Committee Report 17

Diagnosis of Atherosclerosis

Executive Summary of the Japan Atherosclerosis Society (JAS) Guidelines for the Diagnosis and Prevention of Atherosclerotic Cardiovascular Diseases in Japan – 2012 Version

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From the perspective of preventing atherosclerotic cardiovascular disease (CVD), it is essential to determine the presence or absence and degree of atherosclerosis before the development of clinical symptoms and to manage or treat risk factors in order to prevent progression or achieve regression of disease. It is necessary to diagnose whether atherosclerosis is present, and if so, to what extent. The diagnostic techniques for atherosclerosis employed in the primary prevention of CVD should be noninvasive. In secondary prevention, however, the use of invasive diagnostic techniques, including angiography, is necessary. Currently, morphological imaging tests are predominantly used to assess the presence and degree of atherosclerosis.

1. Ultrasonography

Noninvasive imaging tests include body surface ultrasonography (a high-frequency probe of ≥7 MHz), which enables observation of the degree of stenosis and plaque formation (localized atherosclerotic lesions) in the peripheral arteries, such as the carotid arteries and arteries of the lower extremities. In particular, in the carotid arteries, ultrasonography is used to determine the degree of stenosis quantitatively and detect vulnerable plaques that could cause cerebral embolism, thereby assessing the degree of systemic atherosclerosis and/or functioning as an alternative predictor of the presence or development of CVD (e.g., coronary artery disease (CAD), peripheral arterial disease (PAD) or cerebrovascular disease)\(^1,2\). The existence of plaques and intima-media complex thickness (IMT) is often used as a measurement index on carotid ultrasonography\(^3\). Ultrasonography is also useful for making the diagnosis of atherosclerotic renal artery stenosis\(^4\).

2. Computed Tomography (CT)

Multidetector row CT (MDCT) offers superior imaging speed and spatial resolution and enables visualization of the coronary arteries following the injection of contrast medium into peripheral veins. This technique is starting to replace coronary angiography as a diagnosing test for CAD. In particular, it is superior in specificity\(^5-8\), and if no abnormalities are detected using this technique, the existence of organic coronary stenosis can be almost completely ruled out. In addition, this technique allows for visualization of coronary plaques, and the degree of calcification and fat and fiber content can also be estimated to some extent based on the CT number.

3. Magnetic Resonance Imaging (MRI) and MR Angiography (MRA)

MRA is used to visualize the cerebral/carotid arteries, aorta and renal arteries and enables the visualization of coronary stenotic lesions.

4. Angiography

Invasive diagnostic imaging techniques include angiographic evaluations of the degree of stenosis, which remains a central diagnostic technique for assessing arterial stenosis. The degree of arterial stenosis (the stenosis rate) is represented by the formula \((D−S)/D \times 100\)% , where \(D\) is the intravascular luminal diameter at the site proximal to the site of stenosis that appears to be normal and \(S\) is the luminal diameter at the site of stenosis. However, because intimal thickening is more or less observed even at sites that appear to be normal, the stenosis rate is underestimated considering the amount of the plaque volume. Because
plas are usually eccentric and the intravascular luminal diameter is therefore not a precise circle, there are limitations in the ability to determine the stenosis rate based on one cross-section. If there is compensatory vascular remodeling, the blood vessel may not be considered to exhibit luminal stenosis even if the plaques are well-formed; thus, there are severe limitations in establishing the plaque volume using this technique.

5. Intravascular Ultrasound (IVUS)

IVUS is a technique used to observe the arterial wall from the arterial lumen using an ultrasound device. It enables the evaluation of both the plaque volume and the properties of the plaques.

6. Angioscopy

Angioscopy is a technique used to observe the color of the plaque surface and estimate the properties of plaques.

7. Physiological Tests

Diagnostic techniques other than morphological tests include physiological tests, such as the brachial-ankle pulse wave velocity (baPWV) and cardio-ankle vascular index (CAVI). Although these parameters are easily determined by measuring the pulse wave in the extremities using a dedicated device, it should be noted that the values function as indices of artery stiffness and do not always reflect the presence of atherosclerosis. The ankle-brachial blood pressure index (ABI), can be used to diagnose PAD in the lower extremities (<0.9 or ≥1.3). The techniques used to measure the vascular endothelial function impaired in the early stage of atherosclerosis include flow-mediated vasodilation (FMD), which measures and calculates changes in the vascular diameter following ischemic reactive hyperemia of the extremities using ultrasound, and strain gauge plethysmography, which electrically observes and measures changes in the volume of the arterial blood flow in the extremities as changes in the circumference using a strain gauge. However, the use of these techniques is quite limited in general practice.

If a diagnosis of CAD, particularly effort angina, is suspected, the following noninvasive tests are useful.

8. Exercise Electrocardiography

Exercise electrocardiography has been shown to have a sensitivity of approximately 70% and a specificity of approximately 75% for detecting significant coronary stenosis, neither of which are superior; however, since the procedure can be easily performed at a low cost, it is widely used. Because myocardial ischemia can be induced, it is important to keep in mind the risk of possible cardiac events, including ventricular fibrillation and sudden death, when performing this technique.

9. Myocardial Perfusion Scintigraphy

This technique is widely used in the diagnosis of CAD to assess disease severity, myocardial viability and the prognosis and aids in decision making concerning therapeutic strategies. It is also used to screen for significant coronary stenosis, is relatively minimally invasive and may be a useful monitoring test for preventing atherosclerosis. Stressors include exercise stress, dipyridamole stress and adenosine stress. This technique has been shown to have a sensitivity of 80% to 90% and a specificity of 70% to 95% for detecting significant coronary stenosis.

At present, ultrasonography is a minimally invasive, simple and easy-to-use test for diagnosing atherosclerosis. Coronary CT, exercise electrocardiography and myocardial perfusion scintigraphy are noninvasive and useful diagnostic techniques in cases in which a diagnosis of CAD is suspected.

Footnotes

This is an English version of the guidelines of the Japan Atherosclerosis Society (Chapter 17) published in Japanese in June 2012.

Acknowledgements

We are grateful to the following societies for their collaboration and valuable contributions: Dr. Hide-nori Arai (The Japan Geriatrics Society), Dr. Kiminori Hosoda (Japan Society for the Study of Obesity), Dr. Hiroyasu ISO (Japan Epidemiological Association), Dr. Atsunori Kashiwagi (Japan Diabetes Society), Dr. Masayasu Matsumoto (The Japan Stroke Society), Dr. Hiromi Rakugi (The Japanese Society of Hypertension), Dr. Tetsuo Shoji (Japanese Society of Nephrology) and Dr. Hiroaki Tanaka (Japanese Society of Physical Fitness and Sports Medicine). We also thank Dr. Shinji Koba, Dr. Manabu Minami, Dr. Tetsuro Miyazaki, Dr. Hiroshi Ohmura, Dr. Mariko Harada-Shiba, Dr. Hideaki Shima, Dr. Daisuke Sugiyma, Dr. Minoru Takemoto and Dr. Kazuhisa Tsukamoto for supporting this work.
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