

## Coronary Artery Disease: Toward the End of A Binary Era?

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Since the inception of coronary arteriography in the sixties[1], followed by coronary angioplasty[2] and stenting twenty years later, we live in a binary era : The diagnosis and treatment of Coronary Artery Disease (CAD) is focused on establishing whether a patient has or has not a significant stenosis. One usually considers as significant a stenosis reducing the luminal diameter of the vessel by 50% or more. In the vast majority of cases, patients with significant stenosis will undergo coronary stenting or bypass surgery.

Such a binary approach - the stenosis is significant or not- has tremendous advantages. First, it is easily understandable. Second, it is driven by therapeutic decision making which, in essence, is binary; one can only insert a stent, or not, there being no intermediate pathway. Third, such an approach is logical; it makes sense to try to eliminate a stenosis once it has reached a critical degree.

But the world is changing. Twenty years ago, 50% of the patients referred to a busy SPECT imaging department such as ours had an abnormal result, showing some degree of ischemia, infarction, or a mixture of both.

Today, that number has dropped to 10-15%. Thanks to the important developments of Computed Tomography (CT), we tend to systematically perform calcium scoring in patients with a normal SPECT; half of these patients have a positive result, i.e., they have calcified coronary arteries [3]. As our medicine is improving, we tend to diagnose disease at a much earlier stage.

Atheroma of the coronary arteries, when resulting in a less than 50% reduction of the luminal diameter, is called non-significant. Words have a profound impact on humans, and a non-significant stenosis is considered as a stenosis that has no importance, no meaning.

As indicated above, a number of people have atheroma of their coronary arteries without having a significant stenosis ; it is important to note that their risk can be higher than 30% at ten years if calcium score exceeds 1000, a non-exceptional finding[4].

Therefore, a non-significant stenosis signifies something actually; it carries a risk.

Because healthcare has improved, coronary disease today is addressed at a much earlier stage than it was before. Incidentally, this makes our approach evolve from a binary to a non binary strategy

In this editorial, we would like to underline the importance of focusing on risk evaluation, knowing that risk is a continuous and not a discrete variable; risk does not go by yes-or-no.

In contradiction with what common sense would dictate, most stenosis leading to acute coronary syndromes, such as infarction or death, are not severe. It is our current belief that the more severe the stenosis, the higher the risk. The available literature does not validate this logic. Some critical lesions can be dangerous, but some others, in the range of 20-40% stenosis, can also lead to clinical dramas. [5]The relationship between the degree of a coronary stenosis and the risk of acute event is complex, but certainly not linear.

What is now well established, on the other hand, is the close relationship between the extent of coronary atheroma and the risk of event. The higher the total volume of coronary plaques, the higher the risk. This has been thoroughly demonstrated in tens of thousands patients over the past 15 years with Calcium Scoring, a quantitative assessment of coronary calcified plaques obtained with a non-contrast CT. [6] These numerous trials have shown that the risk increases in parallel with calcium score, once again in a continuous fashion, not a binary one.

Coronary calcium scores provide a significant improvement in the assessment of individual risk when compared to traditional risk factors. People with zero calcium score have an extremely low risk - in the range of 1/1000 per year. As an example, a 45 years old patient with a > 100 calcium score has a higher risk than a 75 years old patient with a 0 calcium score.

It should be noted that calcium score has no ambition to assess

coronary stenosis severity. It is, on the other hand, a strong reflection of the total atherosclerotic burden of the coronary arteries, which—independently of the severity of any underlying coronary stenosis—is a major predictor of coronary events.

More recent studies have extended the concept to non-calcified plaques, and total plaque volume, thanks to the development of CT angiography. An impressive number of studies have been devoted to the characterization of high risk plaques, but not all patients with Acute Coronary Syndromes (ACS) have high risk plaque, and many patients with a high risk plaque do perfectly well. In the end, the most significant, reproducible and robust criteria for stratifying the risk remains the number of plaques and the volume of atherosclerotic burden in a given patient.

From a biological standpoint, what is consistently found in the vast majority of ACS, however, is a pattern of inflammation/high thrombotic state. [7] If I may dare a comparison, imagine a thunderstorm over a small village in the mountain. If there are only 3 chalets in the village, the odds for one of these chalets to be destroyed by the lightning thunder are low. But if there are 500 chalets, one of them will most probably be struck by the lightning thunder. Of course if the chalet is big, and if its roof is made of steel, the odds are even higher. But at the end of the day, what matters most is the number of chalets, the number of targets.

None of these parameters - the extent of coronary atheroma or the risk of future heart attacks - is a binary one. They actually are continuous variables that can be quantified using coronary calcium scoring combined with traditional risk factors.

Such evidence, leading to a continuous approach paradigm for the management of CAD, should not generate frustrations in the medical community; the non-invasive handling of CAD has a tremendous efficacy [8,9]. Smoking cessation can lead to a 50% reduction of cardiac death. A proper diet carries a 20-30% reduction of the risk of death, and the simple fact of drinking one or two glasses of wine per day can reduce the risk of cardiac death by 15%. Regular exercise has been shown to improve both the quality and duration of life, whereas several drugs can also reduce the risk of death by approximately 15% in the general population.

These numbers result from large non-selected surveys. The efficiency of such preventive action is probably much higher in selected populations - those at high risk - and potentially much lower in people who are spontaneously at low risk. Actually, a continuous gradient of risk exists, which can or should be matched by an appropriate gradient of preventive actions and treatments. The current knowledge about what should be done in terms of physical exercise and dietetics, for instance, is in its

early stage. In the upcoming years, more specific information should be available from genomics and big data computing, permitting to answer questions about the type, intensity, and duration of exercises recommended for each of us, with the same kind of information available for food. No doubt, these algorithms will be fairly complex. But, simply put, they might transform the way we live.

Identifying a significant coronary stenosis remains of paramount importance to revascularize patients who need it. But cardiology is evolving toward a more preventive action. Thanks to CT, it has been clearly established over the past few years that non-significant stenosis do signify something in terms of risk. Atheroma of the coronary arteries should be diagnosed, quantified and treated as early as possible. This non-binary approach represents a change in our mindset, but it might lead to a considerable advance in the management of patients with coronary artery disease.

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