Editorial

http://dx.doi.org/10.4070/kcj.2013.43.3.152
Print ISSN 1738-5520 • On-line ISSN 1738-5555

kcj
Korean Circulation Journal

Usefulness of Coronary Computed Tomography Angiography Evaluating the Clinical Importance of Coronary Artery Calcium and Noncalcified Plaque in Asymptomatic Patients

Young Joon Hong, MD

Division of Cardiology, Department of Internal Medicine, Chonnam National University Hospital, Gwangju, Korea

Refer to the page 154-160

Introduction

Direct noninvasive assessment of the characteristics of coronary atherosclerotic plaques is important to improve cardiovascular risk stratification and to monitor the course of coronary artery disease. Coronary computed tomography angiography (CCTA) has become an effective tool for noninvasive evaluation of coronary artery calcium and plaque components.[1)]

Using CCTA, atherosclerotic plaques can be divided into calcified and non-calcified sub-types based on density measurements. Non-calcified plaques (NCP) consist of fibrotic, fibro-fatty and necrotic subtypes. Accurate detection and quantification of atherosclerotic plaques-both calcified and noncalcified-are needed to improve risk stratification and monitor the progression or regression of the disease. Compared to calcified plaques (CP), NCPs are associated with increased risk of acute coronary syndromes.

The prevalence of NCP identified by CCTA is not relatively low in asymptomatic patients without coronary artery calcium. However, clinical risk factors and prognostic significance of NCP in asymptomatic patients without coronary artery calcium are not well known.

Correspondence: Young Joon Hong, MD, Division of Cardiology, Department of Internal Medicine, Chonnam National University Hospital, 42 Jaebong-ro, Dong-gu, Gwangju 501-757, Korea
Tel: 82-62-220-5778, Fax: 82-62-223-3105
E-mail: hyj200@hanmail.net

• The author has no financial conflicts of interest.

In this editorial, we summarized the usefulness of CCTA to evaluate the importance of coronary artery calcium and NCP in asymptomatic patients.

Classification of Coronary Atherosclerotic Plaque by Coronary Computed Tomography Angiography

The computed attenuation coefficient is displayed as the CT number relative to the attenuation of water {0 Hounsfield units (HU)} and air (-1000 HU). NCP is defined as any clearly discernible structure that could be assigned to the coronary artery wall with a CT density of less than 130 HU but greater than the surrounding connective tissue. CP is defined as any structure with a density of 130 HU or more that could be visualized separately from the contrast-enhanced coronary lumen. There is strong evidence that the presence and extent of CP is independent and incremental to traditional risk assessment in predicting cardiovascular events.[4)] While assessment of CP is performed using noncontrast coronary CT imaging, recent data indicate that contrast-enhanced data acquisition using advanced multidetector CT permits the detection of NCP in addition to CP in good agreement with intravascular ultrasound.[2)]

Clinical Importance of Calcium and Non-Calcified Plaques

The total amount of coronary artery calcium is well established as a strong predictor of future cardiovascular events. Several studies have reported the prevalence of NCP to be from about 5% to 20% in asymptomatic patients without coronary calcium.[3-8)] In the middle-aged predominantly male population of the South Bay Heart Watch study,[3)] the absence of coronary calcium deposit evidenced by a zero coronary artery calcium score (CACS) by CCTA was associated with a 6% 10-year coronary heart disease (CHD) risk. In older men and women of the St. Francis Heart study,[4)] evidence of

zero CACS was associated with a 1% 10-year CHD risk. Cho et al.[7] evaluated the association between standard risk factors and NCP and the prognosis of NCP in middle aged asymptomatic subjects with CACS was zero using non-invasive CCTA. Among a total of 4491 asymptomatic individuals with a CACS of zero, 313 subjects (7%) had NCP; age, male gender, diabetes mellitus, hypertension, and dyslipidemia were independent predictors of NCP, and there was no clinical event after 90 days from index CCTA during a median follow-up duration of 22 months in both the NCP group and the non-NCP group. The results of the manuscript by Cho et al.[7] suggested that traditional risk factors are related to the progression of NCP, but this NCP is not associated with the development of future cardiovascular events in asymptomatic subjects with a CACS of zero.

Individuals with a CACS of zero have not yet developed detectable calcified coronary plaques, but they may display fatty streaking and early stages of plaque along with the presence of obstructive disease. Although previous studies have indicated that the amount of CP is highly related to the overall plaque burden, it represents only approximately 20% of the total atherosclerotic plaque burden and is thought to be present in the advanced stages of atherosclerosis within individual plaques. On the other hand, NCP is considered to be a feature of early atherosclerosis. Furthermore, there is growing evidence suggesting that NCP may be associated with acute coronary syndrome.[8] Yoo et al.[9] reported that the prevalence and severity of NCP were significantly higher in asymptomatic subjects having low CACS (men with CACS from 1 to 50 and women from 1 to 10) compared with those having a CACS of zero, and cardiac event rates were significantly higher in the low CACS group compared with those in the zero CACS group (2.6% vs. 0.27%) during a median follow up of 42 months. Aggarwal et al.[10] reported that the presence of NCP on CCTA was associated with more risk factors, especially smoking, obesity, and hypertension, in patients with a CACS of zero. Moreover, NCP can result in severe coronary stenosis, and NCP may identify patients with late cardiac events in patients with a CACS of zero {no events in the no NCP group, 2/54 (3.7%) events in the NCP without severe stenosis group (one sudden cardiac death and one ventricular tachycardia), and 2/5 (40.0%) patients in the NCP with severe stenosis group had revascularization}. A CACS of zero is another type of variant of low near-term risk for coronary events. However, this does not mean that lesions with a CACS of zero do not have coronary atherosclerosis, so we need to determine the prevalence and the severity of coronary atherosclerosis including NCP in patients with a CACS of zero.

Conclusion

The future risk of developing major adverse cardiac events in patients with a CACS of zero seems to low, even if the frequency of NCPs is too high to be ignored and NCPs are susceptible to rupture resulting in coronary artery thrombosis. Therefore, patients who have cardiovascular risk factors and a CACS of zero need to be evaluated with large-scaled study for the determination of NCP's clinical impact on patient outcomes.

References

1. Achenbach S, Moselewski F, Ropers D, et al. Detection of calcified and noncalcified coronary atherosclerotic plaque by contrast-enhanced, submillimeter multidetector spiral computed tomography: a segment-based comparison with intravascular ultrasound. *Circulation* 2004;109:14-7.
2. Budoff MJ, Achenbach S, Blumenthal RS, et al. Assessment of coronary artery disease by cardiac computed tomography: a scientific statement from the American Heart Association Committee on Cardiovascular Imaging and Intervention, Council on Cardiovascular Radiology and Intervention, and Committee on Cardiac Imaging, Council on Clinical Cardiology. *Circulation* 2006;114:1761-91.
3. Greenland P, LaBree L, Azen SP, Doherty TM, Detrano RC. Coronary artery calcium score combined with Framingham score for risk prediction in asymptomatic individuals. *JAMA* 2004;291:210-5.
4. Arad Y, Goodman KJ, Roth M, Newstein D, Guerci AD. Coronary calcification, coronary disease risk factors, C-reactive protein, and atherosclerotic cardiovascular disease events: the St. Francis Heart Study. *J Am Coll Cardiol* 2005;46:158-65.
5. Tuzcu EM, Kapadia SR, Tutar E, et al. High prevalence of coronary atherosclerosis in asymptomatic teenagers and young adults: evidence from intravascular ultrasound. *Circulation* 2001;103:2705-10.
6. Cheng VY, Lepor NE, Madyoon H, Eshaghian S, Naraghi AL, Shah PK. Presence and severity of noncalcified coronary plaque on 64-slice computed tomographic coronary angiography in patients with zero and low coronary artery calcium. *Am J Cardiol* 2007;99:1183-6.
7. Cho I, Suh JW, Chang HJ, et al. Prevalence and prognostic implication of non-calcified plaque in asymptomatic population with coronary artery calcium score of zero. *Korean Circ J* 2013;43:154-60.
8. Fujii K, Kobayashi Y, Mintz GS, et al. Intravascular ultrasound assessment of ulcerated ruptured plaques: a comparison of culprit and nonculprit lesions of patients with acute coronary syndromes and lesions in patients without acute coronary syndromes. *Circulation* 2003;108:2473-8.
9. Yoo DH, Chun EJ, Choi SI, et al. Significance of noncalcified coronary plaque in asymptomatic subjects with low coronary artery calcium score: assessment with coronary computed tomography angiography. *Int J Cardiovasc Imaging* 2011;27 Suppl 1:27-35.
10. Aggarwal NR, Knickelbine T, Tande A, Stoltzfus L, Lesser JR, Schwartz RS. Noncalcified plaque: relationship between results of multislice computed tomography, risk factors, and late clinical outcome. *Catheter Cardiovasc Interv* 2011;78:1116-24.

 http://dx.doi.org/10.4070/kcj.2013.43.3.152