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COMPUTED TOMOGRAPHY PULMONARY ANGIOGRAPHY (CTPA) USING OPTIMIZED SCAN PROTOCOL – A REVIEW

Radiodiagnosis

Sudhakar P — Post graduate, Department of Radio-diagnosis, Mahatma Gandhi Medical college and Research Institute, Pondicherry, India.

Lokeshkumar T* — Assistant Professor, Department of Radio-diagnosis, Mahatma Gandhi Medical college and Research Institute, Pondicherry, India. *Corresponding Author

Armel Arputha Sivarajan A — Assisatant Professor, Department of Radio-diagnosis, Mahatma Gandhi Medical college and Research Institute, Pondicherry, India.

ABSTRACT

Pulmonary embolism (PE) is the third most common cause of death in cardiovascular related mortality. CT pulmonary angiography is the diagnostic imaging of choice in PE. However the recent advancement in MDCT has resulted in use of reduced contrast medium (CM) volume when compared to its standard volume. The aim was to undertake a review about the image quality in CTPA using altered scan protocol, especially by using low volume contrast medium. A literature search was conducted using PubMed and Google Scholar up to January 2020 with the following key words "CT pulmonary angiography using low volume contrast medium", "CTPA with altered scan protocol", "CTPA using low kVp and low volume of contrast medium". A total of 17 studies met the inclusion criteria and were included in the analysis. Based on the results of study, it can be concluded that due to the recent advancement in MDCT, use of low or reduced volume of contrast medium and with a few required adequate modifications in the scan protocol it was possible to achieve the required diagnostic standard enhancement in the pulmonary arteries and thus were able to get an adequate diagnostic image quality in CTPA.

KEYWORDS

Pulmonary embolism, CT pulmonary angiography, low volume contrast medium, image quality.

INTRODUCTION:

Pulmonary embolism (PE) is the third most common cause of death in cardiovascular related mortality which comprises of ~ 650,000 individuals per year.[1]

The major diagnostic difficulty with PE is its variable clinical presentation and up to two-thirds of patients may be asymptomatic or sudden death may be the first presentation. Hence early diagnosis of PE is one of the key factors in affecting the outcome. To overcome this, physicians have to confide on a combination of clinical assessment, clinical prediction scores, laboratory investigations and imaging to determine the diagnosis. CTPA has become the imaging of choice in suspected cases of PE, due to its higher sensitivity and specificity.[2]

The current standard practice in most institutions is to perform this study using 1.2mL/kg (80 – 150 mL) volume of IV contrast medium(CM).[2] However, recent technical advances in both Multi detector computed tomography (MDCT) scanners and power injectors have made it possible to significantly decrease the amount of IV CM used to perform CTPA. Hence, we would like to review about the diagnostic image quality of CT pulmonary angiography which uses an optimized scan protocol.

METHOD:

Extensive comprehensive research was done in PubMed and Google scholar with the following key words "CT pulmonary angiography using low volume contrast medium", "CTPA with altered scan protocol", "CTPA using low kVp and low volume of contrast medium", "CTPA with radiation dose reduction". Detailed study was done among the results got from the extensive search and have acquired few of the recent articles which were more precise to our topic of interest.

REVIEW OF LITERATURE:

The advancement in MDCT scanners have resulted in imaging study with a shorter acquisition time and thus researchers were able to tailor the scan protocol mostly according to the patient's weight. Szucs-Farkas et al[3] (2009) did a prospective comparative study between 80 kVp and 120 kVp protocol in which patients were divided into four groups of 30 patients with different tube voltage and amount of CM in each group, with a body weight less than 100 kg. They have demonstrated the mean CT attenuation values in respective pulmonary arteries among both groups and have stated that there was a sensitivity of 100% for PE and also there was no significant difference in the specificity between the two protocols. Thus, they have concluded that diagnostic image quality for CTPA in pulmonary embolism with low dose and low kVp protocol is equal to that of a standard protocol in patients weighing less than 100 kg body weight.

T.Singh and KV Lam[4] (2010) have applied this method of optimization of scan protocol among the patients with *renal failure*, who were considered as an exclusion criteria by most of the other researchers. They have demonstrated that adequate enhancement (>200 HU) of the pulmonary arteries to the subsegmental level can be achieved safely using low volume (30 mL) of contrast, with the scan parameters as 120 kVp/ 200–340 mAs/ 0.5 s gantry rotation times and a pitch of 0.673.

Another retrospective matched cohort study done (2012)[5] among 100 patients did a comparison between a low contrast volume (30 ml) group n=50 and a standard volume (100cc) group n=50, of 320 mg I/ml Visipaque. They have also altered the tube current as 100 kVp in patients weighing <200 lb and 120 kVp in patients weighing > 200 lb and have made a change in the trigger position as superior vena cava (SVC) for 30 ml CM group, which was main pulmonary artery (MPA) in studies done by most of the other researchers. In their study they have concluded that the dose of the contrast medium can be reduced significantly without compromising the image quality of CTPA with required changes in the scan parameters. Similar to these few other studies[6,7,8,9,10] have stated that there were no significant differences in subjective(likert scale) and quantitative image quality between normal-dose and a low-dose CM volume protocol.

Few other studies [9,11,12,13] have also demonstrated the additional benefit of reduction in radiation dose with the use of altered scan protocol combined with a reduced contrast medium volume.

Later a new perspective was given to other researchers by Li et al[14] (2015) by altering the pitch and using a different image reconstruction software. They have stated that use of 70 kVp, *high pitch* (3.2) CTPA with SAFIRE (Sinogram Affirmed Iterative Reconstruction) software and a low volume contrast medium (40ml) have allowed them to get a proper diagnostic image quality, simultaneously with a substantial reduction in radiation. In contradiction to this Boos et al[15](2016) was able to attain the required diagnostic image quality in CTPA with the use of low contrast volume combined with *a low pitch protocol*.

Following this Zhang et al[16](2018) was able to demonstrate an additional factor of reduction in total uptake of iodine with the use of low concentration - low volume contrast medium and still were able to obtain a CTPA with an adequate diagnostic image quality and with substantial reduction in radiation dose.

In 2018, a retrospective study done among 151 oncology patients have concluded that a high quality CTPA with an excellent diagnostic image quality is feasible in oncology patients with a low dose contrast media and with substantial reduction in the radiation dose.[17]

In 2019, Aldosari et al has concluded that it was feasible to use a double low dose CTPA (less than 45ml) in the diagnosis of pulmonary embolism and with reduction in tube voltage to 100kVp they were further able to get CTPA with further reduction in radiation dose.[18]

Recently in 2020, a study done by Silva et al among 176 patients using an ultra-low volume (20ml) and low volume (40ml) high concentration (400mgI/dl) contrast medium with a flow rate of 3ml/s have concluded that they were able to obtain a CTPA with an adequate diagnostic image quality and an ultralow volume CTPA rendered a diagnostic contrast enhancement for the assessment of pulmonary arteries.[19]

CONCLUSION:

Due to the recent advancement in MDCT - use of low or reduced volume of contrast medium and with a few required adequate modifications in the scan protocol it was possible to achieve the required diagnostic standard enhancement in the pulmonary arteries and thus were able to get an adequate diagnostic image quality in CTPA in a suspected case of pulmonary embolism. In addition to this they were able to achieve a substantial reduction in the radiation dose. Almost all review articles have stated a clear point that weight based protocol was necessary to achieve a consistent degree of contrast enhancement to get an adequate diagnostic image quality in CTPA while using a reduced volume of contrast medium.

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