·临床研究·

冠状动脉左主干长度及左前降支-左回旋支分叉角度与粥样斑块形成的关系

孟令秀[1*],董福生[2],孙文扬[1]
(秦皇岛市第二医院:[1]心血管内科,[2]麻醉科,河北 秦皇岛 066600)

【摘　要】 **目的** 探讨冠状动脉左主干(LM)长度及左前降支-回旋支(LAD-LCX)分叉角度与粥样斑块形成的关系。**方法** 回顾性分析2020年1月至2022年1月秦皇岛市第二医院收治的行CT血管造影(CTA)检查且结果明确的372例患者的临床资料,依据CTA检查结果将患者分为左冠状动脉病变组($n=244$)和正常组($n=128$),比较各组人群LM长度、LM面积、左冠发出角度LM-LAD夹角、LM-LCX夹角和LAD-LCX夹角之间的差异,并分析LM、LAD-LCX分叉角度与粥样斑块形成的关系。采用SPSS 22.0软件进行数据分析。根据数据类型,组间比较分别采用t检验及χ^2检验。**结果** 正常组LAD-LCX夹角(77.70°±5.78°)小于近段组(79.23°±5.11°)和远段组(81.24°±6.96°),且近段组LAD-LCX夹角小于远段组,差异均有统计学意义($P<0.05$)。正常组LAD-LCX夹角(77.70°±5.78°)小于轻度狭窄组(79.10°±5.05°)和中重度狭窄组(81.07°±6.32°),且轻度狭窄组LAD-LCX夹角小于中重度狭窄组,差异均有统计学意义(均$P<0.05$)。**结论** 左冠状动脉LAD-LCX分叉夹角越大,动脉斑块形成的风险越高。

【关键词】 冠状动脉;左主干长度;左前降支-左回旋支分叉角度;粥样斑块
【中图分类号】 R541.4　　【文献标志码】 A　　【DOI】 10.11915/j.issn.1671-5403.2023.10.161

Relationship of length of left main coronary artery and left anterior descending artery-left circumflex artery bifurcation angle with atheromatous plaque formation

Meng Lingxiu[1*], Dong Fusheng[2], Sun Wenyang[1]
([1]Department of Cardiology, [2]Department of Anesthesiology, Second Hospital of Qinhuangdao, Qinhuangdao 066600, Hebei Province, China)

【Abstract】 **Objective** To investigate the relationship of the length of the left main coronary artery (LM) and left anterior descending artery-left circumflex artery (LAD-LCX) bifurcation angle with the atheromatous plaque formation. **Methods** A retrospective analysis was made of the clinical data of 372 patients admitted to the Second Hospital of Qinhuangdao from January 2020 to January 2022, who underwent CT angiography (CTA) and had clear results. According to CTA findings, the patients were divided into group with lesion at the left coronary artery (lesion group) ($n=244$) and normal group ($n=128$). The groups were compared in LMCA length, LMCA area, LM-LAD angle of the left coronary artery origin, LM-LCX angle and LAD-LCX angle. The relationship between LMCA and LAD-LCX bifurcation angle and atheromatous plaque formation was analyzed. SPSS statistics 22.0 was used for statistical analysis. Data comparison between two groups was perfomed using t test or χ^2 test depending on data type. **Results** The LAD-LCX angle in the normal group (77.70°±5.78°) was lower than the proximal group (79.23°±5.11°) and the distal group (81.24°±6.96°), and the LAD-LCX angle in the proximal group was lower in the distal group, the differences being statistically significant ($P<0.05$ for all). Additionally, the LAD-LCX angle in the normal group (77.70°±5.78°) was lower than the mild stenosis group (79.10°±5.05°) and the moderate to severe stenosis group (81.07°±6.32°), and the mild stenosis group had a lower LAD-LCX angle than the moderate to severe stenosis group, the differences being statistically significant ($P<0.05$ for all). **Conclusion** The greater the LAD-LCX bifurcation angle, the higher the risk of arterial plaque formation.

【Key words】 coronary artery; length of left main trunk; left anterior descending artery-left circumflex artery bifurcation angle; atheromatous plaque
Corresponding author: *Meng Lingxiu*, *E-mail*: *13333289325@163.com*

冠状动脉性猝死等急性冠脉综合征的病因关键在于动脉粥样斑块的溃疡、破裂和出血[1,2],而动脉粥样斑块形成的原因又是多样化的,血管壁对多种始动因素的异常反应均可诱发形成粥样斑块[3]。最新研究指出,动脉分叉外侧壁处低血流剪切力是动脉粥样硬化起源的关键因素之一,较低的血流剪切力可致血管内壁厚度发生改变,血管内皮细胞和平滑肌细胞结构和功能出现异常,使得动脉管腔狭

收稿日期:2023-02-13;接受日期:2023-04-21
通信作者:孟令秀, E-mail: 13333289325@163.com

窄,最终导致粥样硬化,诱发冠心病[4]。通过查阅文献发现,既往研究面向冠状动脉病态学的研究较多,而对其解剖学方面的报道较少[5]。基于此,本研究分析冠状动脉 CT 血管造影(CT angiography,CTA)患者冠状动脉左干支(left main coronary artery,LM)长度和左前降支-回旋支(left anterior descending artery-left circumflex,LAD-LCX)分叉角度对粥样斑块形成的影响,以期为冠心病的临床预防、诊断和治疗提供更多有效支撑。

1 对象与方法

1.1 研究对象

收集 2020 年 1 月至 2022 年 1 月秦皇岛市第二医院心血管内科收治的行 CTA 检查的 386 例患者的临床资料。纳入标准:(1)临床疑似或诊断冠心病患者;(2)能配合顺利完成 CTA 检查。排除标准:(1)冠状动脉支架置入术后;(2)CTA 图像质量差;(3)左冠状动脉存在中间支。排除冠状动脉图像无法评价患者 9 例及有冠状动脉搭桥和支架术史患者 5 例,共 372 例患者纳入本研究。其中男性 227 例,女性 145 例;年龄 35~81(52.61 ± 4.93)岁;心率 53~71(62.31 ± 1.32)次/min;CTA 检查结果正常组患者 128 例,病变组患者 244 例。所有患者临床病史、入院资料及影像学检查结果均齐全;均无高血压、高血脂和糖尿病病史;均为自愿签署 CTA 检查同意书。

1.2 方法

1.2.1 检查方法 开始检查前嘱患者保持静息状态,心率维持在 80 次/min 以下并训练呼吸。检查开始进行时,嘱患者维持仰卧位,头部先进入,双臂上举,使用 64 排 128 层螺旋 CT(厂家:SIEMENS;型号:Definition As 65016)进行扫描,设置扫描参数为电压 120 kV,电流 400 mA,扫描模式设置为前瞻性心电门控容积扫描,延迟 12 s 屏蔽,实时监测扫描。以患者降主动脉作为感兴趣区,阀值 220 Hu,由肘静脉以 5 ml/s 速率高压注射 350 mg/ml 碘海醇 50 ml,并以同等速率注射等体积的生理盐水。CT 扫描范围由支气管隆突下 1 cm 至心脏膈面,以层厚 0.5 mm,层间距 0.25 mm 进行三维图像重建。

1.2.2 图像分析 参考先前的文献[6],由 2 名高年资放射科医师采用 Vitrea Core 工作站及配套处理软件对所有患者的 CT 扫描图像进行血管重建,将血管调整至同一平面以便测量其夹角,同时建立三维立体容积图像,采用曲线重建技术、血管拉直技术和最大密度投影技术测量所有患者的左主干长度、左主干起始处面积、左主干中间点面积、左主干分叉处面积,同时采用多平面重建技术测量左主干发出角度及分叉角度(∠1、∠2、∠3)、左主干-左前降支(left main coronary artery-left anterior descending artery,LM-LAD)夹角、左主干-回旋支(left main coronary artery-left circumflex,LM-LCX)夹角以及 LAD-LCX 夹角。所有数据均重复测量 3 次取平均值作为最终结果。依据左冠状动脉自主动脉起源位置和发出角度的不同对左主干发出角度∠1、∠2、∠3 进行定义:∠1 为 CT 图像横轴位左主干与主动脉夹角;∠2 为冠状位左主干与主动脉头侧夹角;∠3 为冠状位左主干与主动脉尾侧夹角。

1.2.3 分组处理 参考美国心脏学会冠状动脉分段准则[7]依据斑块位置不同将 244 例病变患者分为近端病变组($n=159$)和远端病变组($n=85$),其中左主干、左前降支近段和左回旋支近端病变均为近端病变,左前降支远端及左回旋支远端病变均为远端病变。此外,利用曲面重建技术和血管拉直分析技术测量结果评估患者血管直径是否存在狭窄,依据 CTA 结果中狭窄程度的不同将患者分为轻度狭窄组($n=141$)和中重度狭窄组($n=103$),其中狭窄程度<50%为轻度狭窄,狭窄程度≥50%为中重度狭窄。

1.3 统计学处理

采用 SPSS 22.0 统计软件进行数据分析。计量资料用均数±标准差($\bar{x}\pm s$)表示,采用 t 检验;计数资料用例数(百分率)表示,采用 χ^2 检验。$P<0.05$ 为差异有统计学意义。

2 结 果

2.1 正常组及病变组一般资料比较

病变组和正常组患者一般资料比较,差异无统计学意义($P>0.05$;表 1)。

2.2 冠状动脉左主干长度、直径、面积及分叉角度与斑块位置的关系

正常组、近段组和远段组 LM 长度、LM 起始处面积、LM 中间点面积和 LM 分叉处面积差异均无统计学意义($P>0.05$;表 2)。

2.3 左冠状动脉发出角度、分叉角度与斑块位置的关系

3 组 LAD-LCX 夹角之间的差异有统计学意义,正常组 LAD-LCX 夹角小于近段组和远段组($P<0.05$),近段组 LAD-LCX 夹角小于远段组($P<0.05$;表 3)。

表1 2组患者一般资料比较

Table 1 Comparison of general data between two groups

Group	n	Gender[n(%)]		Age(years, $\bar{x}\pm s$)	Heart rate (beats/min, $\bar{x}\pm s$)	BMI(kg/m^2, $\bar{x}\pm s$)
		Male	Female			
Normal	128	85(66.4)	43(33.6)	52.33±4.87	62.45±1.29	22.13±1.06
Pathological	244	142(58.2)	102(41.8)	52.75±5.04	62.23±1.44	21.98±1.21
t/χ^2		2.379		0.772	1.450	1.184
P value		0.123		0.440	0.148	0.237

BMI: body mass index.

表2 冠状动脉左主干长度、直径、面积及分叉角度与斑块位置的关系

Table 2 Relationship of length, diameter, area and bifurcation angle of left main coronary artery with plaque location ($\bar{x}\pm s$)

Group	n	LM length(mm)	LM area(mm^2)		
			Starting point	Midpoint	Bifurcation
Normal	128	9.66±1.23	18.13±4.28	13.20±2.83	14.04±3.15
Proximal	159	9.34±1.47	18.46±4.52	13.55±2.79	14.88±3.02
Distal	85	9.51±1.39	19.01±4.66	13.68±3.05	14.63±3.79
F		1.938	0.990	0.856	2.410
P value		0.145	0.373	0.426	0.091

LM: left main coronary artery.

表3 左冠发出角度、分叉角度与斑块位置的关系

Table 3 Relationship of left coronal angle and bifurcation angle with plaque position ($\bar{x}\pm s$)

Group	n	Left crown emitting angle			Bifurcation angle		
		∠1	∠2	∠3	LM-LAD included angle	LM-LCX included angle	LAD-LCX included angle
Normal	128	90.31°±10.26°	111.44°±12.08°	69.55°±9.97°	146.29°±12.43°	125.48°±17.67°	77.70°±5.78°
Proximal	159	87.64°±12.78°	116.71°±13.45°	71.23°±10.36°	142.33°±15.78°	123.46°±18.95°	79.23°±5.11°*
Distal	85	89.93°±11.35°	113.92°±14.21°	68.84°±11.01°	143.65°±13.95°	121.37°±16.72°	81.24°±6.96°*#
F		2.158	1.649	1.748	2.756	1.348	9.514
P value		0.117	0.194	0.176	0.065	0.261	<0.001

LM-LAD: left main coronary artery-left anterior descending artery; LM-LCX: left main coronary artery-left circumflex artery; LAD-LCX: left anterior descending artery-left circumflex artery. Compared with normal group, *$P<0.05$; compared with proximal group, #$P<0.05$.

2.4 左冠状动脉长度、直径、面积与左冠状动脉狭窄程度的关系

正常组、轻度狭窄组和中重度狭窄组LM长度、LM起始处面积、LM中间点面积和LM分叉处面积比较,差异均无统计学意义(均$P>0.05$;表4)。

2.5 左冠状动脉发出角度、分叉角度与左冠状动脉狭窄程度的关系

3组LAD-LCX夹角之间的差异有统计学意义($P<0.05$);正常组LAD-LCX夹角小于轻度狭窄组和中重度狭窄组,轻度狭窄组LAD-LCX夹角小于中重度狭窄组,差异均有统计学意义($P<0.05$;表5)。

3 讨 论

血流动力学变化所致的冠状动脉左主干及分叉部位解剖学改变是导致粥样斑块形成的主要原因[8],其中冠状动脉分支处和近段管腔是冠状动脉粥样斑块形成的常见部位。研究显示,冠状动脉的左主干长度和分叉角度等解剖学位置与其斑块产生和分布存在关联[9],基于此,越来越多的研究开始从冠状动脉LM、LAD及LCX入手探寻冠心病的临床介入治疗手段。

本研究结果发现,正常组LAD-LCX夹角小于近段组和远段组,近段组LAD-LCX夹角小于远段组,且正常组LAD-LCX夹角小于轻度狭窄组和中重度狭窄组,轻度狭窄组LAD-LCX夹角小于中重度狭窄组,说明左冠状动脉LAD-LCX分叉角度越大,动脉管腔狭窄越严重,血流动力学改变越明显,诱导血管重构和左主干远段血管内平滑肌细胞和弹性成分损伤及减少,使得左主干远段血管管腔扩张程度较近段及正常人群更为严重[10]。推测原因仍与血流动力学变化对血管内壁的影响有关[11,12],血液流动形式在左冠动脉血管LAD-LCX分叉处发生改变,血流由原本平缓、分层的流线形式变为涡流和湍流[13],使得左主干及分叉处侧壁受到低剪切应力影响血管内皮细胞正常排列紊乱,细胞间的连接作用减弱,黏附分子表达异常升高,血管壁对于巨噬细胞及脂质

表 4 左冠状动脉长度、直径、面积与左冠状动脉狭窄程度的关系

Table 4 Relationship of length, diameter, and area of left coronary artery with degree of left coronary artery stenosis ($\bar{x}\pm s$)

Group	n	LM length(mm)	LM area(mm^2)		
			Starting point	Midpoint	Bifurcation
Normal	128	9.66±1.23	18.13±4.28	13.20±2.83	14.04±3.15
Mild stenosis	141	9.38±1.26	18.57±4.98	13.67±2.91	14.76±3.93
Moderate to severe stenosis	103	9.43±1.37	18.76±5.11	13.50±3.02	14.83±3.42
F		1.759	0.542	0.885	1.897
P value		0.174	0.582	0.413	0.151

LM: left main coronary artery.

表 5 左冠状动脉发出角度、分叉角度与左冠状动脉狭窄程度的关系

Table 5 Relationship of angle of departure and bifurcation of the left coronary artery with degree of left coronary artery stenosis ($\bar{x}\pm s$)

Group	n	Left crown emitting angle			Bifurcation angle		
		∠1	∠2	∠3	LM-LAD included angle	LM-LCX included angle	LAD-LCX included angle
Normal	128	90.31°±10.2°	111.44°±12.08°	69.55°±9.97°	146.29°±12.43°	125.48°±17.67°	77.70°±5.78°
Mild stenosis	141	88.62°±9.89°	116.23°±19.85°	69.83°±9.41°	141.98°±15.73°	121.08°±19.85°	79.10°±5.05°*
Moderate to severe stenosis	103	88.19°±10.33°	115.07°±17.63°	71.18°±10.25°	143.90°±16.62°	124.99°±18.11°	81.07°±6.32°*#
F		1.483	2.858	0.873	2.792	2.222	10.075
P value		0.228	0.059	0.419	0.063	0.110	<0.001

LM-LAD: left main coronary artery-left anterior descending artery; LM-LCX: left main coronary artery-left circumflex artery; LAD-LCX: left anterior descending artery-left circumflex artery. Compared with normal group, *$P<0.05$; compared with proximal group, #$P<0.05$.

等分子的渗透率发生改善[14]，最终在 LAD-LCX 处形成明显的粥样硬化斑块。而冠状动脉粥样硬化形成过程中始终伴随有血管重构，当血流通过斑块近端或狭窄部位时明显受限，这时血管重塑作用又能使近端或狭窄面积及直径增大，变异性增强[15]，形成不良循环。

综上，LAD-LCX 夹角与左冠状动脉粥样斑块形成高度相关，LAD-LCX 分叉夹角越大，动脉斑块形成的风险越高。本研究揭示的冠状动脉解剖学特点与斑块形成之间的关系对于临床防治冠心病有着积极重要的意义。

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(编辑：温玲玲)