Comparing Myocardial Perfusion Imaging and Multi-slice Computed Tomographic Coronary Angiography: Leading to discrepancy or complementarity?

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Abstract

The aim of this review is the in depth evaluation of two different diagnostic modalities, Myocardial Perfusion Imaging (MPI) and Multi slice Computed Tomographic Coronary Angiography (MSCTA) for the assessment of coronary artery disease. MPI using single photon emission computed tomography (SPECT) seems to be a simple and accurate integrated method for the evaluation of coronary flow reserve, offering high diagnostic and prognostic information to define coronary artery disease risk. On the other hand MSCTA is a novel technique with excellent diagnostic sensitivity for identifying stenoses, providing also qualitative and quantitative information concerning atherosclerotic plaque composition. A few studies have reported direct comparison of the two methods. All previous publications , support the notion that the two diagnostic modalities provide divergent, but apparently complementary information. The pre test likelihood of CAD, patients' individual characteristics, as well as the advantages and disadvantages or limitations of each method should be taken into consideration prior to the performance of either imaging technique.

Key words: Myocardial Perfusion Imaging, Multi slice Computed Tomographic Coronary Angiography.

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Introduction

Atherosclerosis is by far the most frequent underlying cause of coronary, carotid and peripheral arterial disease (1). According to current estimates, 61 800 000 Americans develop one or more manifestations of cardiovascular disease (2), the leading cause of death in developed countries. Every year, over 1 million people in the United States and over 19 million worldwide experience an acute coronary syndrome, a large portion of whom had no prior symptoms (3, 4). Although considerable progress has been achieved in the field of cardiology, leading to significant decrease in morbidity and mortality caused by coronary atherosclerosis, coronary events continue to be the leading cause of death in the United States, accounting for >479 000 deaths (1 in 5 deaths) in 2003 (5). Among the various imaging techniques used for the evaluation of coronary artery disease, invasive coronary angiography (ICA) is currently considered as the "gold standard" for coronary artery lumen assessment, as indicated by its wide use in a continuously increasing number of patients during the last years (6). In 2003, about 2 million ICA procedures were performed only in Europe (7). Although complications are infrequent, the well known procedure-related morbidity inherent to cardiac catheterizations (8), in combination with the associated economic burden, the inconvenience of patients and the fact that an estimated 20 – 30% of coronary angiographies reveal normal coronary arteries or absence of significant stenosis (9), have intensified the quest for an alternative, non-invasive method for the assessment of coronary artery disease (9,10). On the other hand, ICA still remains the ideal technique for precise evaluation of the severity and location of coronary stenoses prior to angioplasty or by-pass surgery (11), although the invasive nature of the procedure discourages its application as a screening method. Today, a plethora of non-invasive techniques are available in a physician's diagnostic arsenal for the assessment of coronary artery tree pathology, as well as for the evaluation of myocardial function. The available

non invasive tests, including treadmill exercise test, stress echocardiography and myocardial perfusion imaging (MPI) are based on the interpretation of ECG abnormalities, myocardial wall motion and perfusion respectively, reflecting the underlying imbalance between myocardial oxygen demand and supply. The above mentioned tests have shown high correlation with coronary angiography and high prognostic value (i.e. ability to predict future coronary events) (12). Furthermore, the increasing use, during the past five years, of multi-slice computerised tomography (CT) for the detection of atherosclerosis in the coronary arteries has drawn wide scientific attention. Technical refinements, enabled by the ongoing transition from 16-slice to 64-slice CT coronary angiography, and the subsequent improvement of the acquired data render this novel technique a much promising non invasive test for the diagnosis of CAD, potentially launching a new era in the field of CAD evaluation. It should be noticed though, that the multiplication of diagnostic techniques for the evaluation of patients with known or suspected coronary disease, has revolutionized the every day clinical practice by offering many alternative choices, but on the other hand gave rise to conflicts and questions concerning the special role and utility of each diagnostic modality. Questions like: Which are the absolute or relative indications of each test, or who is the suitable candidate for a particular diagnostic procedure, or can a new imaging test like CT coronary angiography surpass the advantages of a well-established long standing technique such as ICA or MPI are common among physicians, committed to the implementation of evidence-based medicine. The aim of this review is to investigate the different modalities and especially the application of both the MSCTA and MPI in the evaluation of CAD, as the leading non-invasive methods, as well as to examine the possible discordance or complementary role of the above methods, based on evidence provided by existing comparative trials and current bibliography.

Myocardial Perfusion Imaging (MPI)

MPI using single-photon emission computed tomography (SPECT) constitutes an established method for the non-invasive diagnosis and prognosis of coronary artery disease (CAD) already included in all the professional guidelines (12). MPI not only exhibits considerably high diagnostic accuracy, about 85%, for the detection of CAD, but also enables evaluation of the functional consequences related to flow-limiting coronary stenosis (13). Additionally, it provides useful prognostic information for cardiac risk stratification, guiding the selection of patients who are expected to benefit from further therapeutic intervention. The fact that patients with documented CAD but normal MPI are at low risk for major cardiac events, comparable to these patients without CAD (13-19) is indicative of the considerable prognostic value of this technique.

In terms of diagnostic value, MPI represents a significant tool for the assessment of both acute and chronic chest pain, suggestive of coronary disease. The superior diagnostic accuracy of MPI compared to the exercise ECG is widely recognised in the cases of stable chest pain syndromes and chronic stable angina. Regarding the reported overall diagnostic accuracy of MPI, good quality studies exhibit sensitivity for angiographically defined CAD (>50 stenosis) as high as 90% and a normalcy rate of 89%. (13,20) Apart from its diagnostic accuracy, the indisputable value of the method lies mainly on the high prognostic value of myocardial perfusion imaging (15-18), apparently superior to the purely anatomical information derived by invasive (and recently non-invasive) angiography (14). Assessment of prognosis is crucial for the selection of optimal treatment in patients with either suspected or established coronary artery disease (19). Plenty of studies have already reported low incidence of major adverse cardiac outcomes in patients with normal MPI, associating a normal SPECT result, with an annual death or non-fatal myocardial infarct rate of <1% (21), a rate comparable to an intermediate-risk, asymptomatic cohort, irrespectively of the angiographically proven CAD (22). In 19 reports, a total of 39,173 patients had a median rate of major adverse cardiac events of 0.6% per year (23). On the other hand, the likelihood of future major cardiac events is significantly increased in the presence of myocardial perfusion abnormalities (20). As reported in a meta-analysis of 39 studies, the risk for major adverse cardiac events significantly differs among patients with high- and low-risk perfusion imaging studies over a follow up period of 2 to 4 years. In fact, a logarithmical increase of cardiovascular events is observed among individuals with abnormal MPI, which corresponds to an average 5- to 7-fold relative risk ratio elevation. From a total of 69,655 patients, the median annual rate of cardiac death or nonfatal myocardial infarction was 5.9% for those with high-risk SPECT results, compared to 1.2% for patients judged as low-risk (23).

On the basis of this evidence, post-test management can reliably be guided, according to the results of MPI. It is therefore obvious that aggressive management, mainly including coronary angiography and revascularisation, should be applied only to those individuals classified as high-risk patients.

The evidence-based selection of patients to be referred for a specific diagnostic procedure is entwined with the underlying risk in any given patient group. ?he estimation of pre-test risk is considered crucial for achieving maximal benefit in post test interpretation of the acquired information. According to current guidelines, a careful assessment of the pre-test likelihood of CAD should precede the use of MPI or any stress imaging study in general (24). Optimal selection of MPI candidates is based on Bayesian theorem, as initially developed by Diamond and colleagues (25, 26). Conclusively, a priori evaluation of the pre-test CAD likelihood determines who will benefit

by the added information acquired from a nuclear imaging examination. According to the American College of Cardiology/American Heart Association (ACC/AHA/ASNC) guidelines (13), which lie in accordance with European guidelines (27-29), myocardial perfusion imaging is most useful in patients with an intermediate likelihood of angiographically significant CAD, on the basis of age, sex, symptoms, risk factors, and the results of stress testing (for patients who are able to undertake a stress test- class I indications) (13). The reason is that in low-risk patients, the shift from pre-test to post-test risk estimation is minimal, making the application of MPI in this group of patients diagnostically ineffective and costly. On the other hand, many intermediate-risk patients may be shifted to lower- or higher risk cohorts, guided by the results of MPI. Patients reclassified as low-likelihood will still require modifications of cardiovascular risk factors, while patients who are reclassified as having a high likelihood of CAD, may become the suitable candidates for cardiac catheterization depending on the magnitude of the stress induced ischemia.

Additionally, MPI is also strongly indicated for the clinical evaluation of high likelihood for CAD patients. The extent of myocardial ischemia revealed by MPI study strengthens the indication that the patient would benefit from revascularization (PCI or CABG) (30), while a normal or slightly abnormal MPS study classifies them as low-risk patients concerning major cardiac events and no further invasive intervention needed (31, 32).

Multi-Slice Computer Tomography Coronary Angiography (MSCTA)

Cardiac CT is increasingly being used for the non invasive assessment of coronary arteries (33-35), supporting the general expectancy that non-invasive CT angiography could constitute an effective gatekeeper for conventional invasive coronary angiography (ICA) in a substantial number of patients.

MSCTA is an innovative and much promising non-invasive technique that enables visualization of coronary arteries with high precision and has a high sensitivity and specificity for detecting coronary stenosis (33-35). In particular, the negative predictive value of MSCT approaches 100%, thus making it an accurate test for excluding coronary atherosclerosis (36). The estimated sensitivity of 16- slice MSCT for the detection of significant stenoses compared to ICA has been reported to be around 88% and the specificity to rule out significant stenosis about 96% (37, 38), while the overall diagnostic accuracy of 64-slice Multi Slice Computed Tomography (MSCT), according to recent studies performing a head-to-head comparison between 64-slice MSCTA and ICA, reached a sensitivity of 91% and a specificity of 96% (39). Over the recent years, a rapid evolution of MSCTA technology, enabled by the transition from 4-slice MSCT into the current 64-slice MSCT technology (40), resulted in overcoming the image-degrading artifacts related to motion, pixel noise, dense calcification or coronary stents to a major extent (41). Indeed, 64-slice approach has lead to very high sensitivity and specificity for CAD evaluation, minimizing the number of uninterpretable coronary segments due to motion (41-44), enabling accurate diagnosis in patients with coronary calcification, tachycardia and obesity (38, 41, 45). In addition to the improved diagnostic accuracy, other advantages of 64-MSCT, compared to 16-slice MSCT, include decreased total scan time, facilitating shorter breath-holding, as well as decreased amount of contrast media, thus reducing the risk of contrast nephropathy and the other side effects.

Prognostic value of MSCTA

Apart from its diagnostic accuracy, few preliminary data exist on the prognostic value of this novel technique. As reported by Pundziute et al (46), identification of coronary atherosclerosis on MSCTA was associated with poor prognosis, predominantly among patients with obstructive coronary lesions, where risk of cardiac events was considerably higher. However, it is noteworthy that patients with non obstructive CAD exhibited elevated risk too, compared with patients without CAD. This might be attributed to the ability of MSCTA to depict not only lumen narrowing but also early, non-obstructive atherosclerotic lesions (47). Dorbala et al (48), postulate that unlike ICA, MSCTA not only assesses disease within the coronary lumen, but can also provide direct qualitative and quantitative information about non-obstructive plaque burden and its composition. This fact lies in accordance with previous studies supporting the notion that plaque composition in addition to the extent of lumen stenosis is predictive of future cardiac events. Lipid core size, minimal cap thickness and the presence of calcification are recognised as factors associated with plaque vulnerability (49), and are not necessarily related to absolute plaque size or degree of stenosis (50). Non-obstructive lesions, to some degree depictable by the application of MSCTA, as opposed to the conventional invasive "lumenography", are of undisputable clinical significance, potentially resulting in acute coronary syndromes, perhaps even for the majority of such events, considering that non-obstructive coronary atherosclerotic lesions are more frequent than severely obstructive plaques (51-55)

Additionally, MSCTA has the unique advantage of coronary calcium assessment (56,57), given that coronary calcium allows detection of atherosclerotic lesions often long before they become hemodynamically significant (56). The amount of coronary calcium, usually assessed with the Agatston method of calcium quantification and scoring, correlates strongly with the overall amount of coronary plaques (both calcified and non-calcified) as revealed by post-mortem examination (58). Coronary artery calcium score, assessed by electron beam computed

tomography (EBCT) or by MSCTA, has been used for risk stratification in patients with known or suspected CAD (46). A calcium score <100 has been associated with excellent outcome, with an increase in the event rate paralleling the increase in calcium score (46,59, 60). According to published guidelines, the coronary calcium score may help in identifying asymptomatic patients at low-to-intermediate risk, who may benefit from more aggressive risk factor modification (59,60). However, calcification implies atherosclerosis but not necessarily the presence of a stenosis. Although, the presence of coronary calcium is a sensitive test for the existence of coronary artery disease, is not specific for identification of significant coronary lumen narrowing (61-63).

The above finding is probably explained by a process referred as the "Glagov phenomenon" (64). According to this, during the early stages of atherosclerosis the formation of atherosclerotic plaques may initially result in the dilatation of the external elastic membrane of the vessel, thus producing little or no protrusion of the lesion into the vascular lumen, leading only to a limited lumen narrowing. Indeed, coronary luminal area was shown to be preserved during early plaque progression, as a result of internal elastic lamina expansion, phenomenon also known as "positive remodelling". The degree of stenosis is gradually magnified / intensified with the progression of atherosclerosis to the point that the plaque becomes evident by angiography. This pathophysiological aspect provides the explanation why the degree of stenosis does not always correlate with the incidence of acute coronary syndromes (65). As a result, according to the authors, estimation of total plaque burden by assessment of coronary calcium allows detection of early atherosclerotic lesions, often long before they become haemodynamically significant. In other words, coronary calcification implies atherosclerosis, not always resulting in lumen stenosis and reduced myocardial blood supply.

It must be mentioned however that certain conditions limit the applicability and diagnostic accuracy of MSCTA, among which tachycardia is the most common, often necessitating the administration of beta-blockers, in order to achieve a regular heart rhythm and a relatively low heart rate (usually less than 70 bpm). Aside from arrhythmias and tachycardia, resulting in diagnostic performance variation (66), a common misinterpretation cause is the presence of dense calcification of coronary arteries. A further limitation is the lack of patients' cooperation, since respiratory motion must be eliminated by breath holding for 10-20 secs. As far as radioprotection is concerned the relatively high radiation dose received with MSCTA, compared with ICA, is a disadvantage that cannot be ignored, despite the remarkable progress of successive generation of scanners.

Due to the repeatedly documented high specificity, high negative predictive value of MSCT coronary angiography (>95%) (36) and its consequent ability to rule out significant (i.e. obstructive) CAD, this innovative technique is still looking for its place in an algorithm concerning CAD diagnosis and management. A drawback in the majority of existing studies reporting on the diagnostic and prognostic value of MSCT CA concerns patient selection, since most trials include entirely, or to some extent, patients with high pre-test likelihood of CAD, in whom the gain in post-test likelihood of disease is minimal based on the Bayesian theorem (11), and invasive angiography is the method of choice (since an intervention may follow directly) over a non-invasive test.

Indications of MSCTA

MSCTA will potentially be embodied in the diagnostic approach of patients with an intermediate pre-test likelihood of CAD, who could become the most suitable candidates to be assessed by MSCTA. The identification of critical coronary stenoses in the proximal portions of the coronary arteries, would constitute indication for further assessment with catheter-based coronary angiography, possibly directly followed by percutaneus transluminal coronary angioplasty (PTCA) or coronary artery bypass grafting (CABG). On the other hand, depiction of a coronary artery tree with no abnormalities (no atherosclerosis) or without significant coronary calcification would necessitate no further evaluation. However, considering that MSCTA visualizes atherosclerosis, which does not necessarily result in ischemia, a substantial number, if not the majority, of stenoses depicted by coronary MSCTA will be of no hemodynamic significance.

Besides, the application of MSCTA could be the suggested examination as a second step in the evaluation of some patients with strong clinical suspicion of CAD despite an apparently normal MPI, or patients with discordance between nuclear and clinical or electrocardiography (ECG) responses to stress (56).

Additionally, MSCTA can also be used to further determine therapeutic strategies in patients with confirmed coronary artery disease who have undergone either CAGB or PTCA, considering that MSCTA exhibits a good specificity (96%) to rule out stenoses in the grafts, as well as excluding stent occlusion, but not in-stent restenosis (67,68).

Another potential of MSCTA may be the detection of coronary artery plaque content. The ability of CTA to distinguish between calcified and non-calcified atherosclerotic plaques, can lead to the evaluation of the "vulnerability" of atherosclerotic lesions (49), which, in association with coronary calcium score assessment, adds further prognostic value to this diagnostic method.

On the other hand, both limited availability and a number of technical issues concerning the quality of acquired data, limit the broad application of MSCTA as a first-step noninvasive diagnostic tool in patients with intermediate pretest likelihood of CAD. According to a recently published meta-analysis on the diagnostic performance of, as compared with conventional invasive coronary

angiography, MSCTA has some technical shortcoms, difficult to overcome in daily practice. This implies that only selected patients can be explored by MSCTA for CAD assessment (69). In light of this notification, MPI would remain the exam of choice for risk stratification and patient management.

Comparing MPI and MSCTA.

Few studies have directly compared MPI and MSCTA in terms of diagnostic accuracy, sensitivity, specificity, negative and positive prognostic values in the detection of CAD. These studies either perform a head to head, or vessel to vessel comparison of the above mentioned diagnostic modalities. An interesting point is that sensitivity and specificity are extracted from the results of ICA, which is considered to be the "gold standard" for the evaluation of CAD.

In a study by Schuijf et al, a cohort of 114 patients with predominantly intermediate pre test likelihood of CAD was evaluated, undergoing both tests within 30 days of each other (70). The two non-invasive imaging approaches were also compared with the results of ICA, which was performed in a subgroup of 8 patients. This study, in accordance with previews surveys, also confirmed the high diagnostic sensitivity of MSCTA, revealing an excellent agreement between MSCTA and ICA, as many as 52 out of 58 (90%) patients were correctly diagnosed concerning the grade of coronary artery obstruction. However, the study resulted in a distinct discrepancy to the MPI results, since only 45% (33 of 73) of patients with abnormal MSCTA showed perfusion abnormalities on stress SPECT study, while, among patients with normal MPI about 52% exhibited an occluded artery in MSCTA, indicating possibly that a normal MPI does not exclude coronary atherosclerosis (70, 48) and reversely, the identification of coronary atherosclerotic plaques is not necessarily synonymous with ischemia. The authors finally agree for the complementary role of the two modalities, suggesting the different information that can be obtained by each of them.

In another study by Hacker M et al. (71), 38 patients with known or with high suspicion of coronary artery disease were evaluated with both methods, while a subgroup of 30 patients had additionally ICA. Independent of the pre-test likelihood for CAD, the sensitivity, specificity, negative and positive predictive values of MSCTA in detecting the reversible perfusion defects seen on gated SPECT were 63%, 80%, 94% and 32%, respectively, in vessel based analysis and 71%, 62%, 72% and 60%, respectively, in patient-based analysis. The above results become more significant when high risk patients or severe stenoses (luminal narrowing ≥50%) were estimated. The above results are also supported by a previous clinical investigation performed by the same authors, concerning the functionally significant coronary artery lesions (72). The investigators conclude that MSCTA, when used for detecting functional myocardial ischemia, reached a positive predictive value of only 29% in a non selected study cohort, as defined by reversible perfusion defects on MPI. Even though the patient cohort was heterogeneous, including patients with known CAD after coronary surgery or intracoronary stenting, (reflecting however the diversity experienced in everyday clinical routine). On the other hand, MSCTA still had a very high negative predictive value (almost 100%) in excluding coronary artery stenoses in symptomatic patients. According to the study results (71), MSCTA failed to predict the functional relevance of coronary stenoses as it was depicted by MPI, but it gave precious complementary information concerning the grade and extent of atherosclerosis in coronary vessels.

Accuracy of 64-slice MSCTA for the detection of functionally significant coronary stenoses as assessed by myocardial perfusion SPECT, was also assessed by another study by Gaemperli et al (73), and performed in 100 consecutive patients. About 1302 coronary segments were examined by means of quantitative MSCTA revealing ≥50% stenosis in 15.2% and ≥75% stenosis in 8,5% of the coronary arteries. The accuracy of MSCTA for the detection of any (fixed and reversible) MPI defect was improved when a cut-off area stenosis was set at ≥75%. Additionally MSCTA yielded a sensitivity of 75%, a specificity of 90%, a negative predictive value of 93%, a positive predictive value of 68% and an accuracy of 87%, when the above cited criterion was fulfilled. In contrast with all the other papers, this study argues that MSCTA is a reliable tool to rule out functionally relevant CAD in a population with intermediate pretest likelihood of disease. It supports though the need that both tests should be performed in order to evaluate functional ischemia.

Discussion

Almost all the current studies reached the conclusion that when evaluating a patient with suspected or documented coronary artery disease, the purely anatomical information depicted by invasive or non-invasive angiography offers limited functional and prognostic data for evidence-based risk stratification and subsequent clinical management (14). The formation of atheromatous plaques is no longer considered a passive procedure of sub-endothelial lipid accumulation merely resulting in a space-occupying lesion protruding into the vessel lumen of the affected arteries. This notion is supported by the observation that vulnerable (= prone to rupture) plaques can be associated with a variety of stenosis severity, underlining that non obstructive lesions more frequently contribute to acute coronary events. In fact, myocardial infarction is usually attributed to mild or moderate coronary stenoses, considering that less obstructive plaques are more prone to rupture, compared to the severely obstructive plaques (51). In light of these data, the main interest has currently focused not only to the

depiction of the extent of coronary stenoses / lumen narrowing (by means of conventional or noninvasive coronary angiography), but also to the functional consequences of the decreased myocardial blood supply and the probability of a given atherosclerotic plaque to be ruptured and thus generate a (potentially fatal) acute coronary syndrome. Furthermore, vasomotor tone and coronary collateral flow, both of which are known to affect myocardial perfusion, cannot be assessed by merely assessing the severity of stenosis (48). Under these circumstances, MPI providing an estimation of coronary flow reserve seems to be a cost effective technique. Of course, MSCTA can provide useful information concerning the composition of atherosclerotic plaques (not being just a "lumenography" like invasive coronary angiography), failing though to define functionally relevant coronary stenoses.

Another important aspect is the selection of the suitable test for the appropriate patient, meaning that such a decision should be made on an individual basis. Several clinical questions to be answered should be taken into consideration, concerning the confirmation of suspected or the follow-up of already diagnosed coronary artery disease, the eligibility of revascularization as well as the limitations and contraindications of each diagnostic procedure. In patients with suspected CAD, the pre test likelihood of disease is considered as the most important determinant for the initial test use. Conventionally, these risk factors are aggregated into a global score, such as the Framingham Risk Score (FRS), which is expressed as a number reflecting the likelihood of CAD death or nonfatal myocardial infarction over a 10-year period (74). The FRS has been used both for risk assessment and the estimation of the need for aggressive antiatherosclerotic treatment among asymptomatic patients.

Regarding asymptomatic patients, a calcium score, as measured by means of Electron beam Computed Tomography or MSCTA, would probably be much more beneficial (48). In patients with low to intermediate (15-50%) pre-test likelihood for CAD, MPI has limited diagnostic accuracy in excluding CAD. In that case MSCTA could probably help to define the suitable treatment in symptomatic patients (48, 56). On the other hand, patients with intermediate to high (50% to 85%) pre-test likelihood for CAD, MPI could probably be the first step in the evaluation of CAD, since MSCTA appears to be less cost effective and with lower predictive value (32,40,75,76). In fact, evaluating the existence of viable myocardium, MPI, remains the procedure of choice - the absolute procedure in selecting patient for further ICA and revascularization (48). MSCTA could probably solve problems arising from any discrepancy of the other diagnostic modalities, such as MPI and treadmill exercise test (56). Concerning patients in high risk for CAD, the use of both diagnostic procedures, i.e. MPI and MSCTA would be the optimal, since MSCTA excludes the diagnosis of atherosclerosis whereas MPI excludes ischemia (48). The identification of critical coronary stenoses in the proximal portions of the coronary arteries would indicate further assessment with catheter-based coronary angiography, possibly directly followed by PTCA or CABG. On the other hand depiction of the coronary artery tree with no abnormalities (no atherosclerosis) or significant coronary calcification would necessitate no further evaluation. However, considering that MSCTA visualizes atherosclerosis, which does not necessarily result in ischemia, a substantial number, if not the majority, of stenoses depicted by coronary MSCTA will be of uncertain hemodynamical significance. In that case, the combination of the anatomic information of atherosclerosis with functional information arising from an "ischemia-test" (nuclear imaging or stress echocardiography) would be required to clarify the hemodynamic consequences and avoid unnecessary interventions, the so-called oculo-stenotic reflex (77).

Conclusion

In summary, the comprehension of the data derived by the use of coronary angiography (invasive or not) and cardiac radionuclide imaging is of paramount importance in order to avoid misinterpretations of the "discrepancies" of the two diagnostic modalities. Coronary angiography is the ideal technique for assessing epicardial coronary anatomy, namely the extent of lumen stenosis. On the other hand, MPI is the standard technique for assessing myocardial ishemia and thus the potential physiological significance of the depicted coronary lumen stenosis (43). As a consequence, discordance between coronary anatomy and myocardial perfusion should not be considered as a diagnostic weakness of either. The application of MPI by definition does not predict merely the presence of epicardial coronary disease. The depiction of inducible perfusion abnormality indicates impaired perfusion reserve, usually corresponding to epicardial coronary artery stenosis, while its location and extent provide unique diagnostic and prognostic information. Conversely, normal stress MPI indicates the absence of clinically significant myocardial ischemia and a very low incidence of future cardiac events, even in patients with angiographically proven CAD. Large prospective trials are still needed to evaluate the impact of SPECT and MSCTA on outcomes, usefulness and cost. Until then, many clinical questions concerning the necessity, utility or the right sequence of both tests will remain under scrutiny.

Conflict of interest

This review was written independently. The authors did not receive any financial help with the preparation of the manuscript.

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