Correlation between Uric Acid Level and the Severity of Coronary Atherosclerosis and Plaque Composition Detected by Multi-Detector Computed Tomography

Thesis

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بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا إلا ما علمتنا إنك أنت العليم الحكيم

صدق الله العظيم

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List of Contents

Title	Page No.

List of Tables

List of Figures

Fig. No.	Title	Page No.

List of Figures cont...

List of Abbreviations

Abb.	Full term
ACS	Acute coronary syndrome
CAC	Coronary artery calcium
CACS	Coronary artery calcium score
CACTI study	Coronary artery calcification in Type 1 DM study
CAD	Coronary artery disease
CCTA	Coronary computed tomography angiography
CHD	Coronary heart disease
CT	Computed Tomography
CTA	Computed tomography angiography
CV	Cardiovascular
CVD	Cardiovascular diseases
DM	Diabetes Mellitus
ECG	Electrocardiogram
H.U.	Hounsefiled unit
IVUS	Intra-vascular ultrasound
MDCT	Multi-detector computed tomography
MSCT	Multi-slice computed tomography
PCI	Percutaneous coronary intervention
STEMI	ST-segment Elevation Myocardial Infarction
UA	Uric Acid

Abstract

In the evaluation of patients with suspected coronary artery disease (CAD), the role of non-invasive imaging has increased exponentially over the past decades, particularly in patients with an intermediate likelihood of CAD.

Multi-detector computed tomography (MDCT) has emerged as a powerful tool for accurate non-invasive assessment of CAD whenever "appropriate". It has a high sensitivity and specificity for diagnosis and risk assessment of CAD if used appropriately and with proper patient selection.

MDCT allows assessment of CAD by two methods, namely calcium screening and CT angiography. The recent developments expanded the scope of cardiac CT to allow, not just visualization of the coronary artery lumen and detection of stenosis, but also detection and quantification of different types of atherosclerotic plaques, which was shown to have a prognostic value by determining the "vulnerable" plaques which are more liable to cause acute coronary syndromes (ACS), and thus associated with increased mortality.

Meanwhile, preventive cardiology has emerged as a promising branch in recent decades. It focuses mainly on determining the risk factors for CAD and dealing with the "modifiable" risk factors to decrease the burden of CAD. Smoking, obesity, diabetes, hypertension and dyslipidemia are among the well-known modifiable CV risk factors.

Since the beginning of the 20th century, uric acid (UA) has been suggested as a CV risk factor, and numerous studies were conducted to determine its actual relationship to CAD, which is still in fact a matter of debate.

Key words: Acute coronary syndrome- Coronary artery calcium- Coronary artery disease- Computed Tomography- Diabetes Mellitus- Electrocardiogram

INTRODUCTION

Cardiovascular diseases (CVD), and particularly coronary heart disease (CHD), remain the leading cause of mortality worldwide, despite recent substantial declines. It is clear that progress in reducing the burden of CVD depends on early identification of its risk factors. Over the past few years, remarkable progress has been made in determining new risk factors for cardiovascular disease [(1)].

The majority of CVD is caused by risk factors that can be controlled, treated or modified, such as high blood pressure, cholesterol, overweight/obesity, tobacco use, lack of physical activity and diabetes. However, there are also some major cardiovascular (CV) risk factors that cannot be controlled. These non-modifiable risk factors include age, gender and family history.

Since the beginning of the Twentieth century, uric acid (UA) has been suggested as a risk factor for CVD. Some clinical evidence has found a significant and specific association between serum UA levels and coronary atherosclerosis; however there is much controversy concerning this relationship, and some studies in fact came to the opposite conclusion [(1)].

Coronary computed tomography angiography (CCTA) allows coronary artery visualization and the detection of coronary stenosis. In addition; it has been suggested as a novel, noninvasive modality for coronary atherosclerotic plaque detection, characterization, and quantification.

CCTA is typically performed on multi-detector computed tomography (MDCT) systems after the injection of iodine contrast media for opacification of the lumen. To some degree, plaques can be classified based on their typical visual appearance. Based on the relative amount of calcified and non-calcified components, plaques are usually classified into 1 of 3 categories: non-calcified, calcified, or partially calcified “mixed” plaque. (2)

Early CT-based retrospective studies indicated that coronary plaques responsible for acute coronary syndrome (ACS) have larger vessel areas, more positive remodeling, and less overall calcification, compared with non-culprit lesions. Several small studies consistently showed that culprit lesions in ACS had a higher proportion of positive remodeling and higher remodeling index. In addition, culprit lesions had a higher proportion of non-calcified and partially calcified components, and they had lower overall attenuation values. (3)

Huang et al. in ***2010*** compared plaque characteristics in patients with ACS with ST-segment elevation versus those without ST-segment elevation and showed that the presence of ST-segment elevation was associated with greater plaque burden, higher remodeling index, and lower plaque attenuation values. (4)

In ***2011***, ***Ahmadi et al.*** demonstrated that CT-derived plaque type had important predictive value, showing that mortality incrementally increased from calcified plaque (1.4%) to partially calcified plaque (3.3%) to non-calcified plaque (9.6%). (5)

Since recent studies have demonstrated that UA could be one of the important modifiable CV risk factors, and that coronary atherosclerotic plaque composition has important predictive value; this study was designed to evaluate whether serum UA can be used to determine the type of atherosclerotic plaques shown by multi-detector computed tomography (MDCT) of the coronary arteries.

AIM OF THE WORK

1- To study the relationship between uric acid level and the presence of atherosclerotic coronary artery diseases.
2- To evaluate whether serum uric acid is associated with the severity of coronary atherosclerotic plaques shown by MDCT.
3- To correlate between serum uric acid level and the morphology & composition of coronary atherosclerotic plaques shown by MDCT.

Chapter I

IMAGING OF CORONARY ATHEROSCLEROSIS BY COMPUTED TOMOGRAPHY

Computed tomography (CT) was introduced in the early 1970s and has revolutionized not only diagnostic radiology, but also the entire practice of medicine. In 1979, G. Hounsfield and A.M. Cormack received the Nobel Prize for their significant contributions to the development of computed axial tomography. Using computer reconstruction techniques, Hounsfield showed that the internal structures of an object could be reconstructed based on the attenuation pattern of an X-ray beam passing through the object at different angles. In 1971, Hounsfield constructed the first CT scanner that could image the brain. [(6)]

Cardiovascular CT has continued to rapidly evolve over the past decade, gaining new and expanded indications for non-invasive assessment of the heart, great vessels and peripheral vasculature.

High spatial and temporal resolution is essential to make imaging of the heart and its coronaries possible. At first, CT imaging lacked sufficient temporal resolution to visualize the rapidly moving heart. [(7)]

However, the introduction of electron beam CT in the early 1990s followed by the development of multi-detector CT (MDCT) scanners markedly improved the ability to perform CT imaging of cardiac structures, including the coronary arteries. MDCT technology continued to evolve rapidly. Sixty-four-slice CT systems are now the minimum prerequisite for high-quality imaging of the heart and its coronaries, and recently systems with even more detector rows (up to 320 slices) as well as systems with two tubes and detectors (dual source CT) were developed to further improve image quality beyond 64-slice CT. Under certain prerequisites, most importantly a low and stable heart rate, MDCT allows relatively accurate visualization of the heart and its coronary arteries. [(7)]

Besides the detection of coronary artery stenosis, MDCT offers two ways of assessing coronary atherosclerosis. In CT scans performed without injection of contrast agent (calcium screening), coronary calcium can be detected and quantified. In scans performed during intravenous injection of contrast agent and with more refined imaging protocols (coronary CT angiography), it is also possible to detect non-calcified plaque components and, to some degree, to perform characterization of such plaque. [(7)]

Coronary calcium

It was noted that calcifications in the coronary arteries are almost always found in the context of atherosclerosis, except in patients with advanced chronic kidney disease, in whom non-atherosclerotic medial calcification of the walls of the coronaries also may occur. [(8)] In 2000, ***O'Rourke et al.***