Note: This is a two-article spread with a shared commentary. Please scroll down for the second article.

DIAGNOSIS

Review: Helical computed tomography for suspected pulmonary embolism needs further evaluation

Mullins MD, Becker DM, Hagspiel KD, Philbrick JT. **The role of spiral volumetric computed tomography in the diagnosis of pulmonary embolism.** Arch Intern Med. 2000 Feb 14;160:293-8.

QUESTIONS

How accurate is helical computed tomography (CT) for the diagnosis of pulmonary embolism (PE), and do the published studies have high methodologic quality?

DATA SOURCES

English-language studies were identified by using MEDLINE (1966 to 1998) and *Current Contents* (January to July 1998).

STUDY SELECTION

Studies were selected if they compared helical CT with pulmonary angiography or another clinical reference standard, such as ventilation-perfusion scanning, combined with high clinical suspicion.

DATA EXTRACTION

Data were extracted on country and year of publication, CT and diagnostic standards, study quality (measured using 11 predefined methodologic criteria), vessels imaged, sensitivity, and specificity. Criteria for methodologic quality were description of scanning technique, criteria for normal and abnormal results, blinding, reliability measured by repeated testing, description of patients enrolled and not enrolled, reporting of disease severity and other diseases identified, procedures for using the diagnostic standard and CT scan regardless of results of the other test, and independent interpretation of test results.

MAIN RESULTS

After initial screening, 14 studies were assessed, and 11 were included in the analysis (724 patients). Pooling was not done because of study differences. Only 5 studies met ≥ 5 of the 11 methodologic criteria (range 2 to 8 criteria met). Radiographic readings were blinded in only 4 studies. In the 6 studies (268 patients) that used pulmonary angiography as the diagnostic standard, the sensitivity of CT ranged from 64% to 93%, specificity ranged from 89% to 100%, {+likelihood ratio (LR) ranged from 5.7 to infinity, and –LR ranged from 0.07 to 0.4}*. For central pulmonary artery PE, the sensitivity of CT was from 83% to 100%, specificity was from 92% to 100%, {+LR was from 11.1 to infinity, and –LR was from 0.07 to 0.3}*. 17 patients had confirmed subsegmental PE (6 studies); 5 (29%) of these were identified by CT. In 4 studies, lung diseases that were not PE related were detected in 17% to 38% of patients.

CONCLUSION

The usefulness of helical computed tomography to identify pulmonary embolism in symptomatic patients, especially isolated subsegmental pulmonary embolism, has not been adequately studied using high-quality methods.

Source of funding: No external funding.

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* Numbers calculated from data in article.

COMMENTARY

Helical CT has emerged in recent years as an alternative technique for diagnosing PE. It is widely available, relatively safe, and can provide more detailed information about intrathoracic structures than other techniques. These factors probably account for its increasing popularity in many institutions. In contrast to this enthusiasm, however, the 2 excellent systematic reviews by Mullins and Rathbun and their colleagues sound a timely and urgent note of caution.

Both studies comprehensively analyze the existing data on the diagnostic properties of helical CT for PE. As expected, both reviews included essentially the same set of articles; the Rathbun review omitted 1 pertinent study (1) but identified 2 more recent studies. The major strength of both reviews is the evaluation of every study by using explicit methodologic criteria. These criteria differed somewhat in the reviews but were derived from well-established sources. Therefore, the 2 reviews provide complementary results, and they arrive at virtually identical conclusions.

The most striking finding is the failure of all the studies to satisfy the basic methodologic criteria necessary for the results to be regarded as valid. No study enrolled consecutive patients suspected of having PE and subjected all of them to both helical CT and an acceptable diagnostic standard. Workup bias and diagnostic-review bias were present in most of the studies. Selection criteria and methodology were heterogeneous among the studies, probably contributing to the heterogeneity in the sensitivities and specificities reported. For these reasons, both groups of authors wisely concluded that combining these studies in a meta-analysis would be inappropriate.

Most studies indicate that a normal helical CT scan lowers the likelihood of PE but does not lower it sufficiently to rule out PE. CT is particularly poor at identifying subsegmental emboli. The clinical significance of subsegmental emboli is unknown, but no direct evidence shows that anticoagulation can be safely withheld from patients with isolated subsegmental PE. Rathbun and colleagues sought in vain for high-quality studies describing clinical outcomes of untreated patients with normal findings on CT scans, but the limited data available suggests that such patients may still have a clinically meaningful risk for recurrent PE (2). A normal CT scan, much like a low-probability ventilation-perfusion scan, should therefore be regarded as a nondiagnostic result.

The data on abnormal helical CT scans are much more uniform. Despite occasional false-positive results, nearly all studies found that

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Review: Helical computed tomography for suspected pulmonary embolism needs further evaluation

Rathbun SW, Raskob GE, Whitsett TL. **Sensitivity and specificity of helical computed tomography in the diagnosis of pulmonary embolism: a systematic review.** Ann Intern Med. 2000 Feb 1; 132:227-32.

QUESTIONS

How accurate is helical computed tomography (CT) for the diagnosis of pulmonary embolism (PE) in symptomatic patients? Is it safe to withhold anticoagulant therapy without further objective testing for venous thromboembolism in patients who are suspected of having PE but who have a normal CT scan?

DATA SOURCES

English-language studies with human participants were identified by using MEDLINE (1986 to November 1999) with the terms pulmonary embolism and tomography, x-ray computed. Bibliographies of retrieved studies were also checked.

STUDY SELECTION

Diagnostic studies were selected if the data were collected prospectively and patients were suspected of having PE (symptomatic). Follow-up studies were included if duration and outcomes were provided.

DATA EXTRACTION

Data were extracted on year of publication; study quality; number of patients; and CT and pulmonary angiography information, including blinding, vessels imaged, size of embolism, sensitivity, specificity, and follow-up.

MAIN RESULTS

15 studies were included in the analysis, although none met all the predefined quality indicators. Pooling was not done because of study differences. 2 studies explicitly included consecutive patients, 8 studies were interpreted in a blinded fashion, 13 studies provided data on the vessels imaged, and 6 studies provided data on the size of the PEs using angiography. Sensitivity ranged from 53% to 100%, specificity ranged from 81% to 100%, {+ likelihood ratio (LR) ranged from 3.2 to infinity, and –LR ranged from 0 to 0.49}.

No studies evaluated withholding anticoagulant therapy without further testing for venous thromboembolism in symptomatic patients who had a normal CT scan. Only 1 study reported results on patients with an intermediate-probability ventilation-perfusion scan and negative results on duplex ultrasonography of the legs. 125 of 164 patients had a normal CT scan. Among these patients, 15 had pulmonary angiography and 1 had PE; all 15 received anticoagulants. 3 of 109 patients with a normal CT scan who did not receive anticoagulants in 3 months of follow-up had PE, 1 of which was fatal.

CONCLUSIONS

The use of helical computed tomography for the diagnosis of pulmonary embolism in symptomatic patients has not been adequately studied. The safety of withholding anticoagulants in patients with suspected pulmonary embolism who have a normal computed tomography scan has not been adequately evaluated.

Source of funding: University of Oklahoma College of Medicine Alumni Research Award.

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* Numbers calculated from data in article.

COMMENTARY

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an abnormal CT scan yielded high +LRs. Current evidence thus shows that an abnormal CT scan carries much greater diagnostic certainty than a normal scan and can be considered to rule in PE, obviating the need for further testing.

Which patients are likely to benefit from having a helical CT scan instead of another diagnostic test? At present, no direct evidence answers this question. However, as Mullins and colleagues show, not only is CT scanning capable of definitively diagnosing PE, it also has the unique advantage of finding alternative diagnoses in up to 33% of patients tested. Choosing helical CT in patients known to show abnormalities on chest radiography or other pulmonary diseases would therefore represent a reasonable strategy. For other patients, it is less clear whether CT or ventilation-perfusion scanning is preferable.

Proceeding to helical CT after a nondiagnostic ventilation-perfusion scan, or vice versa, is even more questionable. Although this approach may increase the number of PE diagnoses somewhat, it still cannot safely exclude PE; no evidence shows that the clinical outcome is improved by such a strategy, and both tests are expensive. Alternative diagnostic algorithms involving serial leg ultrasonography or initial ultrasonography plus D-dimer measurement has been shown to rule out PE reliably after a nondiagnostic ventilation-perfusion scan (3). It might be reasonable to use such tests after getting normal findings on CT scan, although this strategy has yet to be directly evaluated.

Better studies, particularly to examine clinical outcomes of treatment decisions based on results of helical CT scans, are needed before the proper place of CT scanning in the evaluation of suspected PE can be known.

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