

# **Ambiguity and Variability in Reporting of CT Pulmonary Angiography for Evaluation of Pulmonary Embolism in Pregnant Patients**

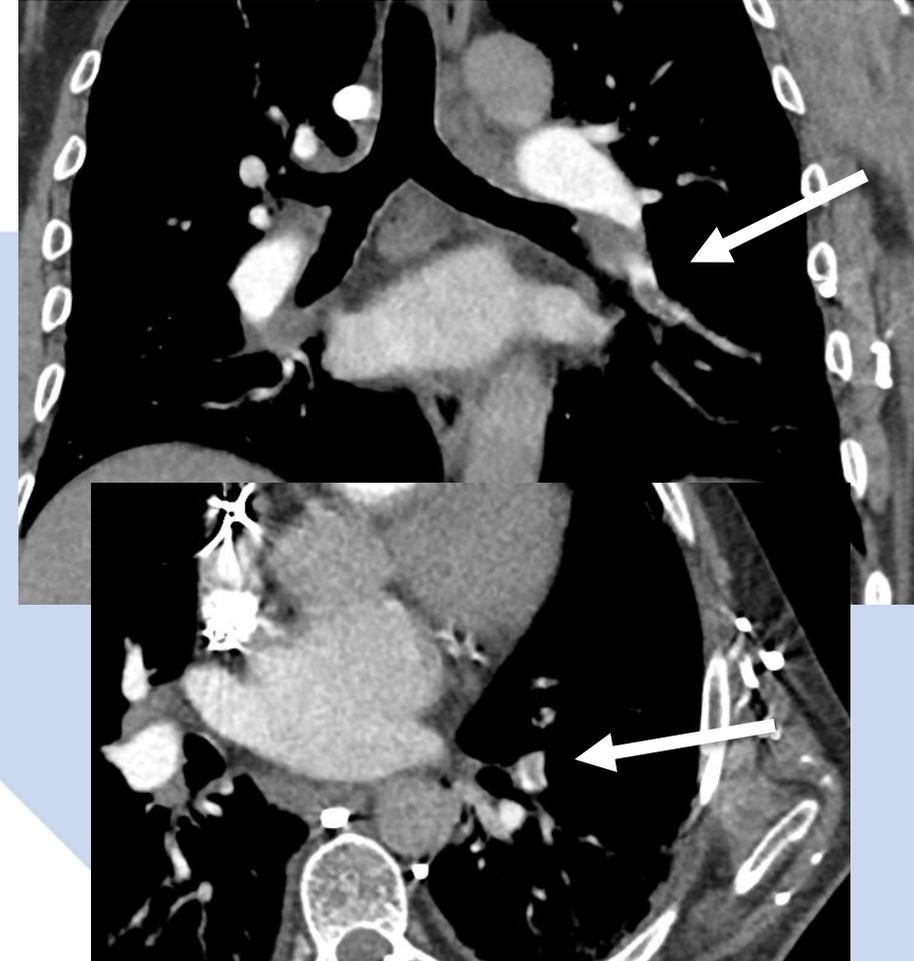
**ACR Annual Meeting, May 2019; Washington D.C.**

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**Disclosures:** I have no relevant financial or nonfinancial relationships in the subject matter described, reviewed, evaluated, or compared in this presentation.

# Introduction

- Venous thromboembolism (DVT and PE) is 10x more likely in pregnancy, as pregnancy is considered a hypercoagulable state, with mortality as high as 20%.<sup>1-5</sup>
- In a nonpregnant patient, CT Pulmonary angiography (CTPA) is the standard exam for suspected PE.<sup>6-8</sup>
- However, CTPA is more likely to be interpreted as limited in pregnancy than the general population.<sup>9-12</sup>
- When CTPA is indeterminate, pregnancy guidelines recommend additional testing with CTPA or lung scintigraphy.<sup>13</sup>
- Repeat imaging carries cancer risk to the mother and fetus, and may not be needed for slightly limited exams.<sup>14-18</sup>
- **Therefore, CTPA study limitations have to be properly described for the clinician to determine need for repeat imaging in this radiation sensitive population.**



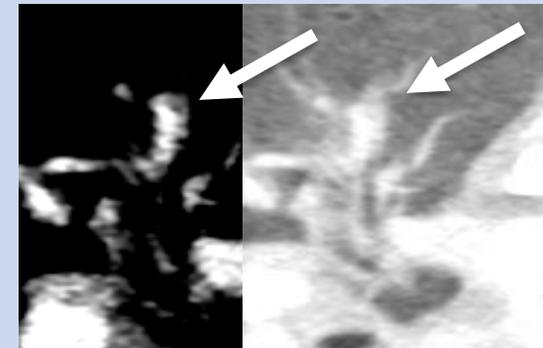
# Describing limitations on CTPA

- When limited, understanding limitation anatomy, severity, and cause in conjunction with clinical suspicion impacts a clinician's decision for additional testing and choice of testing.
- Anatomy: Which branches of the pulmonary arterial tree can be completely evaluated, and which branches have limited evaluation?
  - Limitations are usually sequential, involving the most proximal limited arteries and extending distally. The cut off between "central" and "peripheral" PA is ambiguous, as these terms have conflicting definitions in the literature.
- Severity: Is the ability to evaluate the vessels slightly limited or severely limited?
- Cause: Is the limitation due to patient body habitus, respiratory motion, or another reason?
- Repeat imaging may not be needed for limitations of more peripheral arteries, mild limitation, or nonreproducible causes.
- However, the combinations matter, as mild limitations of more proximal arteries may have to be repeated, whereas severe limitations in the most distal arteries may not.

**Severity:** example of a nondiagnostic study



**Cause:** Motion artifact obscures evaluation for pulmonary emboli.



# Purpose

- The purpose of this study is to characterize ambiguity and variety in reporting of CTPA reported as limited during pregnancy.

# Methods

- Retrospective study of consecutive pregnant patients across a large health system with CTPA during pregnancy January 2006 - April 2017.
- Data from electronic medical record and radiology information system.
- CTPA protocol determined per site protocol across large health system.
- Study specifically evaluated limited studies identified by searching the radiology information system (RIS) for CTPA report for positive pregnancy status indicated in the clinician's examination order.
- For each limited study, the limitation was qualified from radiology report.

# Study limitation

- CTPA reports were analyzed by a first year radiology resident.
- CTPA reports interpreted as limited were defined by any limitation described in the reports.
- Those reports with limitations were quantified by:
  - Where the limitations were described (ie. body, impression, both).
    - If described in both, the reporting concordance was also quantified.
  - Anatomy: The most proximal pulmonary arteries that were described as limited.
    - Central/lobar PA classification: Inferred lobar PA anatomy from the remainder of report as central, lobar, or not able to be determined.
  - Severity: Whether the report qualified the degree of limitation (ie. mild, moderate, severe).
  - Cause: The stated reason(s) for study limitation.

# Statistical Analysis

- Chi square was used to compare the report rate of the cause of limitation (cause), specific limited pulmonary arteries (anatomy), and qualification of limitation severity (severity).
- Chi Square was also used to study the effects of different variables on the cause, anatomy, and severity report rate.
  - Study variables: weekend/weekday, day (8am-8pm)/night, or whether a trainee was present/absent.
- The rates that the lobar pulmonary artery was classified as central or peripheral, inferred from the report, were compared using Chi square.

# Results

Patient Characteristics	Mean	N (%)
Age	29.5	285 (100%)
<b>Race</b>		
Asian		24 (8.4%)
African American		93 (32.6%)
Other/Unknown		62 (21.8%)
White		106 (37.2%)
<b>Patient Location</b>		
Emergency Department		197 (69.1%)
Inpatient		69 (24.2%)
Outpatient		19 (6.7%)
<b>Time Of Day</b>		
AM		169 (59.3%)
PM		116 (40.7%)
<b>Day Of Week</b>		
Weekend		72 (25.3%)
Weekday		214 (75.1%)

Limitations	N/Total (%)
Any Limitation	285/817 (34.9%)
<b>Where Limited Is Described</b>	
Body Only	45/285 (15.8%)
Impression Only	5/285 (1.8%)
Both	236/285 (82.8%)
<b>Description Of Limited<sup>1</sup></b>	
Anatomy	204/285 (71.6%)
Severity	48/285 (16.8%)
Cause	250/285 (87.7%)
P-Value <sup>2</sup>	<0.01
<b>Limited Severity Between Body and Impression</b>	
Concordant	228/236 (96.6%)
Discordant	7/236 (3.0%)
<b>Number of Limitations Described</b>	
All 3—Anatomy, Severity and Cause	3/285 (1.1%)
Any 2	222/285 (77.2%)
Anatomy and Severity	4/285 (1.4%)
Anatomy and Cause	184/285 (64.6%)
Reason and Severity	43/285 (15.1%)
<b>Use of Term “Central” Or “Peripheral”</b>	
Used Either Term in Report	139/285 (48.8%)
Did Not Use Either Term in Report	71/285 (24.9%)
<b>Implied Meaning Of the Lobar Pulmonary Arteries</b>	
Implied Central	54/139 (38.8%)
Implied Peripheral	14/139 (10.1%)
Ambiguous Lobar Artery Anatomy	71/139 (51.1%)
P-Value <sup>3</sup>	P<0.01

<sup>1</sup>No significant difference in distribution of limited description category by study factors (trainee, time of day, day of week).

<sup>2</sup>P value for differences in describing anatomy, severity, and cause.

<sup>3</sup>P value for differences in implying the lobar pulmonary arteries as central vs. peripheral pulmonary arteries.

# Results

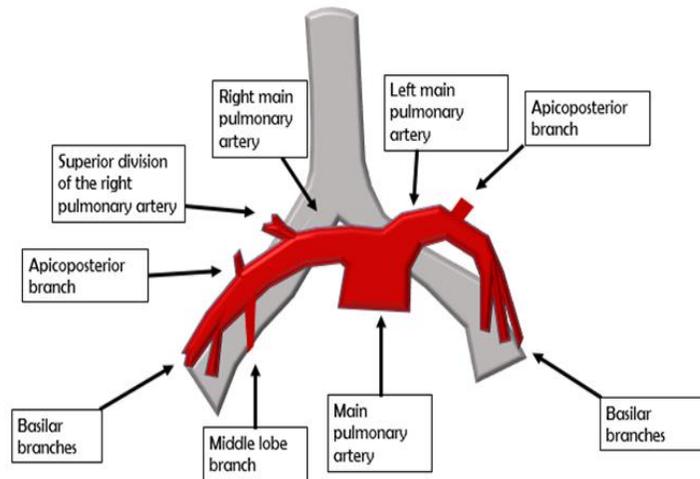
Most Proximal Limited PA Anatomy Described (Mutually Exclusive)		Extent Of Limitation Described (Mutually Exclusive)		Reason For Limitation Described (Categories Not Mutually Exclusive)	
Segmental PA	65 (22.8%)	Nondiagnostic	25 (8.8%)	Contrast Related	183 (64.2%)
Subsegmental PA	21 (7.4%)	Slightly	8 (2.8%)	Transient Interruption	9 (3.2%)
Peripheral PA	33 (11.6%)	Somewhat	6 (2.1%)	Body Habitus	8 (2.8%)
Lobar PA	7 (2.5%)	Partially	3 (1.1%)	Streak Artifact	7 (2.5%)
Distal PA	12 (4.2%)	Mildly	3 (1.1%)	Motion	77 (27.0%)
Lower Lobe PA	3 (1.1%)	Severely	1 (0.4%)	Reason Not Specified	35 (12.3%)
Main PA	1 (0.4%)	Extremely	1 (0.4%)		
Left Lower Lobe PA	1 (0.4%)	Marked	1 (0.4%)		
Anatomy Not Specified	81 (28.4%)	Limitation Not Specified	237 (83.2%)		

# Discussion: Variability in Reporting

- Reporting conformity and ease of understanding of limitations are needed for the referring clinician in this patient population, as repeat studies lead to radiation risks to the mother and fetus.
- 35% of total CTPA studies in pregnant patients were reported as limited, but higher than studies in nonpregnant patients. This similar to the rates reported in other studies during pregnancy.<sup>19-25</sup>
- The description of the study limitations can vary from the body to the impression of the report. Limitations are sometimes only reported in the body, and may not be seen by the clinician.
- There is variability in how often the limited anatomy, severity, and cause of limitation are described. There is also variability in the words used to describe anatomy, severity, and cause.
- The distribution of these descriptions did not vary by time of day, weekend/weekday, or presence of a trainee
- There is variability in the descriptor used for each type of limitation

# Discussion: Central and Peripheral Terminology

- In our study, 49% of studies used the word “central” or “peripheral.”
- 51% of the time, the terms “central” or “peripheral” were used, the implied anatomy could not be inferred from the remainder of the text. When the meaning of the terms could be inferred from the text, the lobar artery was 4x as likely to be implied as central.



- The cut off between “central” and “peripheral,” however, varies in the literature, and should not be used.
- 11 Articles were found to use the word “central” or “peripheral” when evaluating pulmonary embolism: <sup>26-37</sup>
  - 1 of 11 defined central PA anatomy to include just the main pulmonary artery.
  - 3 of 11 defined central PA anatomy to include the main pulmonary stem and the right/ left pulmonary arteries.
  - 3 of 11 defined central PA anatomy to include the main to the lobar pulmonary arteries.
  - 1 of 11 defined central PA anatomy to include the main pulmonary artery to the segmental pulmonary arteries.
  - 3 of 11 defined central PA anatomy to include the left, right and the lobar pulmonary arteries, but not the main PA.

# Limitations and Future Directions

- **Limitations:**

- Retrospective study, single health system
- Although pulled from a large sample size, the sample size of limited pulmonary embolism reports was a smaller sample size (285 reports)

- **Future directions:**

- Validate findings
- Determine the impact of terminology on repeat imaging
- Standardize reporting of PE studies, and their limitations to control use of ambiguous term and nonuniform reporting

# Conclusion

35% of CTPA during pregnancy were reported as limited using variable, undefined, and ambiguous terminology.

Standard reporting is needed to assure clear, consistent, and meaningful language to prevent unnecessary imaging in a particularly radiosensitive patient population.

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Thank You

Feel free to contact me with any questions/comments

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