Radiation dose reduction of CT pulmonary angiography for PE by limiting acquisition length: Simple yet effective

Vistasp Daruwalla MD, Vasavi Paidpally MD, Shane Newberger MD, Mounika Gunduru MD, Gassan Shahin, MD Adnan Fateh, MD.
Financial Disclosures:

• None of the authors have any financial disclosures or have a financial relationship with a commercial organization that may have a direct or indirect interest in the content.
INTRODUCTION

- CT pulmonary angiography (CTPA) has become the preferred method for diagnosing pulmonary embolism (PE).
- The need for rapid and accurate PE diagnosis combined with the widespread availability of multidetector CT have led to a significant increase in the number of patients being imaged for PE by CT both in emergency department and hospitalized patients.
- Unfortunately, the radiation dose associated with CTPA can be substantial, ranging from 2 to 20 mSv.
- Because scan length is linearly related to radiation dose, reduction of scan length has the potential to significantly decrease patient dose without altering the diagnostic accuracy for PE detection.
- It has been suggested that a scan length from just above the aortic arch to just below the diaphragm maintains diagnostic accuracy for PE while yielding significant dose reduction.
MATERIALS AND METHODS

• A new CTPA protocol was designed to reduce the scan length for CTPA from just above the aortic arch to just below the diaphragm.

• Patients who underwent CTPA for PE at Detroit Receiving Hospital for the month of November 2015 before the application of the new protocol were reviewed for study characteristics like the age, sex, volume CT dose index (CTD\text{i}v) and dose-length product (DLP). This group was labeled as the Pre-modification group.

• After the application of the new protocol in February, Patients who underwent CTPA at Harper hospital for March 2016 were reviewed for study characteristics like the age, sex, volume CT dose index (CTD\text{i}v) and dose-length product (DLP). This group was labeled as the Post-modification group.
MATERIALS AND METHODS

• The Pre-modification group consisted of 101 consecutive patients imaged utilizing the original protocol, scan range from thoracic inlet to upper abdomen. These patients were retrospectively reviewed for the study characteristics.

• The Post-modification group consisted of 110 consecutive patients imaged utilizing the modified protocol, scan range from 2 cm above arch of aorta to dome of the lowest diaphragm.

• Within the Post modification a subgroup of 30 patients was created.

• This subgroup had a prior CTPA performed in the past one year, allowing more accurate comparison for radiation dose reduction by matching confounding factors like age, sex and BMI.

• CTDIv and DLP were also obtained for the prior CTPA performed in the above subgroup.
MATERIALS AND METHODS

• The Effective radiation Dose (ED) was calculated using the following formulae:

\[ ED \text{ (mSv)} \approx k \times \text{DLP}. \]

• For the whole-body scan, we used a $k$ value of 0.018 mSv $\times$ mGy$^{-1}$ $\times$ cm$^{-1}$, which is the conversion factor suggested for trunk.

• ED for the pre and post modification group was calculated using the obtained study characteristics.

• ED was also calculated for the matched subgroup in the post modification group and their prior CTPAs.

• Statistical analysis was performed by paired two tailed t-test. P-value of less than 0.05 was considered significant.
RESULTS

- The study a total of 211 patients were included in the study with the mean age of 50 years-old (range: 18-90 years).

- The average age, volCTDI, DLP and ED of 100 consecutive patients in the Pre modification group was 51.67 years, 100.44 mGy, 1065.82 mGy · cm and 15.98mSv

- The average age, volCTDI, DLP and ED of 110 consecutive unmatched patients in the Post-modification group is 48.95 years, 106.65mGy, 640.33 mGy · cm and 9.604mSv.

- The Post-modification group of unmatched patients demonstrated a decrease in average ED by 6.376mSv measuring a 40% decrease in radiation dose after reducing the scan length.

- The difference in ED values was significant (p < 0.05).
RESULTS

• The subgroup in the Post-modification group demonstrated an average volCTDI, DLP and ED of 87.86 mGy, 1052.53 mGy · cm and 15.78 mSv in the prior scans performed in the past year compared to 115.3 mGy, 412.84 mGy · cm and 6.192 mSv after the protocol change.

• This subgroup consists of patients matched in age, sex and BMI which affect the amount of radiation dose administered to perform the scan.

• This group of matched 30 patients demonstrated a decrease in average ED by 9.58 mSv, measuring a 60.76% decrease in radiation dose compared to 40% in the unmatched group.
DISCUSSION

• Our study applied the new protocol of reduced scan length, from just above the aortic arch to just below the diaphragm and then prospectively calculate the effective dose reduction.

• Our study demonstrated a 40% reduction in radiation dose between to unmatched groups (Pre modification and Post-modification).

• We demonstrate that study characteristics like age, sex and predominately BMI significantly influence the radiation dose reduction.

• Our study demonstrates matching subgroup in the Post-modification group demonstrates a radiation dose reduction by 60% as compared to 40 % in the non matched group.
CONCLUSION

• With nearly one-third of the CT scans (30 %) are estimated to be performed in adults aged 35–54 years, 13 % in those aged 18–34 years, radiation-associated cancer risks are of particular concern.

• Studies have demonstrated that reduction in scan length provides maximum reduction in radiation dose while potentially maintaining diagnostic accuracy.

• Our study that reduction in scan length from 2 cm above arch of aorta to dome of the lowest diaphragm reduced radiation dose by 40 to 60%.

• Physicians were informed about the change in protocol to avoid errors in ordering CTPA for indications other than PE.

• Patients will be reviewed if the change in protocol necessitates further evaluation of the excluded zones by a complete CT thorax.
THANK YOU