Acute mediastinitis: multidetector computed tomography findings following cardiac surgery*

Mediastinite aguda: aspectos de imagem pós-cirurgias cardíacas na tomografia computadorizada de multidetectores

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Abstract **Postoperative mediastinitis is defined as an infection of the organs and tissues in the mediastinal space, with an incidence ranging between 0.4% and 5% of cases. This disease severity varies from infection of superficial tissues in the chest wall to fulminant mediastinitis with sternal involvement. Diagnostic criterion for postoperative detection of acute mediastinitis at computed tomography is the presence of fluid collections and gas in the mediastinal space, which might or might not be associated with peristernal abnormalities such as edema of soft tissues, separation of sternal segments with marginal bone resorption, sclerosis and osteomyelitis. Other associated findings include lymphadenomegaly, pulmonary consolidation and pleural/pericardial effusion. Some of these findings, such as mediastinal gas and small fluid collections can be typically found in the absence of infection, early in the period following thoracic surgery where the effectiveness of computed tomography is limited. After approximately two weeks, computed tomography achieves almost 100% sensitivity and specificity. Patients with clinical suspicion of mediastinitis should be submitted to computed tomography for investigating the presence of fluid collections to identify the extent and nature of the disease. Multidetector computed tomography allows 3D images reconstruction, contributing particularly to the evaluation of the sternum.**

Keywords: Acute mediastinitis; Postoperative infection; Mediastinitis.

Resumo **Mediastinite pós-cirurgias torácicas é definida como a infecção dos órgãos e tecidos do espaço mediastinal, ocorrendo em 0,4% a 5% dos casos. A gravidade da infecção pós-operatória varia desde infecção de tecidos superficiais da parede torácica até mediastinite fulminante com envolvimento esternal. O critério diagnóstico da tomografia computadorizada para mediastinite aguda pós-cirúrgica é a presença de coleção mediastinal, podendo estar associada ou não a anormalidades periesternais como edema/borramento de partes moles, separação dos segmentos esternais com reabsorção óssea marginal, esclerose e osteomielite. Achados associados incluem linfonodomegalias, consolidações pulmonares e derrame pleural e pericárdico. Pequenas coleções e gás mediastinais podem ser usualmente encontradas em pós-operatório recente de cirurgias torácicas sem a presença de infecções, limitando a eficácia da tomografia computadorizada nas duas primeiras semanas. Após esse período, a tomografia alcança quase 100% de sensibilidade e especificidade. Pacientes com suspeita clínica de mediastinite devem ser submetidos a exame de tomografia para pesquisa de coleções, identificando a extensão da doença e sua natureza. A versão de multidetectores propicia recursos de reconstruções em diversos planos e janelas, contribuindo especialmente para o estudo do esterno.**

Unitermos: Mediastinite aguda; Infecção pós-cirúrgica; Mediastinite.

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INTRODUCTION

Mediastinitis following thoracic surgery is defined as an infection of organs and tissues in the mediastinal space, with an incidence ranging between 0.4% and 5% of cases, according to the recent literature[1–3]. Early diagnosis is extremely important, considering the high rates of morbidity and mortality, the latter ranging between 14% and 47%[4,5].

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The severity of postoperative infection ranges from infection of superficial tissues in the chest wall to fulminant mediastinitis with sternal involvement (sternal dehiscence and osteomyelitis)[5]. Several studies have demonstrated the existence of risk factors contributing to the occurrence of mediastinitis, such as advanced age, male sex, obesity, hypertension, dyslipidemia, diabetes mellitus, chronic obstructive pulmonary disease, prolonged surgery, bilateral internal mammary artery grafts, prolonged hospital stay, reoperation for bleeding management and multiple blood transfusions[2,3,5].

Computed tomography (CT) examinations performed up to the 15th day after the surgery presents a low specificity because of the short period elapsed[6]. So, pathological findings are hardly differentiated from those typically expected in the postoperative period of these types of procedures. Frequent post-surgical trauma symptoms such as fever and chest pain may result from other factors that justify a tomographic study for investigation of mediastinitis.

The clinical picture is an extremely relevant factor to be taken into consideration when early mediastinitis is suspected. This method may be inconclusive at the first two weeks after the surgical procedure. At our institution, the diagnosis of postoperative mediastinitis is based on signs and symptoms associated with CT findings and results from the surgical wound secretion culture. Symptoms suggestive of this disease include: persistent fever four days after the surgery, systemic toxic condition and leukocytosis (sepsis), sternal pain and instability, and spontaneous purulent drainage from the surgical wound site[1,7–9].

The present study included 22 patients referred to the diagnosis center with clinical suspicion of acute poststernotomy for diagnostic elucidation and early interventional therapy planning. Thirteen patients had been submitted to myocardial revascularization surgery, and nine to valve replacement. CT studies were performed in multislice tomography equipment with 16 (MX 8000 – Philips Medical Systems; Eindhoven, The Netherlands) and 64 channels (Aquillion – Toshiba Medical Systems; Tokyo, Japan), with respectively 0.75 mm- and 0.5 mm-thick axial slices, 120 kV and mAs automatically calculated. Multiplanar reconstruction was performed with gross slices at 7 mm intervals, demonstrating mediastinal and bone windows. Contrast-enhanced images were acquired as required by the severity of the patients' clinical picture, excepting for some cases where contrast-enhancement was contraindicated.

TOMOGRAPHIC FINDINGS IN ACUTE MEDIASTINITIS

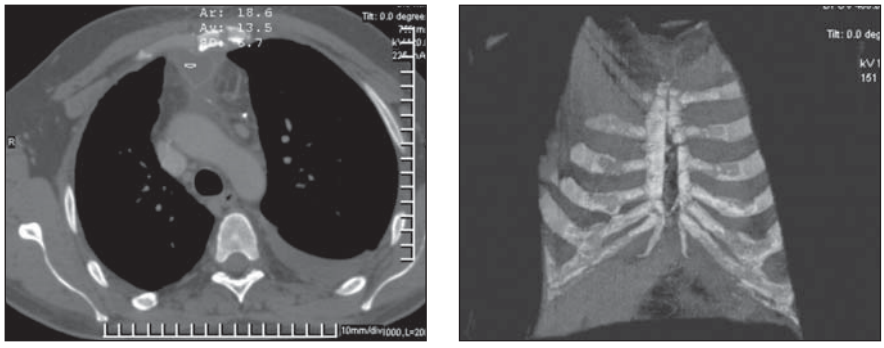
CT diagnostic criterion for acute postoperative mediastinitis is the presence of fluid collection in the mediastinum in association or not with peristernal abnormalities such as soft tissues edema/densification, sternum separation with marginal bone resorption, sclerosis and osteomyelitis[10–12]. Other associated findings include lymphadenomegaly, pleural and pericardial effusion, subcutaneous emphysema and pulmonary consolidation[12]. Small mediastinal collections and gas may be typically found without the presence of infection in patients submitted to thoracic surgery, early in the postoperative period. In these cases, CT effectiveness is limited at the first two weeks following the surgery[10]. Later in the postoperative period, CT achieves almost 100% sensitivity and specificity[10].

Minor or = 20 UH mediastinal collections are indicative of the presence of fluid content. However, higher densities suggesting the presence of blood do not exclude the presence of a concomitant infection. In the present study, higher density levels were obtained in valve replacement surgeries. This result is compatible with a procedure for opening the myocardium e accessing the valve that results in a more intense bleeding than in the surgery for myocardial revascularization. Most of patients who underwent computed tomography for suspicion of mediastinitis after the 15th postoperative day presented mediastinal collection or sternal alterations such as sternal separation, marginal bone resorption, sclerosis and signs of partial bone destruction (Figure 1).

INDICATIONS FOR CT, AND MULTISLICE CT ADVANTAGES IN MEDIASTINITIS DIAGNOSIS AND PROGRESSION FOLLOW-UP

Patients with clinical suspicion of mediastinitis or surgical wound infection should be submitted to computed tomography for investigation of mediastinal collections, densification/edema of adjacent soft tissues and determination of the disease extent. In cases where spontaneous drainage from the surgical wound, computed tomography plays a significant role in the identification of the superficial or deep collection origin, besides defining its nature. However, considering the disease severity in these patients, routine percutaneous drainage is not performed in our institution with diagnostic purposes. In selected cases, CT-guided percutaneous drainage is required for culture purposes.

The multislice modality allows multiplanar reconstruction and windowing, contributing particularly to the evaluation of the sternum. Curved MPR reconstruction



A **B**

Figure 1. Male, 45-year-old patient, at the 47th day after myocardial revascularization. Retrosternal collection with fluid density (13.5 UH) associated with blurring of adjacent fat plane and pleural effusion (**A**). Volumetric reconstruction of chest image demonstrating sternal dehiscence (**B**).

plays a significant role in the visualization of this structure. The sagittal plane is useful for determining the disease extent, besides characterizing the communication between the mediastinal and parietal compartments, so the spontaneous drainage can be foreseen.

CT is a useful tool in the medium- and long-term follow-up, for the clinical management after introduction of antibiotic therapy besides confirming the resolution of the inflammatory process. After the debridement surgery, computed tomographic follow-up plays a significant role in the identification of debris and possible infection recidivation[13].

Out of the 22 patients evaluated for clinical suspicion of mediastinitis, computed tomography identified mediastinal collection in 19 (86.3%), 10 of them with presence of gas, and sternal alterations such as sternal dehiscence, marginal bone erosion, sclerosis and signs of partial sternal destruction in 12 patients (63%) (Figures 2 and 3). Two patients were diagnosed with sternal osteomyelitis resulting from bone destruction and adjacent infected collection (Figure 4). Two of the three patients whose mediastinal collection was not identified at CT, presented blurring of fat planes, and the

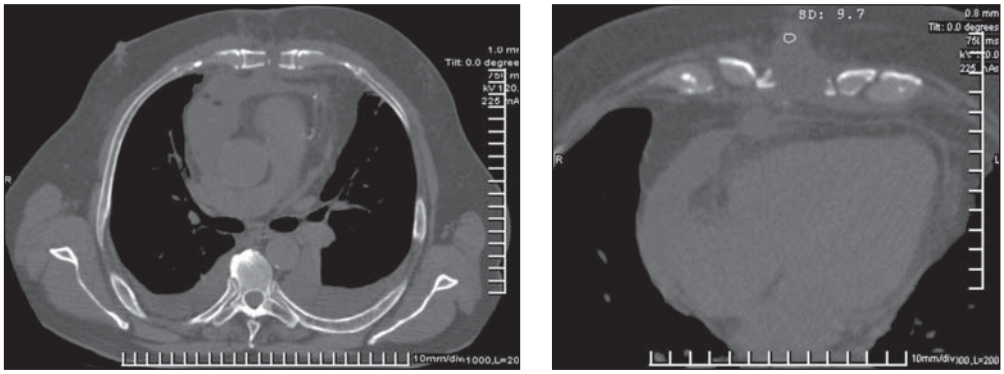


Figure 2. Male, 68-year-old patient, at the 14th day following myocardial revascularization. Mediastinal collection with air-fluid levels, bilateral pleural effusion, sternal dehiscence with spontaneous secretion drainage between bone segments.

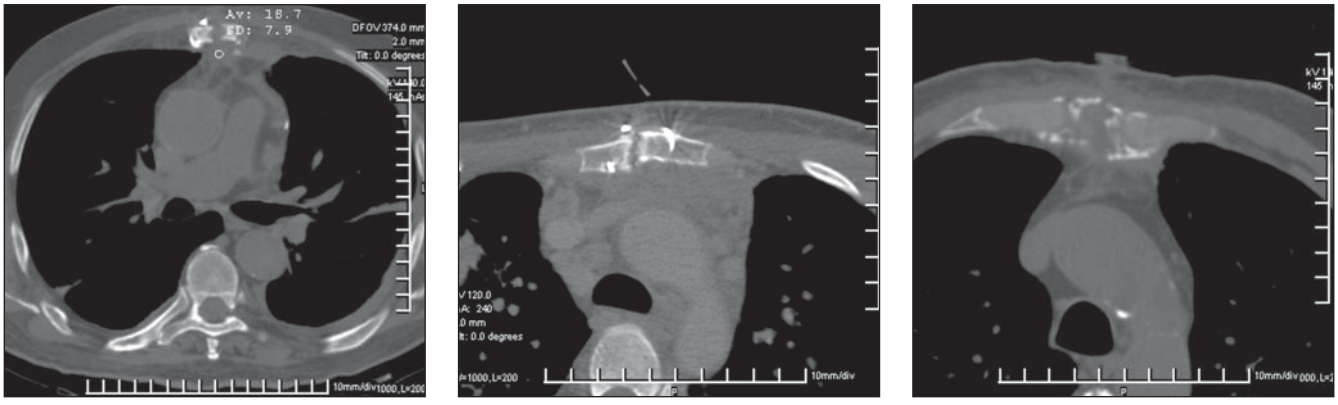


Figure 3. Postoperative sternal abnormalities in patients submitted to cardiac surgeries. Small-sized mediastinal collection and marginal bone resorption of sternal segments (**A**), bone extremity sclerosis and irregularities (**B**), and fragmentation with sternal erosion (**C**).

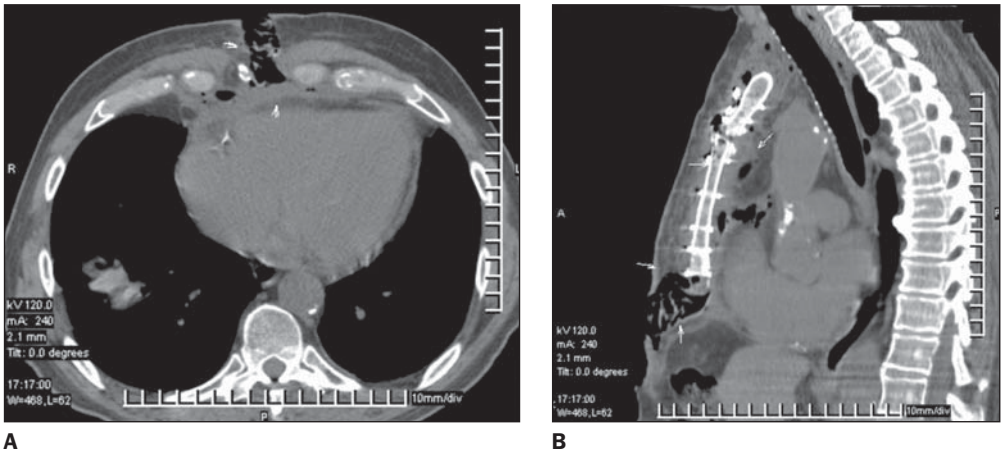
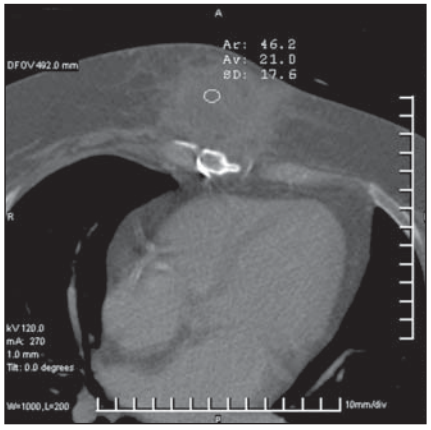


Figure 4. Male, 73-year-old patient, at 17th postoperative day following myocardial revascularization. Presence of extensive dehiscence of the surgical wound, retrosternal collection with gas (sagittal plane), besides other findings such as pericardial fluid and pulmonary atelectasis.



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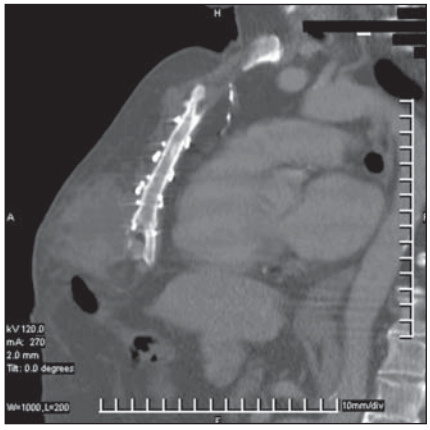

B

Figure 5. Male patient at the 32nd postoperative day following myocardial revascularization. Organizing collection in the presternal space with fluid density demonstrated on axial and sagittal images, compatible with chest-wall abscess.

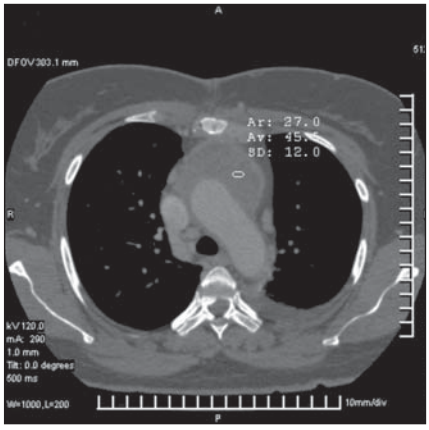

Figure 6. Female, 47-year-old patient at the 17th day following valvar replacement. Encapsulated collection in the retrosternal space, with 45 UH density, confirmed as an infected hematoma.

other presented a presternal formation compatible with surgical wound abscess (Figure 5).

Wound secretion culture could be obtained in 14 cases. In the other five cases, secretion culture could not be obtained because of the insufficient amount of spontaneously drained secretion and disease severity hindering the percutaneous drainage, because these patients had less than 15 days from their surgery. Eleven (78.5%) patients had a positive wound secretion culture, and three (21.4%) negative. Multibacterial growth was detected in the cultures, with *Staphyloccocus aureus* identified in 66% of cases.

The interval between surgery and CT study was > 15 days in 11 (50%) patients. Among the other patients with less than 15 days from their surgery, three had a positive culture, two had a negative culture, and five had insufficient amount of drained secretion.

Among the patients with positive culture (11 cases), the density of mediastinal collection at CT was > 20 UH in seven (63%), and only three (27%) were in their early postoperative period (< 15 postoperative days). Higher collection densities were observed in patients submitted to valve replacement (77%).

DISCUSSION

In patients undergoing their postoperative period with a clinical picture suggestive of mediastinitis after thoracic surgeries, CT plays a significant role in the detection of collections and respective characteristics, including the presence of gas and signs of sternal destruction suggestive of osteomyelitis[6]. CT can determine the presence of the inflammatory entity either in the mediastinum or in the anterior chest wall, and also identify the presence of a drainable abscess or diffuse inflammatory process. The multislice modality allows multiplanar reconstruction and windowing, contributing particularly to the evaluation of the sternum. The diagnosis of sternal osteomyelitis represents a challenge for the radiologist, considering the anatomic complexity of the sternal structure that in association with the surgical trauma makes a definite diagnosis more difficult. Imaging findings of sternal dehiscence with marginal erosion and sclerosis, and signs of bone destruction suggest the presence of osteomyelitis, especially in cases where these findings are correlated with clinical signs and presence of adjacent infected collection.

Mediastinal collections with density ≤ 20 UH are indicative of fluid content, but higher densities indicating the presence of blood do not exclude the presence of a concomitant infection. In the present study, higher density levels were obtained in valve replacement surgeries. This result is compatible with a procedure for opening the myocardium e accessing the valve that results in a more intense bleeding than in the surgery for myocardial revascularization (Figure 6).

The culture in samples of secretion spontaneously drained from the surgical wound confers on computed tomography a significant role in identifying the origin of the collection, whether deep or superficial/parietal. Considering the disease severity in these patients, diagnostic percutaneous drainage is not routinely performed in out institution.

CT studies performed up to the 15th postoperative day lack specificity, considering the short time elapsed from the surgery, so the differentiation of pathological findings from those typically expected in these cases becomes more difficult. Signs like fever that may arise for other causes, as well as chest pain that frequently arises as a result from surgical trauma, determine the necessity of CT studies to investigate the presence of mediastinitis in patients undergoing their postoperative period. Clinical signs should be particularly taken into consideration in the suspicion of early mediastinitis. Many times, the method could not be conclusive at the first two postoperative weeks. Only 27% of patients with positive secretion cultures were included into this category, suggesting that the majority of patients will present with a more exuberant condition only after this period.

The presence of gas in the mediastinum should be carefully evaluated. The hypothesis suggesting infection by gas-producing organisms may be inappropriate, considering the presence of a communication between the mediastinum and the external environment in theses surgical procedures.

CONCLUSION

Multidetector CT represents a valuable method in the diagnosis and evolutive follow-up in cases of acute postoperative mediastinitis, particularly in those where its results are associated with the patients' clinical picture and length of time of disease progression. This method offers a broad contribution to the definite diagnosis of mediastinitis after the two first postoperative weeks, accurately identifying the collection localization, nature, as well as other alterations associated with the inflammatory process.

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