Pulmonary Embolism in Pediatric Patients:

Survey of CT Pulmonary Angiography Practices and Policies

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Rationale and Objectives: To determine the current policies and practices of Society for Pediatric Radiology (SPR) members regarding the evaluation of pediatric patients with suspected pulmonary embolism (PE) with an emphasis on use of computed tomography pulmonary angiography (CTPA).

Materials and Methods: Institutional review board exemption was granted for this study. Surveys were mailed electronically to the 1575 members of the SPR representing 416 institutions. Information gathered included the existence of written policies, the imaging study of choice for suspected PE, routine acquisition of chest radiographs before CTPA, currently used CTPA techniques, modifications of protocols for radiation dose reduction, typical DLP (dose-length-product) for CTPA, and estimated annual frequency of performing CTPA for evaluating PE in children. Survey items pertaining to policies and practices were compared between practice settings and populations using chi-square analysis.

Results: One hundred and sixty members representing 118 institutions responded, which resulted in a response rate of 28% (118/416), on an institutional basis. Of these 118 respondents, 104 (88%) perform CTPA in children with clinical suspicion of PE. Of the 104 respondents who perform CTPA, 26 (25%) have a written policy for CTPA, 93 (89%) perform CTPA as the first study choice, and 67 (64%) routinely obtain chest radiographs before CTPA. The most commonly used CTPA techniques in children with clinical suspicion of PE include intravenous contrast amount of 2 mL/kg, mechanical injection of intravenous contrast, and tailored bolus tracking method for CTPA scan initiation by observing the Hounsfield units of contrast in the central pulmonary artery on the monitoring scan. Sixty respondents (58%) modify CTPA imaging protocols for evaluating PE in children in order to decrease radiation dose. The two most common modifications for radiation dose reduction were reduced mAs in 41 (68%) and automatic exposure control in 38 (63%). The majority of respondents (88%) did not know the typical DLP for a 20-kg child during CTPA study performed to evaluate for PE. A significantly greater percentage of radiation dose-reduction techniques are performed within academic institutions compared with private institutions ($P = .03$).

Conclusion: Most survey respondents perform CTPA as the study of choice for evaluating PE in children, but there is considerable variability in their policies and practices. Respondents from academic medical centers are more likely to employ radiation dose-reduction techniques for CTPA than those in private practice settings.

Key Words: Pulmonary embolism (PE); computed tomography pulmonary angiography (CTPA); imaging policy and practice; radiation dose reduction; children; survey.

Although ventilation-perfusion scanning and conventional pulmonary angiography have traditionally served as the mainstay of imaging for suspected pulmonary embolism (PE) in children (1–4), recent studies suggest an increasing role of computed tomography pulmonary angiography (CTPA) for this indication (5–8). For example, a high prevalence of PE (14%–15%) has been reported when using CTPA to image children with clinically suspected PE at large pediatric tertiary care hospitals (5,6). Among children with clinically suspected but excluded PE, pneumonia and atelectasis have been found to be the most common alternative diagnoses on CTPA (7). Furthermore, optimizing contrast enhancement techniques with CTPA in children with congenital heart disease after a lateral tunnel Fontan have been also investigated (8).

However, to our knowledge, there is no published information regarding how CTPA is performed in children across different institutions in both academic and private practice settings. Therefore, the purpose of this study was to determine the current policies and practices of Society of Pediatric Radiology (SPR) members regarding the evaluation of children with clinical suspicion of PE with an emphasis on CTPA.

MATERIALS AND METHODS

Institutional Review Board Approval

Institutional review board exemption was granted for this study, which included consenting participants. However, all

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Society for Pediatric Radiology members contacted by email were informed of the purpose of our study before they gave their consent to participate.

Survey Methods

In June 2009, an electronic survey was sent to radiologist members of the SPR. To enhance the response rate, the survey was electronically mailed a second time 1 month later. All survey responses were completed online and electronically returned for collection and tabulation of results. As stated in an introductory message to recipients of the survey, our goal was to obtain only one response from each institution. Therefore, for instances in which duplicate responses were received from the same institution, only the first response was analyzed. However, duplicate responses from the same institution were analyzed to determine the level of consistency of responses to individual survey items.

As shown in Appendix 1, the survey included a variety of questions related to practices and policies of CTPA in children. The initial question asked whether the respondent's institution performs CTPA in children (<18 years of age) with clinical suspicion of PE. Those who answered "no" to this question were directed to the final portion of the survey, which asked several demographic questions. For those respondents who answered "yes" to the first question, subsequent questions gathered information regarding: 1) the existence of a written policy or clinical pathway for the imaging of pediatric patients with clinically suspected PE; 2) the study of choice for evaluating PE at their institution; 3) whether a chest radiograph is routinely obtained before CTPA; 4) currently used CTPA techniques; 5) modifications of protocols for radiation dose reduction; 6) typical dose-length-product (DLP) for CTPA; and 7) annual frequency of CTPA for evaluating PE in children at the respondent's institution. Finally, the respondents were asked to answer a series of demographic questions.

Statistical Analysis

Continuous data such as contrast amount and Hounsfield unit (HU) values used for scanning initiation are expressed using the mean and standard deviation. Survey items were compared between groups using chi-square analysis for r × c contingency tables (9). Statistical analysis was conducted using SPSS software (version 16.0, SPSS Inc/IBM, Chicago, IL). Two-tailed values of $P < .05$ were considered statistically significant.

RESULTS

Survey Responses

Surveys were sent to 1575 electronic addresses representing 416 individual institutions listed on the membership list of the SPR. A total of 160 completed surveys representing 118 individual institutions were received. For institutions with greater than one survey response ($n = 42$), only the first received response was analyzed. Therefore, our final data analysis was based on 118 responses from 118 institutions, which represented a 28% (118/416) response rate on an institution basis. A high degree of consistency (93%) was observed among duplicate responses from the same institution. Specific items for which inconsistencies were identified included: the amount of contrast used during CTPA studies (2/42; 5%), modifications of CTPA protocols for dose reduction (3/42; 7%), and the annual frequency with which CTPA is performed in children in their institutions (4/42; 9%).

Policies and Practice Patterns

Of the 118 respondents, 104 (88%) perform CTPA in children with suspected PE. Among these 104 respondents, 26 (25%) work in an institution that has a written policy or clinical pathway for the imaging pediatric patients with suspected PE. When asked about the usual study of choice at their institution for evaluating pediatric patients with suspected PE, 93 (89%) reported CTPA, 10 (10%) reported ventilation-perfusion scan, and only 1 (1%) reported conventional pulmonary angiography.

When asked whether a chest radiograph is usually performed before CTPA, 67 (64%) of 104 respondents reported "yes" and 7 (7%) reported "no." The remaining 30 (29%) reported that it "varies depending on clinical circumstances and/or ordering physician's preference."

With regard to the annual frequency with which CTPA is performed in children in their institutions, 51 (49%) of 104 respondents reported 1–5 times, 23 (22%) reported 6–10 times, 18 (17%) reported >15 times, and 12 (12%) reported 11–15 times.

CTPA Technique Details

Amount of intravenous contrast. The majority ($n = 68$; 65%) of respondents reported that the amount of intravenous (IV) contrast used for CTPA is 2 mL/kg (Table 1). The remaining responses included "1.5 mL/kg" ($n = 12$; 12%), "don't know" ($n = 9$; 9%), "1.0 mL/kg" ($n = 7$; 7%), "3.0 mL/kg" ($n = 5$, 5%), and "2.5 mL/kg" ($n = 3$; 3%).

Methods of IV contrast administration. When asked how they administer IV contrast during CTPA for evaluating PE in children, 58 (56%) of 104 respondents reported that they use mechanical (power) injection, whereas a hand (manual) injection method was used by 3 respondents (3%) (Table 1). The remaining 43 (41%) respondents reported that the method of IV contrast injection (ie, mechanical versus manual injection) during CTPA in children is dependent on the size of the IV catheter.

Timing of CTPA scan initiation. Regarding CTPA scan initiation, 80 (77%) respondents reported that they use a tailored bolus tracking method for CTPA scan initiation by observing