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Triple rule-out MDCT-angiography for chest pain in emergency room

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TRIPLE RULE-OUT MDCT-ANGIOGRAPHY FOR CHEST PAIN IN EMERGENCY ROOM

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ABSTRACT

One of the most common symptoms encountered in emergency rooms (ER) is chest pain. It does not only have cardiac origin, differential diagnoses include vascular origin of pain as acute aortic dissection and pulmonary origin of pain such as pulmonary embolism.

Several articles have demonstrated the importance and accuracy of a triple rule-out (TRO) multidetector computed tomography angiography (MDCT-angiography) for managing chest pain in the ER. This article is a review of the “TRO” MDCT-angiography for chest pain in ER.

While there are many exams for every clinical diagnosis, there is no diagnostic technique that can provide as comprehensive evaluation and allow quick diagnostic orientation and targeted taking care for chest pain in the emergency department as TRO MDCT-angiography.

TRO MDCT-angiography is the examination of choice to perform in the emergency department for patient with chest pain. It can assess the coronary arteries, the pulmonary arteries, the thoracic aorta and other thoracic diseases.

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INTRODUCTION

Chest pain is one of the most common symptoms encountered in emergency rooms (ER) [1]. In the US, each year, more than six million patients present to emergency departments (ED) for chest pain suggestive of acute coronary syndrome (ACS). Over 40% of these patients are hospitalized, and admissions are costly [2]. But in one hand, most of these patients do not have ACS [3] and on other, despite diagnostic advances, 2% to 8% of ACS patients are misdiagnosed and sent home, resulting in increased mortality rate [4].

Chest pain in ER does not only have cardiac origin, differential diagnoses include vascular origin of pain as acute aortic

dissection and pulmonary origin of pain such as pulmonary embolism. Other etiologies may also be mentioned such as pleural and pericardial pain, digestive or muscular pain [5;6].

In the ED, the management of a typical chest pain suggestive of acute coronary syndrome has become well codified; managing atypical chest pain remains more complex [7]. The proper diagnosis of the etiology of chest pain for patients in the ER is still difficult and there is always a challenge to differentiate patients with ACS, aortic dissection or pulmonary embolism. Proper and timely treatment of aortic dissection or pulmonary embolism depends on early etiologic diagnosis [8;9].

Access to the thoracic multidetector MDCT-angiography with cardiac gating improves emergency medicine. One exam, fast, simple and reliable, allows quick diagnostic orientation and targeted taking care for chest pain presenting to the emergency department. The “triple rule-out protocol” (TRO) assesses simultaneously the coronary arteries, the aorta, the pulmonary artery and thoracic structures. A real support that makes the medical team less perplexed.

METHODOLOGY

A literature search on pubmed was performed using the “triple rule-out” keywords. Relevant articles published between 2007 and 2015 were analyzed. Several articles that demonstrated the importance and accuracy of a TRO MDCT-angiography were reviewed and the most pertinent ones were selected.

These articles were analyzed selected and selected by one author. This article is a systemic review of the TRO MDCT-angiography for chest pain in the emergency room.

TRIPLE RULE-OUT MDCT ANGIOGRAPHY

1- Technique

It is important to pay particular attention to the preparation of patients, the technology acquisition, and the injection technique for optimal homogeneous opacification of the aorta, the coronary arteries, and the pulmonary arteries. The electrocardiogram (ECG) synchronization during a TRO MDCT-angiography eliminates artifacts due to heart beats and, therefore, allows a better visualization of the coronary arteries, the pulmonary arterial tree and the thoracic aorta compared to MDCT-angiography carried out without ECG synchronization.

2- Patient selection

It is important to do an appropriate patient selection for TRO MDCT-angiography; otherwise it will not be a cost-effective procedure for chest pain in ER [10]. Patient selection criteria for TRO MDCT-angiography are listed in **figure 1** [10].

3- Patient preparation

It is impossible to inform the patient of the necessity of stopping the caffeine prior to completion of the MDCT-angiography for someone who presents to the emergency for chest pain, this is not a patient who makes an appointment for cold diagnosis examination. In this case, it is necessary to administer intravenous β -blocker for faster heart rate control to achieve 60 beats per minute [10].

The intravenous (IV) access must be considerably wide for injecting rapid bolus IV contrast. An 18-20 gauge catheter is inserted into a vein in the antecubital fossa. A bolus of saline is injected before the contrast agent to test the permeability of the catheter and to avoid extravasations of the contrast agent. The arm should be placed over the head to avoid compression of the subclavian vein [10].

- Clinical presentation: low to moderate risk of acute coronary syndrome (ACS)
- Clinical presentation: non-ACS diagnosis considered
- Negative biomarkers (myoglobin and troponin-I)
- Normal ECG or nonspecific changes
- No history to suggest extensive coronary calcium
- Not recommended for patients with bypass or stents
- Patient able to tolerate computed tomography and hold breath
- Cardiac rhythm acceptable for ECG-gated scan
- Adequate renal function

Figure 1: Patient selection criteria for triple rule-out CT-angiography [10]

The electrodes are placed on the anterior chest wall above and below the heart level for a better cardiac gating [10]. It is important to check the creatinine level of the patient, his allergic history and his current treatment before intravenous administration of contrast agent.

4- Protocol

TRO MDCT-angiography must include the heart, coronary arteries, the pulmonary arteries and the aorta. If a pulmonary cause is suspected, the volume of the scanner includes the pulmonary apex; Otherwise it is better to start the scanner upstream of the aortic arch to minimize patient irradiation. The examination is performed with breath hold to eliminate breathing artifacts.

According to Halpern [10], IV injection of contrast should be biphasic for a good opacification of the coronary arteries and the pulmonary arteries. During the first phase, 70 mL of contrast with iodine concentration of 350 mg.mL⁻¹, are injected with a 5 mL.s⁻¹ flow rate. During the second phase, 50 mL of contrast diluted to 50% with saline serum are also injected with a flow rate of 5 mL.s⁻¹ [10]. Dilution minimizes artifacts due to the density of the contrast agent.

When the density of the contrast agent reaches 150 HU at the proximal portion of the ascending aorta, the acquisition of the MDCT-angiography starts [7], it takes about 15 to 20 seconds.

Different reconstructions are then performed for the analysis of the coronary arteries, the pulmonary arteries and the aorta.

DIFFERENTIAL DIAGNOSIS

1- Atypical Coronary Syndrome

The differential diagnosis of chest pain remains a complex

problem for doctors in the ER. The diagnosis of ACS includes unstable angina (**Figure 2**), myocardial without ST segment elevation, and myocardial infarction with ST segment elevation.

Among patients presenting to an ED with ACS symptoms, only 25% will have a confirmed diagnosis of ACS [4] (**Figures 3 and 4**). Patients for whom the diagnosis of ACS is not diagnosed tend to be younger, to have atypical chest pain and a normal ECG [11]. The uncertainty in the diagnosis of ACS leads to an increase in the number of diagnostic tests and to an increase in hospital admissions rate [12], therefore increasing the cost of diagnosis.

The TRO MDCT-angiography prescribed in the ED for chest pain, allows the analysis of coronary arteries to confirm or deny the

presence of coronary artery disease that can explain this chest pain (**Figure 5**).

2- Pulmonary embolism

Pulmonary embolism must be raised before any chest pain presenting to the ED. However, the diagnosis of pulmonary embolism remains a challenge, especially when the final outcome depends on the speed of starting a targeted treatment (**Figures 6 and 7**).

The TRO MDCT-angiography can confirm or reject the diagnosis of pulmonary embolism. A negative MDCT-angiography excludes

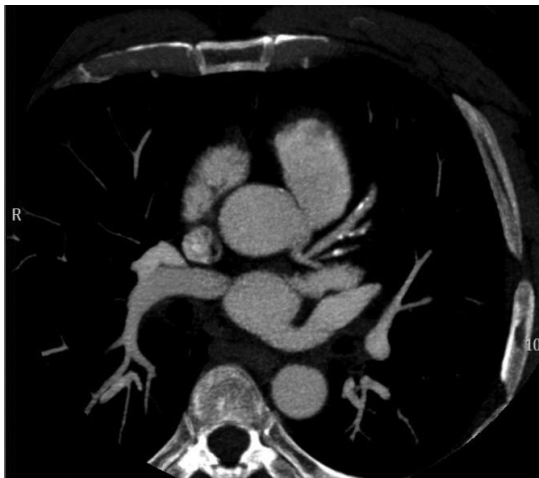


Figure 2: A 48-year-old man presented with atypical chest pain. He has a family history of myocardial infarction. Electrocardiogram and troponin were normal. TRO MDCT-angiography obtained one hour later shows calcified eccentric plaques along the left anterior descending artery and the diagonal arteries. The aorta is normal \LNader©

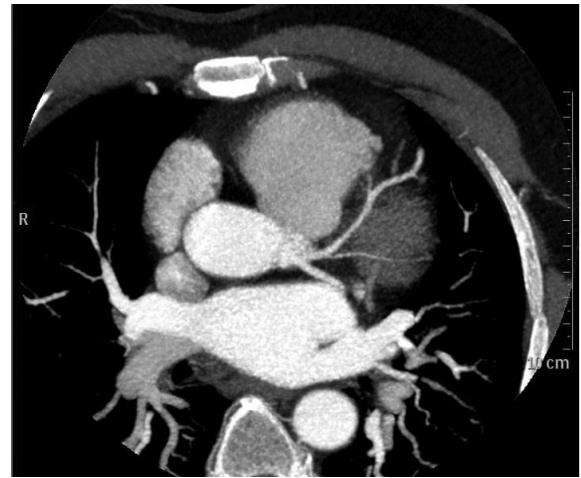
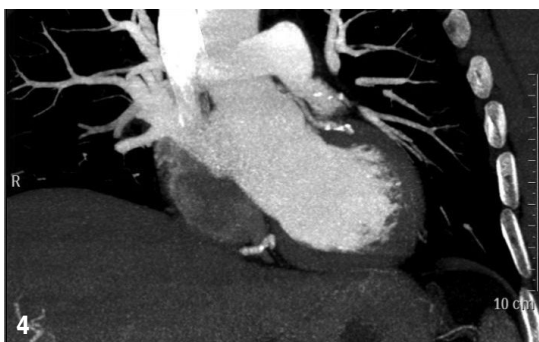
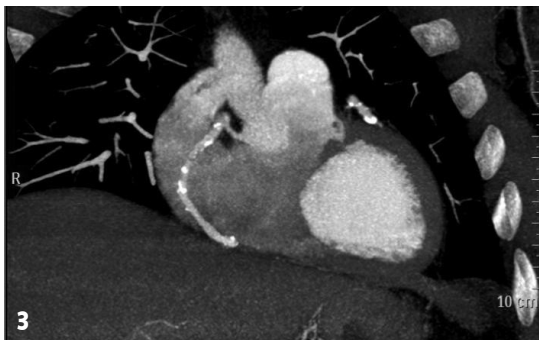


Figure 5: A 50-year-old man presented with chest discomfort. No family history of coronary artery disease. He never smoked. There is no history of hypertension, diabetes or hyperlipidemia. He works at the stock exchange. The TRO MDCT-angiography shows normal coronary arteries, normal pulmonary arteries, normal aorta and no lung disease \LNader©



Figures 3 and 4: A 52-year-old man presented with unstable angina. His father died of myocardial infarction at age 60. TRO MDCT-angiography shows severely calcified coronary arteries with significant coronary artery stenosis involving the left anterior descending artery and the right coronary artery \LNader©

an pulmonary embolism if the clinical probability is not high or in combination with a negative lower limbs venous doppler ultrasound if the clinical probability is high [13].

3- Aortic Dissection

Aortic dissection is the most common cause of aortic origin for chest pain presenting to the ED. Aortic dissection can be deadly and quick diagnosis can be life-saving for the patient (**Figures 8 to 10**).

In aortic dissection, the TRO MDCT-angiography during can: confirm the diagnosis, locate the dissection, show its extent, classify the dissection and analyze the involvement of all the bifurcation of the aorta [14]. It can also quickly guide treatment and prevent fatal death.

4- Other thoracic diseases

TRO MDCT-angiography prescribed in the ER allows, besides exploring thoracic vascular structures, the study of the lung parenchyma, the myocardium, the pericardium, the chest wall, etc. which in some cases may be of a remarkable utility for the



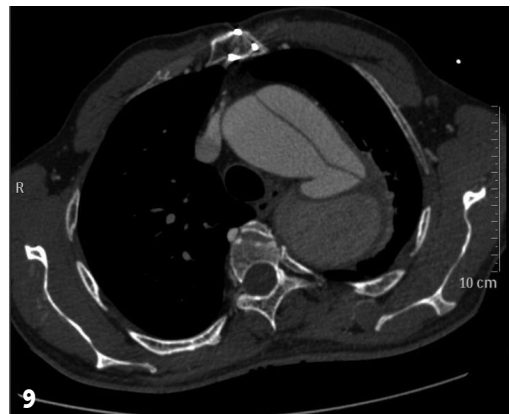
Figures 6 and 7: A 65-year-old woman presented to the ER with atypical chest discomfort associated with mild dyspnea. He was a heavy smoker and never underwent any diagnostic chest exam. There is no history of coronary artery disease. The TRO MDCT-angiography shows distal pulmonary embolism involving the right lower lobe. On the other side a pulmonary mass is seen within the lingula \LNader©

diagnosis of pneumonia, pleural effusion, pericardial effusion, or other chest pathologies (**Figures 6 and 7**).

CONCLUSION

The multidetector TRO MDCT-angiography with cardiac gating is the investigation of choice to perform for atypical chest pain in the ED, which may be cardiac, pulmonary, vascular or thoracic. The TRO MDCT-angiography allows quick and targeted treatment depending on the etiology.

It can be used as a routine protocol for atypical chest pain emergencies. It can eliminate the need for further diagnostic testing in over 75% of patients. It can reduce diagnostic time, number of hospitalizations, numbers of diagnostic tests, rate of



Figures 8 to 10: A 53-year-old man operated five years ago of aortic valve replacement, presented to the ER with severe chest pain. Electrocardiogram and troponin were normal. TRO MDCT-angiography shows aortic dissection extending from the ascending thoracic aorta, two cm above the aortic valve, involving the aortic arch and the descending thoracic aorta. A posterior parietal hematoma is noted at the level of the descending thoracic aorta \LNader©

mortality and morbidity due to misdiagnosis or delayed diagnosis [15;16].

Are emergency physicians in ER aware of the TRO MDCT-angiography protocol? Are radiologists specialized to perform and analyze such advanced protocol?

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