Cost Effectiveness of CT Coronary Angiography in Patients with Suspected Coronary Artery Disease

Sunil Kumar K.1, Naveen J.2, Rimiki Challam3, Subhaschandra S.4

1Assistant Professor, Department of Radiology, Shridevi Institute of Medical Sciences and Research Hospital, Tumkur, Karnataka. 2Assistant Professor, Department of Radiology, Bangalore Medical College and Research Institute, Bengaluru, Karnataka. 3Radiologist, Civil Hospital, Shillong, Meghalaya. 4Professor, Department of Radiology, Regional Institute of Medical Sciences, Imphal, Manipur.

ABSTRACT

BACKGROUND
Coronary artery disease is one of the leading causes of death in India. Evaluation of the coronary artery can be done by CT, MRI or conventional angiography and conventional angiography is the gold standard. Convention angiography is invasive, expensive, has fewer complication and not easily available. CT coronary angiography is accurate, non-invasive, easily available and has fewer complications. In this study usefulness of performing CT coronary angiography prior to conventional angiography is assessed. The purpose of study was to determine the cost effectiveness of performing CT coronary angiography prior to conventional angiography in patients with suspected coronary artery disease.

METHODS
Patients with chest pain suspected to have coronary artery disease underwent CT coronary angiography. Patients were referred to conventional angiography only if significant stenosis was identified on CT coronary angiography. Cost effectiveness of performing CT coronary angiography before conventional angiography was compared with patients directly going for conventional angiography.

RESULTS
19 patients (63.3%) had normal coronary arteries and 5 patients (16.6%) had non-significant stenosis (<50%). 6 patients (20%) had significant stenosis (>50%) and were referred for conventional angiography. Assessment of cost incurred showed performing CT coronary angiography before conventional angiography could reduce the cost up to 50%.

CONCLUSIONS
In patients with suspected to have coronary artery disease, performing CT coronary angiography prior to invasive angiography can reduce the cost by up to 50%.

KEYWORDS
Coronary Angiography, Cost Effectiveness, Coronary Artery Disease
Coronary Heart Disease (CHD) is the leading cause of death in India with a death rate of 1.46 million. Prevalence of coronary heart disease in India is 3% with unadjusted CHD rate of 1.6% to 7.4% in rural populations and 1% to 13.2% in urban populations. Imaging modalities available for evaluation of suspected coronary artery disease (CAD) are convention angiography, computed tomography coronary angiography (CTA), magnetic resonance angiography, single photon emission computed tomography (SPECT), positron emission tomography (PET) and cardiac MRI.

CT coronary angiography has very high accuracy for detecting coronary artery stenosis of more than 50% with sensitivity of 93 to 100%, specificity of 91 to 96% and negative predictive value of 96 to 100%. Currently CT coronary angiography is used as a diagnostic tool for ruling out coronary artery disease or for determining diagnosis in suspected cases of coronary artery disease. SPECT has sensitivity and specificity of 86% and 74% for detecting significant coronary stenosis (>50%). Positron emission tomography PET has sensitivity of 92% and a specificity of 85% for diagnosing significant CAD (>50%). Cardiac MRI has sensitivity of 89% and specificity of 80% for the diagnosis of significant CAD.

Sensitivity and specificity of CT coronary angiography in detecting or ruling out significant stenosis is well established. Study comparing the cost effectiveness of CT coronary angiography and conventional angiography are very limited.

METHODS

All patients with chest pain suspected to have coronary artery disease referred for CT coronary angiography between January 2012 to December 2014 were included in the study. All scans were done on Philips Brilliance 64 slice CT scan machine. Patients heart rate was kept below 60 beats per minute by administering beta blockers. Contrast enhanced coronary angiography was done with retrospective ECG gating by bolus tracking method with locator and tracker at the level of arch of aorta. About 100 ml of non-iodinated contrast agent was injected at the rate of 5ml/sec using dual head power injector (OptiVantage DH, Mallinckrodt), followed by saline bolus of 30 ml at rate of 5 ml/sec. CT parameters were, Collimation 64 × 0.625, Pitch 0.2, Rotation time 0.4 sec, FOV 150 mm, Thickness 0.8 mm, Increment 0.4 mm, kV 120, mAs/slice 1050. Reconstruction were done in 35%, 45%, 70%, 80% and 90% phases. Image reconstruction was done on Philips extended brilliance Workspace. Axial, Multiplanar, curved multiplanar reformation and volume rendered images were used for evaluation of coronary arteries. Left main, left anterior descending, left circumflex, right coronary artery, diagonal, acute and obtuse marginal arteries were assessed for calcified plaque, soft plaque and amount of stenosis.

Patients were categorized as normal, non-significant stenosis (<50% luminal stenosis) and significant stenosis (>50% luminal stenosis). Patients only with significant stenosis were referred for conventional angiography for further management. Cost effectiveness of performing CT coronary angiography before conventional angiography was compared with patients directly going for conventional angiography. Average cost of CT coronary angiography and conventional coronary angiography are summarized in table 1.

| Modality                  | Average Cost in INR |
|---------------------------|---------------------|
| CT Coronary Angiography   |                     |
| Procedure Charges         | 10000               |
| Hospitalization Charges   | Nil                 |
| Conventional Angiography  |                     |
| Procedure Charges         | 15000               |
| Hospital Charges          | 5000                |

Table 1. Average Cost of CT Angiography and Conventional Angiography

Patient demographic and CT angiography results are summarized in table 2.

| Total Number of Patients | Mean Age | M:F |
|-------------------------|----------|-----|
|                         |          |     |
| Non-significant stenosis (<50% stenosis) | 16 | 20 |
| Significant stenosis (>50% stenosis) | 14 | 20 |

Table 2. Patient Demographic and CT Angiography

Total of 30 patients were included in the study with mean age of 55.5 years (range 35 to 79 years), 23 patients were male and 7 were female. 19 patients (63%) had normal coronary arteries and 5 patients (16.6%) had non-significant stenosis (<50%). 6 patients (20%) had significant stenosis (> 50%). No further evaluation was done in patients with normal CTA and non-significant stenosis. Patients with significant stenosis were referred for conventional angiography for further management. Performing CT coronary angiography prior to invasive angiography would reduce the cost up to 50% compared to patients directly going for invasive angiography.

DISCUSSION

In our study, 19 patients (63%) had normal coronary arteries and 5 patients (16.6%) had non-significant stenosis and no further evaluation was done in both groups. 6 patients (20%) had significant stenosis who underwent conventional angiography for further management. Assessment of cost incurred showed performing CT coronary angiography before conventional angiography could reduce the cost up to 50%. Findings in the current study are in concordance with other studies. Study done by Goehler et al comparing the clinical and economical outcome between standard of care treatment and coronary CTA-based triage in patients with chest pain showed decrease in number of patients undergoing for conventional angiography and...
decreased cost in patients who underwent CTA based triage.\textsuperscript{13}

Study done by Halpern et al in patients with positive stress test with no symptoms showed performing coronary CTA before conventional angiography is a cost-effective and can reduce unwanted catheter angiography.\textsuperscript{14} In patients with chest pain without coronary artery disease performing only coronary CT angiography is the most cost-effective diagnostic strategy.\textsuperscript{15} Another study done by Min JK et al comparing the cost and clinical outcome between CTA and SPECT in patients with no coronary artery disease showed reduced cost in patients who underwent CTA and similar adverse cardiac events and hospitalization in both groups.\textsuperscript{16}

Limitations
Study is limited by small sample size, study with large sample size is required to validate the findings. Long term outcome were not assessed in the study.

**CONCLUSIONS**

In patients with suspected to have coronary artery disease, performing CT coronary angiography prior to invasive angiography can reduce the cost by up to 50%.

**REFERENCES**

[1] Huffman MD. Coronary heart disease in India. 2011. http://sancd.org/uploads/pdf/factsheet_CHD.pdf.
[2] Gupta R. Recent trends in coronary heart disease epidemiology in India. Indian Heart J 2008;60(2 Suppl B):84-18.
[3] Pakkal M, Raj V, McCann GP. Non-invasive imaging in coronary artery disease including anatomical and functional evaluation of ischemia and viability assessment. Br J Radiol 2011;84(Spec Iss 3):S280-95.
[4] Sun Z, Ng KH. Diagnostic value of coronary CT angiography with prospective ECG-gating in the diagnosis of coronary artery disease: a systematic review and meta-analysis. Int J Cardiovasc Imaging 2012;28(8):2109-2119.
[5] Vanhoenacker PK, Heijenbrok-Kal MH, Van Heste R, et al. Diagnostic performance of multidetector CT angiography for assessment of coronary artery disease: Meta-analysis. Radiology 2007;244(2):419-428.
[6] Meijer AB, Ying LO, Geleijn J, et al. Meta-analysis of 40- and 64- MDCT angiography for assessing coronary artery stenosis. Am J Roentgenol 2008;191(6):1667-1675.
[7] Paech DC, Weston AR. A systematic review of the clinical effectiveness of 64-slice or higher computed tomography angiography as an alternative to invasive coronary angiography in the investigation of suspected coronary artery disease. BMC Cardiovasc Disord 2011;11:32.
[8] Gouya H, Varenne O, Trinquart L, et al. Coronary artery stenosis in high – risk patients: 64–section CT and coronary angiography - prospective study and analysis of discordance. Radiology 2009;252(2):377-385.
[9] Gherdin E, Litmanovich D, Dragu R, et al. 16-MDCT coronary angiography versus invasive coronary angiography in acute chest pain syndrome: a blinded prospective study. Am J Roentgenol 2006;186(1):177-184.
[10] Zhang S, Levin DC, Halpern EJ, et al. Accuracy of MDCT in assessing the degree of stenosis caused by calcified coronary artery plaques. Am J Roentgenol 2008;191(6):1676-1683.
[11] Nikolaou K, Knez A, Rist C, et al. Accuracy of 64-MDCT in the diagnosis of ischemic heart disease. Am J Roentgenol 2006;187(1):111-117.
[12] Bastarrika G, Lee YS, Huda W, et al. CT of coronary artery disease. Radiology 2009;253(2):317-338.
[13] Goehler A, Ollendorf DA, Jaeiger M, et al. A simulation model of clinical and economic outcomes of cardiac CT triage of patients with acute chest pain in the emergency department. Am J Roentgenol 2011;196(4):853-861.
[14] Halpern EJ, Savage MP, Fischman DL, et al. Cost-effectiveness of coronary CT angiography in evaluation of patients without symptoms who have positive stress test results. Am J Roentgenol 2010;194(5):1257-1262.
[15] Min JK, Gilmore A, Budoff MJ, et al. Cost-effectiveness of coronary CT angiography versus myocardial perfusion SPECT for evaluation of patients with chest pain and no known coronary artery disease. Radiology 2010;254(3):801-808.
[16] Min JK, Kang N, Shaw LJ, et al. Costs and clinical outcomes after coronary multidetector CT angiography in patients without known coronary artery disease: comparison to myocardial perfusion SPECT. Radiology 2008;249(1):62-70.