Canadian Association of General Surgeons Evidence Based Reviews in Surgery. 3. Helical computed tomography versus pulmonary arteriography in pulmonary embolism

Harry J.A. Henteleff, MD; John W. Drover, MD; for Members of the CAGS Evidence Based Reviews in Surgery Group*

CAGS Evidence Based Reviews in Surgery

In September 2000, the Canadian Association of General Surgeons (CAGS) initiated a program entitled "CAGS Evidence Based Reviews in Surgery" (CAGS-EBRS) to help practising clinicians improve their critical appraisal skills. During the academic year, 8 clinical articles are chosen for review and discussion. Both methodologic and clinical reviews of the article are performed by experts in the relevant areas. The *Canadian Journal of Surgery* will publish 4 of these reviews each year. Each review will consist of an abstract of the selected article and a summary of the methodologic and clinical reviews. We hope that readers will find these useful and learn skills that can be used to evaluate other articles. For more information about the CAGS-EBRS or information about participating in the program, send an email to mmckenzie@mtsinai.on.ca.

Selected article

Qanadli SD, Hajjam ME, Mesurolle B, Barre O, Bruckert F, Joseph T, et al. Pulmonary embolism detection: prospective evaluation of dual-section helical CT versus selective pulmonary arteriography in 157 patients. *Radiology* 2000;217:447-55.

Abstract

Question: How does dual-section helical computed tomography compare to selective pulmonary arteriography (SPA) in diagnosing pulmonary embolism (PE)? Design: A prospective cross-sectional study. Setting: Cardiology and intensive care units of a university teaching hospital in Paris, France. Patients: Two hundred and four consecutive patients were clinically suspected of having an acute PE. Of these, 158 were enrolled (mean age [and standard deviation (SD)], 58 [14]). Eligibility criteria included a clinical suspicion of acute PE (dyspnea, chest pain, hemoptysis, syncope, risk factors for thromboembolic disease, abnormal findings on chest radiography or electrocardiography, or abnormal arterial blood-gas test results), and the mental ability to give informed consent. Description of test and diagnostic standard: All patients underwent dual-section helical CT and SPA within 12 hours of each other. Each image was analyzed by 2 blinded radiologists who determined image quality and the presence of PE. A third blinded radiologist was used to settle any differences. Main outcome measures: Sensitivity, specificity, positive and negative predictive values for PE. Main results: SPA was considered optimal in 147 (93%), suboptimal in 10 (6%) and inconclusive in 1 (0.6%). Dual-section helical CT findings were considered technically optimal in 140 (89%), suboptimal in 11 (7%) and inconclusive in 6 (4%). SPA demonstrated PE in 62 patients. Table 1 shows the sensitivity, specificity, and positive and negative predictive values of dual-section helical CT (based on SPA as the reference standard). Conclusions: Dual-section helical CT offers high sensitivity and specificity for the detection of PE and may replace pulmonary arteriography for the direct demon-

**The CAGS Evidence Based Reviews in Surgery Group comprises Drs. J.S.T. Barkun, G.W.N. Fitzgerald, H.J.A. Henteleff, A.B. Hill, H.M. MacRae, R.S. McLeod, C.S. Richard, M.C. Taylor, E.M. Webber and Ms. M.E. McKenzie.*

Correspondence to: *Ms. Marg McKenzie, RN, Administrative Assistant, CAGS-EBRS, Mount Sinai Hospital, 1560–600 University Ave., Toronto ON M5G 1X5; fax 416 586-5932*

stration of PE in a majority of patients, provided that the appropriate technology and people to read the tests are available.

Commentary

The paper we are reviewing for this month's Evidence Based Reviews in Surgery looks at the use of helical CT in the diagnosis of PE. This technique is becoming increasingly popular, and a well-designed study that clearly determines the value of this test would be an important addition to clinical practice.

The selected study compared dual-section helical CT with SPA in 158 patients suspected on clinical grounds to have PE. Of the 204 patients approached, 158 were enrolled. All but 2 patients had both CT and SPA within 12 hours of each other, and all scans and x-rays were read by 2 blinded radiologists. Disagreements were settled by a third radiologist.

Dual-section helical CT was found to have a sensitivity of 90%, a specificity of 94%, a positive predictive value of 95% and a negative predictive value of 97% in the diagnosis of PE with the use of SPA as the reference standard. These values are excellent and allow us to calculate likelihood ratios, which, arguably, are more useful. Sensitivity and specificity give us only 2 levels of results—positive or negative. But likelihood ratios tell us how much the diagnostic test changes the probability of having the diagnosis in question. The higher the likelihood ratio, the more likely the patient is to have the diagnosis. Specifically, the likelihood ratio of a positive test tells you how much the likelihood of having PE has been increased from baseline in the population at risk to after the positive test. Jaeschke, Guyatt and Sackett[1] have outlined guides to the use of likelihood ratios in their "User's guide to the medical literature." Basically, likelihood ratios greater than 10 (a 10-fold increase in probability) or less than 0.1 (a 10-fold decrease in probability) are thought to generate large and very useful changes from pre-test to post-test probability. Using the data reported in this study (Table 2), we calculated likelihood ratios as follows.

- Likelihood ratio for a positive test result = $[a/(a+c)]/b/(b+d)] = [56/62]/[6/95] = 0.9032/0.0632 = 14.3$.
- Likelihood ratio for a negative test result = $c/(c+a)]/[d/(b+d)] = [6/62]/[89/98] = 0.0968/0.9368 = 0.103$.

Thus, the likelihood ratio for a positive CT is 14.3, and for a negative CT is 0.103, suggesting that dual-section helical CT is an extremely useful test for diagnosing PE.

When we are critically appraising a study assessing the utility of diagnostic tests, we need to see if the authors have addressed several key points.

- The authors should compare the results of the new test with the reference standard, and this was done in all but 2 patients.
- The radiologists should be blinded to the results of the alternate test when deciding whether the test is positive or negative as were the radiologists in the selected study.
- The techniques of both tests should be well described in the study to allow others to reproduce the results and they are in this paper. In fact, in this study, CT technology going back at least 5 years was used. This provides an advantage in that the scanning technique should be available in most institutions. However, the interpretation of CT performed to diagnose PE requires expert radiologists who may not be available in all institutions capable of performing the CT. In the paper the reported κ value, which measures interobserver variation, was only 0.565 for interpreting CT scans whereas the κ value for interpreting arteriograms was somewhat better at 0.678.

The next important issue to assess is the applicability of the results to our own patient population. Was the patient sample a similar one to what we would see in practice? The study population in the article was primarily an outpatient population of 158 patients. The overall rate of PE in the population was 36%. The results may not be applicable to surgical patients or critically ill, ventilated patients because CT may be less accurate in these patients, who may have underlying atelectasis, pneumonia or low blood flow.

The authors reclassified some of the test results based on clinical findings in the study group. Specifically, they reclassified 2 false-positive CTs as true positives, based on clinical findings suggesting PE despite a

Table 1

Sensitivity, Specificity and Predictive Values of Dual-Section Helical Computed Tomography in the Diagnosis of Pulmonary Embolism Based on Selective Pulmonary Arteriography as the Reference Standard

Patient group	Sensitivity, % (and no. /total no. of pts)	Specificity, % (and no. /total no. of pts)	Predictive value, % (and no. /total no. of pts)	
			Positive	Negative
All patients	90 (56/62)	94 (89/95)	95 (56/59)	97 (89/92)

Table 2

Study Data From Which Likelihood Ratios for Pulmonary Embolism Were Calculated

Test results (CT scan)	Reference standard (arteriogram)	
	Disease present	Disease absent
Disease present	56 (a)	6 (b)
Disease absent	6 (c)	89 (d)

negative arteriogram, and they also found 2 CT scans determined to be false negative for PE as being true negative. In these 4 cases the new diagnostic test was therefore found to perform better than the "gold standard." This generates even better sensitivity, specificity, and likelihood ratios for the CT scan. The sensitivity of CT using these calculations goes up to 94%, the specificity increases to 96%, the likelihood ratio of a positive test goes from 14.3 to 22.3, and the likelihood ratio of a negative test goes from 0.103 to 0.067.

Supporting the use of CT in this patient population is the clinical reality of patient care. Pulmonary angiography requires a specialized suite and experienced radiologists and often is available only in tertiary care centres. It is an invasive procedure, which some critically ill patients may not tolerate. CT scanners capable of matching the results of this study are more widely available and are becoming standard equipment in most community hospitals. The skill of the radiologist will always be important in the interpretation of these studies, but access to experienced radiologists is becoming better with electronic transfer capability of diagnostic images to tertiary care centres where there are radiologists who have the specialized expertise. Another advantage of CT is its ability to diagnose other causes of the symptoms suggestive of PE such as pneumonia, pleural effusion and other forms of interstitial lung disease and pleural disease.

Conclusions

This is a good-quality study of a diagnostic test that is now commonly used. It provides evidence for the value of CT in an outpatient population. The results may not be generalizable to the surgical or critically ill patient, who may have atelectasis or low blood flow on positive-pressure ventilation. However, the value of CT in this patient population is its ability to identify these and other problems accurately. CT with up-to-date technology should become the diagnostic test of choice for patients with an abnormal chest radiograph and a suspicion of PE. SPA should be reserved for those in whom CT is inconclusive (i.e., movement artifact) or in whom the accuracy of the test warrants using the "gold standard" test to define the pulmonary vasculature (i.e., chronic distal pulmonary emboli causing pulmonary hypertension).

Acknowledgement: The Canadian Association of General Surgeons Evidence Based Reviews in Surgery is supported by unrestricted educational grant from Ethicon Inc., Ethicon Endo-Surgery Inc.

Reference

1. Jaeschke R, Guyatt G, Sackett DL, for the Evidence-Based Medicine Working Group. User's guides to the medical literature. III. How to use an article about a diagnostic test. B. What are the results and will they help me in caring for my patients? *JAMA* 1994;271(9):703-7.