.⁴ Attenuation of mediastinal fat planes, soft tissue swelling (sometimes with air bubbles) and low density fluid collection are CT findings of mediastinitis with abscess collection. Unfortunately, these findings are similar to early normal postoperative changes, especially during first two weeks of surgery.² Increasing fluid collection or air bubbles especially after the second week of surgery is highly indicative of mediastinitis (Fig. 6).

**Mediastinal hematoma**

Postoperative re-exploration is necessary in 4.6% of CABG patients due to mediastinal hemorrhage.⁵ Mediastinal hematoma appears as fluid collection with high attenuation in the acute phase in non-enhanced CT. Its density decreases gradually in follow-up images due to hemoglobin degradation (Fig. 7).

**Presternal abscesses**

Skin, subcutaneous, fat tissues and muscle components altogether combine soft tissues in the presternal region. The soft tissue remains intact in patients with no infection after sternotomy. Infection in the presternal compartment is detected as stranding, abscess formation and even septation (Fig. 8). Presternal infections should be treated by drainage and appropriate antibiotic therapy.⁶

**Myocardial rejection of heterotopic transplanted heart**

In patients with heterotopic heart transplantation (HHTx), it is difficult to detect the myocardial rejection due to the complex vascular anatomy present after transplant surgery. Endomyocardial biopsies are still of great help for detection of cardiac allograft rejection. However, it is also known to be related to a high risk of complications. Therefore, other harmless methods for monitoring the rejection must be administered. For this purpose, cardiac CT angiography, as a non-invasive and safe method is used for the assessment of heart anatomy, morphology and rejection by visualizing the vascular structure.⁷ (Figs.9-10)
Aortic pseudoaneurysm/dissection

Aortic pseudoaneurysm occurs in less than 0.5% of patients undergoing cardiac surgery. It may present as a pulsatile suprasternal mass or may lead to myocardial ischemia by pressure on the coronary arteries. Stridor and dysphagia are other symptoms. Mediastinitis, poor aortic wall tissue and poor anastomotic techniques are the etiologies. In non-enhanced CT, it appears as a soft tissue density mass bulging from the aortic border. In CT angiography, the lumen of the mass enhances like the aorta or cardiac chambers (Fig. 11). Type A aortic dissection is a rare complication of CABG. It may occur during aortic cannulation, decannulation or insertion of cardioplegia line (Fig. 12).

Fig. 1. CT scan taken from a 54-year-old man with an uneventful CABG, there is retrosternal fluid obliterating the anterior junctional line.

Fig. 2. CT scan taken from a 54-year-old man with uneventful previous CABG.
A. There is a sternal gap as a normal postoperative finding.
B. Impaction of sternal halves makes a step-like appearance in the lower cuts.

Fig. 3. CT scan taken from a 75-year-old man with postoperative fever and sternal pain. CT reveals soft tissue gap, sternal gap with air and sclerosis of the sternal ridge on the right side and lucency on the left side compatible with osteomyelitis.

Fig. 4. CT scan taken from a 71-year-old man with a history of postoperative osteomyelitis. Widespread debridement, left gap in the chest wall, soft tissue and sternal dehiscence up to the level of precardiac fat.

Fig. 5. CT scan taken from a 71-year-old woman with history of stenting of the left coronary artery and bypass of the right coronary artery. She developed osteomyelitis after surgery. The sternum was removed due to widespread infection (sternectomy). The defect may be replaced by a muscular flap later.

Fig. 6. CT scan taken from a 62-year-old man with a history of CABG and Bentall surgery of the ascending aorta. He developed fever and suture discharge 6-weeks after surgery.
A. Shows multiple air bubbles around the aortic root with some fluid collection. The high attenuation of the aortic wall is due to the Bentall graft.
B. Reveals wall enhancement around the collection. CT findings were suggestive of mediastinitis and abscess formation. Reoperation confirmed diagnosis. The result of culture was staphylococcus growth.
Constrictive pericarditis

Pericardial effusion and thickening are normal postoperative changes, but chronic inflammation of pericardium may terminate as constrictive pericarditis. Constrictive pericarditis causes diastolic heart dysfunction, which may rarely occlude the bypass graft. Although it is a chronic postoperative complication (most cases develop two years after surgery), the disease has been reported even one month after CABG. CT is helpful in the diagnosis in 80% of cases. Pericardial thickening and calcification, biatrial enlargement, squeezed ventricles, engorgement of IVC (inferior vena cava) and SVC (superior vena cava) and ascites are the main imaging findings (Fig. 13).

In conclusion, spiral CT is a rapidly improving technique for the evaluation of complications caused after cardiac surgery. The quality of images taken by spiral CT provides high resolution and offers detailed information. As the result, this method has been accepted worldwide as an alternative to evaluate patients after cardiac surgery.
Fig. 12. A 66-year-old man with a history of CABG seven years ago. He had chest pain and wide mediastinum on chest x-ray. CT angiography shows type A dissection with aneurysmal dilation of the false lumen. The left coronary artery originates from the true lumen. Both lumens are patent.

Fig. 13. A 67-year-old man with history of CABG two years ago. He had lower limb edema and ascites. CT shows pericardial thickening and calcification. The IVC is engorged. Findings were in favor of post-operative constrictive pericarditis.

References