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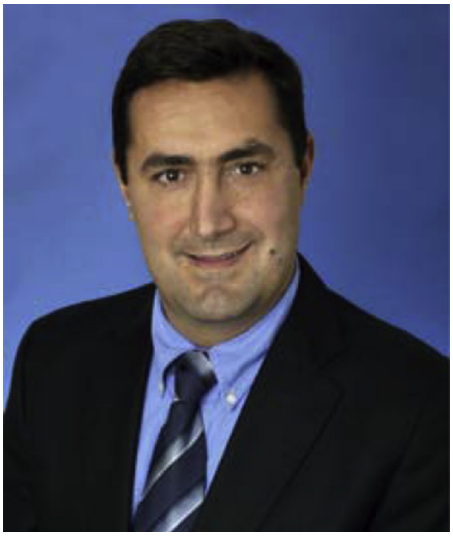
From the Desk of the President

President's page: Coronary CT angiography as a gatekeeper to the catheterization laboratory

Dear Colleagues,



A common practice in cardiology and medicine is to identify which patients who are presenting with stable chest pain symptoms actually have obstructive coronary artery disease (CAD). A detailed clinical history and physical examination are critical to determine the patient's pretest probability of CAD. Noninvasive diagnostic testing is commonly used, particularly in intermediate-risk patients, to determine which patients have abnormal findings for subsequent referral for invasive coronary angiography (ICA). The overall goal is to identify patients with obstructive CAD and/or myocardial ischemia who will benefit from coronary revascularization that may lead to improving clinical outcomes.

Patel et al[1] first reported a low diagnostic yield of elective ICA to detect obstructive CAD in the CathPCI Registry of the National Cardiovascular Data Registry involving almost 400,000 patients. Only 37.6% of patients had obstructive CAD, whereas 39.2% of patients were reported with no CAD (defined as <20% in all vessels). What is also alarming is that 83.9% of patients had a prior noninvasive testing, but a positive result on noninvasive testing had only limited effect on the C statistic model's predictive ability over and above the effect achieved from the addition of clinical risk factors and symptoms. Unfortunately, the information regarding noninvasive testing was lumped together in the article, but we can only assume that most patients assessed during the study period from 2004 to 2008 had noninvasive stress tests (predominantly, exercise and nuclear single-photon emission CT [SPECT]). The authors conclude from this large registry that current strategies, including clinical assessment of risk and the used noninvasive testing, are limited and that a substantial improvement in triaging patients to the cardiac catheterization laboratory is needed.

I was very intrigued by the recently subsequent published article by Patel et al[2] with the updated National Cardiovascular Data Registry data about prevalence of obstructive disease in the United States, as defined by ICA in 661,063 patients (even larger cohort than the previous study). The new data were accumulated from July 2009 to December 2011. First of all, the prevalence of obstructive CAD was reported as only 42%, which is still very low. Second, a preprocedure noninvasive test was performed in 64% of patients, with the vast majority undergoing stress testing with SPECT myocardial perfusion imaging (MPI) (78%). Only 2% had coronary CT angiography (CCTA). The patients who had noninvasive stress tests (including exercise stress test, stress echocardiogram, stress with SPECT MPI, and stress cardiac magnetic resonance [MR]) had a significantly higher rate of nonobstructive CAD compared with obstructive CAD by ICA ($P < .0001$). Specifically, the rate of obstructive CAD in patients undergoing stress SPECT was 44.5% and stress echocardiography was 43.8%. The only noninvasive imaging test that showed a significant better yield to triage patients to the catheterization laboratory was CCTA, where significantly more patients who underwent CCTA had obstructive CAD (69.6%) vs nonobstructive CAD (30.4%) by ICA ($P < .0001$). A modified and adapted table from the article is presented in the following text to illustrate these findings (Table 1). On the one hand, the poor performance of noninvasive stress testing

Table 1 – Findings among patients without history of CAD who had a noninvasive stress test before elective coronary angiography.

Noninvasive test	Patients, N = 387,633, n (%)	Obstructive CAD, N = 173,448, n (%)	Nonobstructive CAD, N = 214,185, n (%)	P
Standard exercise stress test	37,969 (100)	17,016 (44.8)	20,953 (55.2)	<.0001
Stress echocardiogram	44,829 (100)	19,651 (43.8)	25,178 (56.2)	<.0001
Stress testing with SPECT MPI	302,651 (100)	134,670 (44.5)	167,981 (55.5)	<.0001
Stress testing with CMR	2926 (100)	1331 (45.5)	1595 (54.5)	<.0001
Coronary CTA	8323 (100)	5791 (69.6)	2532 (30.4)	<.0001

CAD, coronary artery disease; CMR, cardiac magnetic resonance imaging; CTA, CT angiography; SPECT, single photon emission CT.
Table modified and adapted from Patel et al.[2]

(including exercise stress test, stress echocardiogram, stress with SPECT MPI, and stress cardiac MR) to properly triage patients to the catheterization laboratory is alarming, and the authors emphasize the need for improved diagnostic testing, particularly improvement in use of stress testing results. A subanalysis demonstrated that high-risk features of noninvasive stress testing could lead to a higher yield of detecting obstructive disease by ICA. On the other hand, CCTA performed well in these real world data, and was the only noninvasive test that had a significant impact as an effective gatekeeper to the catheterization laboratory.

The aforementioned data present to us a major opportunity to improve health care utilization. Multiple single-center, multi-center,[3–5] and meta-analysis trials[6–9] have now shown the extremely high negative predictive value of CCTA (~99%) and the ability to exclude obstructive disease, avoiding unnecessary downstream testing, including ICA. The sensitivity and specificity of CCTA are high with a moderately positive predictive value, mainly because of overestimation of stenosis, particularly in the presence of calcified plaques and motion artifacts. However, if CCTA is used as suggested by national guidelines in symptomatic low-to-intermediate-risk chest pain patients, then the ability to exclude disease will be more relevant while still preserving the high sensitivity to detect obstructive CAD in these patients. This strategy, using CCTA as a gatekeeper to the catheterization laboratory, was studied prospectively by Chinnaiyan et al[10] in 6198 patients without known CAD who were being treated at 47 centers in Michigan. All were referred for CT angiography (CTA) within 3 months of a stress test. Most had abnormal stress tests (58.5%), although 24.9% had normal and 16.6% had equivocal results. CTA testing found that only 18.7% of patients had obstructive CAD. Among the 621 patients who underwent invasive angiography, there was a strong correlation between the angiographic findings and CTA (odds ratio, 9.09; 95% confidence interval, 5.57–14.8; $P < .001$). But no such relationship existed between the results of angiography and stress testing (odds ratio, 0.79; 95% confidence interval, 0.56–1.11; $P = .17$). Shaw et al[11] studied 15,207 patients as part of the CONFIRM trial, with patterns of follow-up ICA after CCTA. During follow-up, ICA rates for patients with no CAD to mild CAD according to CCTA were low (2.5% and 8.3%). Conversely, obstructive CAD by CCTA was associated with higher rates of ICA for 1-vessel (44.3%), 2-vessel (53.3%), and 3-vessel (69.4%) CAD, respectively. Overall, these large study findings build a strong case to support the concept that CCTA may be used effectively as a gatekeeper to the catheterization laboratory.

Finally, the future is bright for cardiac CT. We are seeing careful validation of stress myocardial CT perfusion[12–17] and calculation of fractional flow reserve by CT (FFR-CT),[18,19] both noninvasive ways of using cardiac CT data sets to determine the hemodynamic significance of coronary stenosis. Single-center[14] and multi-center trials[16,17] have demonstrated the incremental diagnostic value of myocardial CT perfusion over CCTA to improve diagnostic accuracy to detect hemodynamically significant stenosis, mainly achieved with the increase of the positive predictive value and specificity. FFR-CT has recently demonstrated similar results in a number of multicenter trials.[18,19] Therefore, future studies and clinical pathways will have to validate CCTA with the combination of myocardial CT perfusion and/or FFR-CT data to demonstrate an even better noninvasive tool to properly triage patients to the catheterization laboratory, and even more importantly, to guide clinical decision making with the main goal of improving patient outcome.

In the meantime, we have a great noninvasive tool in CCTA, which can and should be used in appropriate patients to serve as an effective gatekeeper to the catheterization laboratory.

Warm regards,

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