Clinical Research Report

Journal of INTERNATIONAL MEDICAL RESEARCH

Journal of International Medical Research
2018, Vol. 46(12) 5205–5209

DOI: 10.1177/0300060518804723
journals.sagepub.com/home/imr
SAGE

Coronary tortuosity is negatively correlated with coronary atherosclerosis

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Abstract

Objective: The impact of coronary tortuosity on coronary atherosclerosis remains unclear. This study was performed to determine to the relationship between coronary tortuosity and the presence of coronary atherosclerosis.

Methods: Tortuosity and the presence of coronary atherosclerosis in the main coronary arteries were evaluated. The coronary artery was divided into non-tortuous and tortuous segments. The incidence of coronary atherosclerosis between the two segments was compared.

Results: The prevalence of coronary atherosclerotic stenosis was significantly lower in the tortuous than non-tortuous segment.

Conclusion: The prevalence of coronary atherosclerotic stenosis is lower in the coronary tortuous than non-tortuous segment, indicating that coronary tortuosity might be considered a protective factor for atherosclerosis.

Keywords

Coronary tortuosity, coronary atherosclerosis, impact, protective factor, coronary angiography, endothelial shear stress

Date received: 25 July 2018; accepted: 12 September 2018

Introduction

Coronary artery disease has become a major disease burden in both developed and developing countries. Coronary angiography is the main technique used to diagnose coronary artery disease. Coronary tortuosity (CT) is a common finding in

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coronary angiography. The clinical implication of coronary tortuosity remains unclear[1,2]; however, previous studies have shown that CT is closely associated with female sex and hypertension[2,3] and that it might also be linked to myocardial ischemia.[4–9]

Various factors are involved in the development and progression of atherosclerosis, including hemodynamic factors. The relationship between CT and coronary artery disease is controversial.[2,3,9–13] This study was performed to compare the prevalence of coronary atherosclerosis between tortuous and non-tortuous coronary artery segments.

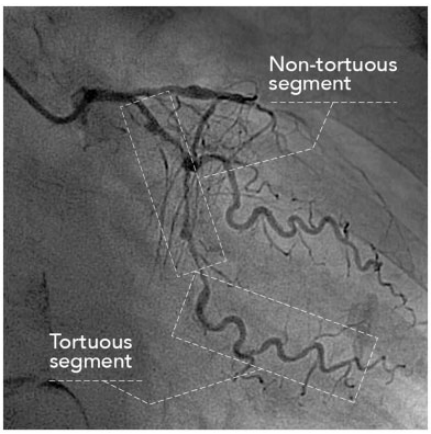

Figure 1. Tortuous and non-tortuous coronary artery segments

Methods

Patients

Consecutive patients who underwent coronary angiography because of suspected coronary artery disease from January 2017 to June 2018 in our department were included in this study. The coronary arteries were observed by various angulations. The left anterior descending coronary artery (LAD) was assessed in the cranial right anterior oblique view, and the left circumflex coronary artery (LCX) was assessed in the caudal right anterior oblique view. The two inclusion criteria for this study were as follows: (1) the presence of CT of the LAD or LCX as indicated by three or more bends along the main trunk (a bend was defined as a $\geq 45^{\circ}$ change in vessel direction) (Figure 1),[2,14] and (2) the coexistence of coronary atherosclerosis in the LAD or LCX (the coexistence of atherosclerosis was defined as an irregular coronary lumen detected by coronary angiography). The severity of coronary stenosis was assessed by quantitative coronary angiography. Two cardiologists independently evaluated the coronary images. This study was approved by the hospital ethics committee (Zhongda Hospital, Southeast University, Nanjing, China) and was performed in accordance with the principles embodied in the Declaration of Helsinki. Written informed consent was obtained from every patient.

Statistical analysis

The data were analyzed using SPSS Statistics for Windows, Version 17.0 (SPSS Inc., Chicago, IL, USA). The difference between two segments was compared by the paired chi-square test. A P value of <0.05 was considered statistically significant.

Results

In total, 121 coronary arteries of 104 patients were included in the analysis. The percentage of $\geq 50\%$ and $<70\%$ stenosis was 7.4% in the tortuous segment and 44.6% in the non-tortuous segment. The percentage of $\geq 70\%$ stenosis was 6.6% in the tortuous segment and 33.9% in the non-tortuous segment. The tortuous segment had less atherosclerotic stenosis than the non-tortuous segment (McNemar's test: $P < 0.001$) (Tables 1 and 2).

Table 1. Descriptive analysis of atherosclerosis in tortuous and non-tortuous segments

	Tortuous segment	Non-tortuous segment	P value
No stenosis	94 (77.7%)	8 (6.6%)	<0.001
<50% stenosis	10 (8.3%)	18 (14.9%)	0.108
50% to <70% stenosis	9 (7.4%)	54 (44.6%)	<0.001
≥70% stenosis	8 (6.6%)	41 (33.9%)	<0.001

Table 2. McNemar's analysis of tortuous and non-tortuous segments

	Non-tortuous segment				
Tortuous segment	No stenosis	<50% stenosis	50% to <70% stenosis	≥70% stenosis	Total
No stenosis	0	18	46	30	94
<50% stenosis	0	0	0	10	10
50% to <70% stenosis	8	0	0	1	9
≥70% stenosis	0	0	8	0	8
Total	8	18	54	41	121

McNemar's test: $P < 0.001$

Discussion

Our study showed that the incidence of coronary atherosclerotic stenosis was significantly lower in the tortuous than non-tortuous segment of the coronary artery. To the best of our knowledge, this is the first study to compare the presence of coronary atherosclerotic stenosis between the tortuous and non-tortuous segments of the same coronary artery. Previous studies have shown that CT is positively associated with hypertension and female sex and that it may be related to myocardial ischemia.[2,4,6,8] Moreover, previous studies have shown that patients with CT are unlikely to be diagnosed with coronary artery disease.[2,3,11] The results of the present study indicate that coronary atherosclerotic stenosis is more unlikely to be found in the tortuous than non-tortuous segment of an individual coronary artery.

Coronary atherosclerosis is a multifactorial process. Progression and rupture of coronary atherosclerotic plaques are dependent on inhomogeneity and irregularities of intracoronary local blood flow and endothelial shear stress (ESS).[15] Therefore, the mechanism underlying our findings might be attributed to hemodynamic factors. ESS is known to be involved in the formation and progression of atherosclerosis. Low ESS regulates endothelial gene expression through complex mechanoreception and mechanotransduction processes, induces the atherosclerotic vascular endothelial phenotype, and causes the formation of early atherosclerosis; low ESS can thus promote the progression of coronary atherosclerosis.[16–18] Low ESS can also promote the occurrence and progression of in-stent restenosis.[19] Local low ESS can predict sites prone to plaque disruption and acute coronary syndromes.[20] In line with the above findings, our previous experimental study showed that tortuous vessels had higher

ESS independent of the severity of CT, indicating that CT might help to prevent the formation of and slow down the progression of atherosclerosis.[21] Similarly, an idealized and patient-specific computational study indicated that an increase of ESS in CT could protect against atherosclerosis.[9] The present study emphasizes that ESS also differs between segments of the coronary artery with and without CT; specifically, atherosclerosis is more likely to develop in the non-tortuous than tortuous segment of the artery.

In conclusion, the tortuous segment of the coronary artery is resistant to coronary atherosclerotic stenosis, and CT can be considered a protective factor for atherosclerosis formation.

Declaration of conflicting interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This research was supported by the National Natural Science Foundation of China (NSFC) (Grant No. 81300159) and the Social Development and Standardized Therapy for Key Diseases of Science and Technology Department of Jiangsu Province, China (Grant No. BE2016785).

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