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Commentary

Commentary on myocardial CT perfusion imaging and atherosclerotic plaque characteristics on coronary CT angiography for the identification of myocardial ischaemia

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Information about both luminal stenoses and their physiological significance is important in guiding revascularisation, but cannot be the whole story in coronary disease. Prognosis is principally determined by the risk of acute myocardial infarction, when an atheromatous plaque becomes unstable and triggers coronary thrombosis. Obstructive plaques are more vulnerable than non-obstructive ones, but the overall burden of the latter is so much greater that they account for the majority of events; however, certain adverse plaque characteristics on imaging predict an increased risk.[1]

In this edition of *Clinical Radiology*, Wang *et al.* report the results of a study using computed tomography (CT) to perform coronary CT angiography (CCTA) and stress dynamic myocardial perfusion in 36 patients.[2] They examined the ability of the presence or absence of coronary stenoses, inducible hypoperfusion, and plaque composition, alone and in combination, to predict the presence or absence of inducible hypoperfusion on stress ^{99m}Tc-sestamibi single-photon-emission computed tomography (SPECT). The patients studied represent a much higher risk cohort than is encountered in most imaging departments, and had a 75% prevalence of obstructive coronary disease: by comparison, the prevalence in the CT arm of the PROMISE trial was only 12%.[3] Therefore, the calculated diagnostic parameters need to be viewed with caution. The use of SPECT as a reference standard is questionable, even though it is widely used in clinical practice: the ^{99m}Tc-labelled perfusion tracers are physiologically imperfect and underestimate ischaemia compared with ^{15}O-H_2O used in positron-emission tomography.[4] Moreover, the failure to perform resting SPECT may have led to some attenuation artefacts being misclassified as ischaemia.

As anticipated, CCTA alone had high sensitivity but poorer specificity for predicting the results of SPECT: all perfusion defects ought to have an underlying coronary stenosis, but not all coronary stenoses will cause a perfusion defect. Being itself a functional test, CT perfusion alone was superior to CCTA against SPECT, and the combination of CCTA with CT perfusion performed hardly any better. Other studies have also shown that both static and dynamic CT perfusion perform well as functional tests, but the future of CT perfusion as a routine investigation may depend on practical considerations.[5,6] CT has become a popular first-line imaging method for suspected coronary disease because CCTA is simple, quick and can now be performed with acceptable radiation exposure (frequently $<$1 mSv on a modern scanner). In the study of Wang *et al.*, the mean effective dose equivalent for CT perfusion (using a 0.028 mSv/mGy·cm conversion factor) was 17 mSv. Given that the dose equivalent for stress SPECT using 400

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MBq of a ^{99m}Tc tracer is only 2–3 mSv, and that stress echocardiography and cardiac magnetic resonance imaging involve no ionising radiation, CT perfusion is at a significant disadvantage. Nevertheless, CT perfusion performed sequentially after CCTA conveniently avoids the need for a separate functional test in patients with obstructive disease, although it creates challenges for an overstretched CT department. Performing both investigations in every patient would expose most to unnecessary radiation whilst taking up valuable scanner time. On the other hand, targeted use of CT perfusion in those with obstructive disease would complicate scheduling and require all CCTAs to be read immediately. In practice, the use of computational fluid dynamics to derive a map of virtual fractional flow reserve from the CCTA acquisition may be a more practical way of generating functional information from a CT scanner than CT perfusion, and may be of equivalent value.[7]

The study offers an interesting insight into the interrelationship between stenosis severity, plaque composition, and physiology. The extent and severity of inducible ischaemia is known to be a powerful predictor of prognosis in patients with stable coronary disease, and is a surrogate for the overall burden of coronary stenoses and hence the total burden of atheroma; however, the findings of Wang *et al.* suggest a more direct link between inducible ischaemia and the risk of acute myocardial infarction. Adverse plaque characteristics were almost as sensitive as CT perfusion for the prediction of vessel-specific ischaemia on SPECT, albeit with lower specificity; moreover, they increased the specificity of CCTA. The suggestion of a direct link between the physiological significance of a luminal stenosis and its plaque composition (and hence its risk of becoming unstable) is consistent with previous observations.[8]

The study of Wang *et al.* reminds us of the complex interplay between coronary anatomy, physiology, and plaque composition. All three types of information can now be provided by a CT scanner, although it remains to be seen whether the addition of CT perfusion to CCTA is realistic in clinical practice.

Conflicts of interest

The author declares no conflict of interest.

References

1. Motoyama S, Sarai M, Harigaya H, *et al.* Computed tomographic angiography characteristics of atherosclerotic plaques subsequently resulting in acute coronary syndrome. *J Am Coll Cardiol* 2009;**54**:49–57.
2. Wang J, Chen H-W, Fang X-M, *et al.* Myocardial CT perfusion imaging and atherosclerotic plaque characteristics on coronary CT angiography for the identification of myocardial ischaemia. *Clin Radiol* 2019;**74**:763–8.
3. Hoffmann U, Ferencik M, Udelson JE, *et al*, PROMISE Investigators. Prognostic value of noninvasive cardiovascular testing in patients with stable chest pain: insights from the PROMISE trial (prospective multicenter imaging study for evaluation of chest pain). *Circulation* 2017;**135**:2320–32.
4. Danad I, Raijmakers PG, Driessen RS, *et al.* Comparison of coronary CT angiography, SPECT, PET, and hybrid imaging for diagnosis of ischemic heart disease determined by fractional flow reserve. *JAMA Cardiol* 2017;**2**:1100–7.
5. Rochitte CE, George RT, Chen MY, *et al.* Computed tomography angiography and perfusion to assess coronary artery stenosis causing perfusion defects by single photon emission computed tomography: the CORE320 study. *Eur Heart J* 2014;**35**:1120–30.
6. Bamberg F, Becker A, Schwarz F, *et al.* Detection of hemodynamically significant coronary artery stenosis: incremental diagnostic value of dynamic CT based myocardial perfusion imaging. *Radiology* 2011;**260**:689–98.
7. Pontone G, Baggiano A, Andreini D, *et al.* Stress computed tomography perfusion versus fractional flow reserve ct derived in suspected coronary artery disease: the PERFECTION study. *JACC Cardiovasc Imag* 2018, https://doi.org/10.1016/j.jcmg.2018.08.023 [Epub ahead of print].
8. Ahmadi A, Leipsic J, Øvrehus KA, *et al.* Lesion-specific and vessel-related determinants of fractional flow reserve beyond coronary artery stenosis. *JACC Cardiovasc Imag* 2018;**11**:521–30.