Cardiothoracic Imaging

Young adult cardiovascular diseases: a single center coronary computed tomography angiography study

Ruei-Je Tsai[a,1], Hsin-Yi Lai[a,1], Cheng-Fu Ni[a], Shu-Min Tsao[a], Gong-Yau Lan[a,*,2], Kevin Li-Chun Hsieh[a,b,c,**,2]

[a] Department of Medical Imaging, Taipei Medical University Hospital, Taipei, Taiwan
[b] Translational Imaging Research Center, College of Medicine, Taipei Medical University, Taipei, Taiwan
[c] Department of Radiology, School of Medicine, College of Medicine, Taipei Medical University, Taipei, Taiwan

A B S T R A C T

Purpose and background: Cardiovascular disease (CVD) is one of the leading causes of death. However, the prevalence of CVD in young adults (< 40 years of age) has not been well documented. We conducted this study to determine the proportion of CVD in both symptomatic and asymptomatic young adults.
Materials and methods: Coronary CT angiography images obtained from April 2015 to July 2017 in our institution was retrospectively reviewed. Young adults were separated into two groups according to whether they had experienced chest discomfort. The diagnosis was classified as normal, coronary artery disease (CAD), myocardial bridging (MB), congenital coronary anomaly, congenital cardiac anomaly, cardiomyopathy, and aortic anomaly. The proportion of different diagnoses in two groups and cardiovascular risk factors were analyzed.
Results: Totally 107 patients (mean age, 35.6 ± 3.55 years) were grouped into 36 cases of symptomatic group and 71 patients of asymptomatic group. Cardiovascular anomalies were found in 61 cases (41%). No significant difference in the occurrence rates of CAD (14% vs 11%, $p = 0.53$), MB (31% vs 42%, $p = 0.51$), and congenital coronary anomaly (7% vs 3%, $p = 0.26$) between groups. Mild arterial stenosis was implied in most CAD cases. Hypertension was the only risk factor significantly correlated with CAD.
Conclusions: Although young adults are conventionally identified as low-risk, more than 60% of the cases in our cohort were proved to present cardiovascular anomalies, with no significant relation to cardiac symptoms. Early interventions should be conducted for aggressive CVD subtypes to prevent future acute events.

1. Introduction

Cardiovascular disease (CVD) is a class of diseases constituting all conditions that affect the heart and the associated blood vessels, and it is currently the leading cause of death. Except for congenital heart disease, CVD is often considered a problem in the elderly population. However, CVD can also affect young adults who are generally unaware of the risk of CVD and hence fail to take necessary preventive measures. Cardiovascular events in young adults, particularly acute coronary syndrome, are considered to be critical health threats and a socioeconomic burden, because such events may lead to devastating consequences including disability and mortality.

Atherosclerotic coronary artery disease (CAD), congenital coronary anomaly, and myocardial bridging (MB) have been demonstrated to be associated with angina, acute myocardial infarction (MI), arrhythmias, cardiac dysfunction, and even sudden cardiac death [1–3]. Structural heart abnormalities including congenital heart disease and cardiomyopathy may result in remarkable symptoms such as fatigue, dyspnea, and heart failure [4,5], which reduce quality of life. However, the prevalence of CVD in young adults and the relevant cardiovascular risk factors associated with CVD have not been thoroughly investigated.

Coronary computed tomography angiography (CTA) has been

established as a noninvasive imaging tool for evaluating the coronary arteries as well as noncoronary cardiac structures. CTA has been proven to have comparable diagnostic accuracy to invasive coronary angiography in CAD detection [6,7]. It has also been demonstrated to identify a variety of clinically relevant cardiovascular abnormalities unrelated to coronary atherosclerosis [8]. In people with suspected CAD, coronary CTA not only facilitates the precise assessment of coronary arteries but also provides crucial information on other cardiac structures.

This retrospective cohort study was conducted to determine the proportion of CVD in young adults who underwent coronary CT angiogram. In addition, the associations between imaging diagnosis, symptoms, and underlying risk factors were investigated.

2. Material and methods

2.1. Patients

This retrospective study was reviewed and approved by an institutional ethics committee (N201708043, TMU-Joint Institutional Review Board, Taipei, Taiwan).

Data from the electronic imaging database of coronary CTA performed from February 2014 to July 2017 at the Department of Medical Imaging of Taipei Medical University Hospital (TMUH) were retrospectively reviewed. Patients younger than 40 years were recruited in this study. Patients were then separated into symptomatic or asymptomatic groups according to if they have experienced chest discomfort or not. The indications of each examination and the major CVD risk factors for each case were extracted from the electronic medical records and investigative questionnaires recorded before each imaging study. Five major CVD risk factors including cigarette smoking, hypertension, diabetes mellitus (DM), hyperlipidemia, and family history of CVD, were recorded. The CVD risk score was defined as the summation of the number of the major CVD risk factors, which ranged from 0 to 5.

2.2. Imaging modality

All the CTA examinations were performed using a 2×128-slice dual-source dual-energy CT scanner (SOMATOM Definition Flash, Siemens Healthcare, Erlangen, Germany). Image acquisition was performed with a volume of imaging data acquired from the level of the tracheal bifurcation through the diaphragm by using prospective or retrospective electrocardiography gating according to the heart rate. In case whose heart rate exceeded 60 beats/min, retrospective gating protocol was applied. Prospective gating protocol was only used in case whose heart rate was slower than 60 beats/min. Sublingual nitroglycerin (NITROSTAT®, 0.6 mg) was administered before examination for a more efficient coronary angiogram depiction. In total, 60–90 mL of nonionic contrast medium (Omnipaque 350®, GE Healthcare, Princeton, NJ, USA) was administered via a 17-gauge intravenous catheter through the upper arm at a rate of 5–6 mL/s by using a power injector.

2.3. Image analysis

The acquired coronary CTA imaging data were transferred to workstations (Aquarius iNtuition, TeraRecon, Foster City, California, USA and syngo.via, Siemens Healthcare, Erlangen, Germany) equipped with maximum-intensity-projection (MIP) reformation and three-dimensional (3D) volume-rendered and multiplanar reconstruction (MPR) techniques to facilitate the visualization of the cardiac axis and coronary tree. All the CTA images were reviewed by two board-certified cardiovascular radiologists with 8 and 28 years of experience, respectively. A difference of opinion was resolved by consensus for determining the final diagnosis and disease severity.

The diagnosis was categorized as normal, CAD, MB, congenital

coronary anomaly, congenital cardiac anomaly, cardiomyopathy, and aortic anomaly. The CAD severity was defined as minimal (degree of stenosis: < 25%), mild (degree of stenosis: 25%–49%), moderate (degree of stenosis: 50%–69%), severe (degree of stenosis: 70%–99%), and total occlusion. The degree of each stenotic segment in the left anterior descending artery (LAD), left circumflex artery (LCX), and right coronary artery (RCA) was individually evaluated. For arteries with multisegmental stenosis, the highest stenosis was recorded as the representative severity of the artery.

2.4. Statistical analysis

The proportion of different diagnoses in asymptomatic and symptomatic groups was compared using the chi-squared test. The correlation between major cardiac anomalies and cardiovascular risks was determined using a nonparametric Spearman correlation test. Statistical significance was set at $p < 0.05$. All statistical analyses were performed using Prism (release 6.0, GraphPad Software Inc. La Jolla, CA, USA) and SPSS (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY, USA).

3. Results

3.1. Demographics

In total, data of 1878 cases who had undergone coronary CTA were recorded from February 2014 to July 2017. Of them, 109 were younger than 40 years. Two of the cases were excluded because of incomplete data in the questionnaires. Finally, 107 cases who had undergone coronary CTA were enrolled (81 men and 26 women; mean age, 35.6 ± 3.55 years; age range, 20–40 years). Among them, 36 cases (33.6%) who had experienced chest discomfort were grouped into symptomatic group. The rest 71 patients (66.4%) were grouped into asymptomatic group. Family history of CVD, smoking, and hyperlipidemia were the three most common cardiovascular risk factors in our cohort. Table 1 presents a summary of the clinical characteristics of the 107 cases indicated for coronary CTA in this study.

3.2. Cardiovascular disease distributions between groups

Cardiovascular anomaly was documented in 61 cases (41%), including 7 cases with more than one abnormality. Among them, CAD (Fig. 1) was diagnosed in 15 cases (13%) and MB (Fig. 2) was noted in 40 cases (34%). Other imaging diagnoses were described as congenital coronary anomaly ($n = 7$, 6%), congenital heart disease ($n = 2$, 2%), cardiomyopathy ($n = 3$, 2%), and aortic anomaly ($n = 3$, 3%). Most MB cases found in our study were the superficial type located in the LAD and LCX. Congenital coronary anomaly was detected in 7 cases (6%), including an anomalous RCA from the left coronary sinus with an interarterial course (Fig. 3) in 2 patients, coronary artery fistula in 2

Table 1
Epidemiological characteristics of the present cohort

Clinical characteristics	Asymptomatic ($n = 71$)	Symptomatic ($n = 36$)
Male:female	55 (77.5%):16 (22.5%)	26(72.2%):10 (27.8%)
Average age	35.5 ± 4.7 years	35.7 ± 4.8 years
Underlying cardiovascular risk factor[a]		
Cigarette smoking	24 (33.8%)	12 (33.3%)
Diabetes mellitus	3 (4.2%)	1 (2.8%)
Hypertension	14 (19.7%)	5 (13.9%)
Hyperlipidemia	16 (22.5%)	9 (25.0%)
Family history of cardiovascular disease	31 (43.7%)	12 (33.3%)

[a] Multiple risk factors can coexist in a case.