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医学影像物理

三维斑点追踪成像对不同程度冠状动脉狭窄患者左心室局部功能评价及冠心病诊断价值分析

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【摘 要】**目的:**探讨三维斑点追踪成像(3D-STI)对不同程度冠状动脉狭窄患者左心室局部功能评价及冠心病的诊断价值。**方法:**选取冠心病疑似患者108例作为研究对象。所有患者均行三维超声心动图检查,采集并存储心脏三维全容积动态图。脱机后利用3D-STI分析心脏三维全容积动态图,并测量患者左室整体长轴收缩期峰值应变(GLS)、左室整体径向收缩期峰值应变(GRS)、左室整体圆周收缩期峰值应变(GCS)、左室整体面积收缩期峰值应变(GAS)、左室整体面积收缩期峰值应变变化率和三维左室整体应变(3D-Strain)。根据冠脉造影(CAG)结果将所有患者分为冠脉正常、冠脉轻度狭窄、冠脉中度狭窄和冠脉重度狭窄4组。分析各3D-STI参数在冠心病诊断中的敏感性和特异性。**结果:**CAG检查确认,冠脉正常23例、冠脉轻度狭窄27例、冠脉中度狭窄31例、冠脉重度狭窄27例。冠脉重度狭窄组左室舒张末期内径为(52.3±6.2) mm,显著高于其他3组,左室质量为(183.7±15.2) g,显著高于冠脉正常和冠脉轻度狭窄组,左室射血分数和三维超声测量的左室射血分数分别为(54.6±8.8)%和(43.8±8.6)%,均显著低于其他3组(P<0.05)。冠脉重度狭窄组各项3D-STI参数均显著低于其余3组(P<0.05);冠脉中度狭窄组患者GLS、GRS、GCS、GAS和3D-Strain均低于冠脉轻度狭窄组和冠脉正常组患者(P<0.05)。各参数对冠脉中-重度狭窄诊断的曲线下面积(AUC)为0.698~0.972,其中GAS和GLS的AUC值最大,敏感度和特异度均高于其他参数。**结论:**3D-STI为冠状动脉狭窄患者左心室局部功能和冠脉中-重度狭窄患者评价和诊断提供了一种准确、方便、无创的方法,具有较好的临床应用价值。

【关键词】三维斑点追踪成像技术;冠状动脉狭窄;冠心病;左心室功能
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Three-dimensional speckle tracking imaging technology in the assessment of left ventricular regional function and the diagnosis of coronary artery disease in patients with coronary artery stenosis

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Abstract: Objective To investigate the feasibility of the three-dimensional speckle tracking imaging (3D-STI) technology in the assessment of left ventricular regional function of patients with varying degrees of coronary artery stenosis and its diagnostic value for coronary heart disease. **Methods** A total of 108 patients suspected of coronary heart disease were selected. We preformed three-dimensional (3D) echocardiography in the selected patients, and collected and stored the 3D volume dynamic images of the heart which were analyzed with 3D-STI technology offline. The corresponding global long axis systolic peak strain (GLS), global radial axis systolic peak strain (GRS), global circumferential axis systolic peak strain (GCS), global area axis systolic peak strain (GAS), global area axis systolic peak strain rate (GAS rate) and 3D-Strain were measured. According to the coronary angiography results, all patients were divided into 4 groups, including normal coronary artery, mild coronary stenosis, moderate coronary stenosis and severe coronary stenosis. The sensitivity and specificity of 3D-STI parameters in the diagnosis of coronary heart disease were analyzed. **Results** Based on the coronary angiography examination, normal coronary artery was confirmed in 23 cases, mild coronary stenosis in 27 cases, moderate coronary stenosis in 31 cases and severe coronary stenosis in 27 cases. Compared with the other three groups, severe coronary stenosis group showed significantly higher left ventricular end-diastolic diameter [(52.3±6.2) mm], and obviously lower left ventricular ejection fraction and left ventricular ejection fraction measured by 3D echocardiography [(54.6±8.8)% and (43.8±8.6)%, respectively; P<0.05]. And the left ventricular mass of severe coronary

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stenosis group was (183.7±15.2) g, significantly higher than that in normal coronary artery group and mild coronary stenosis group. The 3D-STI parameters in severe coronary stenosis group were significantly lower than those in the other three groups (P<0.05). GLS, GRS, GCS, GAS and 3D-Strain in moderate coronary stenosis group were lower than those in normal coronary artery group and mild coronary stenosis group (P<0.05). The area under the curve (AUC) of parameters to diagnose the moderate and severe coronary stenosis was 0.698-0.972, and the AUC values of GAS and GLS were the largest, with a higher sensitivity and specificity than other parameters. **Conclusion** 3D-STI technology provides an accurate, convenient and non-invasive method for the diagnosis of the moderate-severe coronary artery stenosis and the evaluation of left ventricular regional function of patients with coronary artery stenosis.

Keywords: three-dimensional speckle tracking imaging; coronary artery stenosis; coronary heart disease; left ventricular function

前 言

冠心病是目前最为常见的一种心血管疾病，其发病率和死亡率逐年升高，给人们的生命和生活质量带来严重威胁。近年来，临床上将冠状动脉造影术（Coronary Arteriography, CAG）作为冠心病诊断的金标准应用，在经皮冠状动脉介入治疗的应用也逐渐普及，给患者和医生带来了一定的获益[1-2]。但由于CAG是一种有创检查，且术中采用的造影剂对人体有一定的辐射伤害，一部分患者对术中所用的碘过敏，使得该技术在冠心病诊断和筛查中存在局限性[3]。因此，临床需要一些无创性技术来进行冠心病的早期准确筛查和诊断。本研究通过三维斑点追踪成像技术（Three-Dimensional Spot Tracking Imaging Technology, 3D-STI）对不同冠脉狭窄程度患者左心室局部功能进行评价，旨在确定该技术诊断冠心病的敏感性和特异性，以期实现早期冠心病的无创筛查和诊断。

1 资料与方法

1.1 研究对象

选择2015年7月~2016年5月在广东省第二人民医院就诊的冠心病疑似患者108例作为研究对象，其中男性69例，女性39例，年龄54~78岁，平均年龄（64.5±7.3）岁，体质量62~87 kg，平均体质量（70.3±8.5）kg。所有患者行CAG前24 h内进行超声心动图检查，均未见明显节段性室壁运动异常，同时左心室射血分数（Left Ventricular Ejection Fraction, LVEF）>50%。排除标准：① 静息二维超声心动图图像不清晰的患者；② 急性心肌梗死两周内、不稳定性心绞痛；③ 先心病、心肌病、风湿性瓣膜病；④ 病态窦房结综合症、II、III 度房室传导阻滞；⑤ 严重心律失常，如严重的窦性心动过缓心率<50 次/min，频发室早、短阵室速；⑥ 心功能不全，Killip分级≥3级；⑦ 未经控制的高血压，收缩压≥180 mmHg和/或舒张压≥100 mmHg；⑧ 支气管哮喘近期发作；⑨ 已知对腺苷过敏者。

1.2 方法

1.2.1 图像采集 所有患者均连接心电图，取左侧卧位，使用1~5 MHz二维探头采集患者胸骨旁左室长轴、短轴、心尖四腔心、三腔心等切面图像。换用1~5 MHz三维容积探头并在全容积模式下采集心尖四腔心，存储心脏三维全容积动态图。本研究所用仪器为飞利浦iu33超声诊断系统。

1.2.2 3D-STI分析 患者脱机后提取相对应的心脏三维全容积动态图，选择进入三维斑点追踪模式，调整图像基线、角度，清晰显示心内膜、二尖瓣环、心尖部等部位，斑点标记左右二尖瓣环和心尖，点击软件按钮后由系统进行自动超声回声斑点追踪，描绘心内膜曲线，测量患者左室整体长轴收缩期峰值应变（Global Long Axis Systolic Peak Strain, GLS）、左室整体径向收缩期峰值应变（Global Radial Axis Systolic Peak Strain, GRS）、左室整体圆周收缩期峰值应变（Global Circumferential Axis Systolic Peak Strain, GCS）、左室整体面积收缩期峰值应变（Global Area Axis Systolic Peak Strain, GAS）、左室整体面积收缩期峰值应变变化率（Global Area Axis Systolic Peak Strain rate, GAS rate）和三维左室整体应变（Three-Dimensional Strain, 3D-Strain）（图1）。

1.2.3 患者分组 所有患者均行CAG，并根据造影结果冠状动脉狭窄程度对病变冠脉进行分级和分组：① 冠脉正常组：冠脉狭窄率≤25%；② 冠脉轻度狭窄组：25% < 冠脉狭窄率≤50%；③ 冠脉中度狭窄组：50% < 冠脉狭窄率≤75%；④ 冠脉重度狭窄组：冠脉狭窄率>75%。其中，冠脉中度和重度狭窄可确诊为冠心病。

1.3 统计学分析

采用SPSS 19.0统计学软件进行数理统计分析，结果用均数±标准差表示，多组间比较采用单因素方差分析，通过回归分析和ROC曲线分析对各项指标诊断冠心病的敏感性和特异性进行分析。P<0.05表示数据之间具有统计学差异。

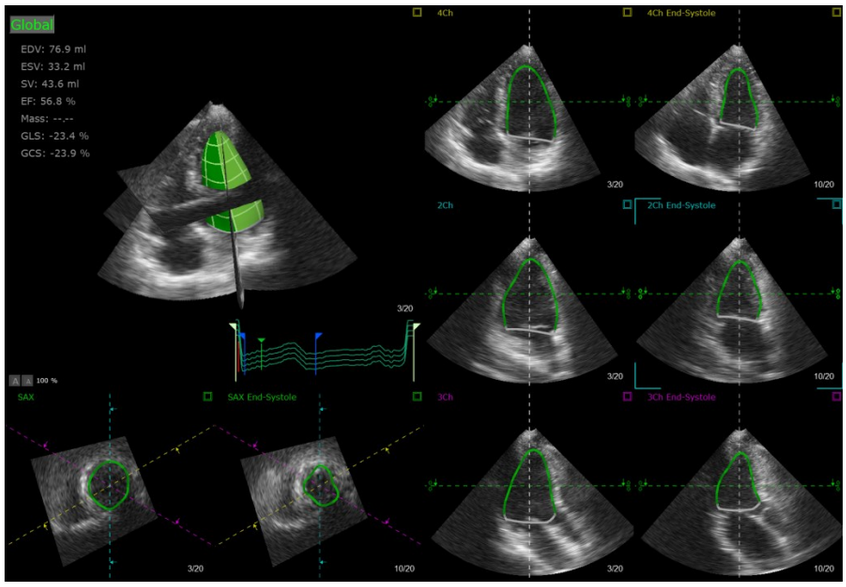

图1 冠脉正常者三维斑点追踪整体收缩期峰值应变声像图

Fig.1 Global systolic peak strain image in patients without coronary artery disease using three-dimensional spot tracking imaging (3D-STI) technology

2 结 果

2.1 冠状动脉造影术结果

108例冠心病疑似患者经CAG检查确认，冠脉正常23例、冠脉轻度狭窄27例、冠脉中度狭窄31例、冠脉重度狭窄27例；冠脉轻度狭窄组中单支病变8例，双支病变7例，三支病12例；冠脉中度狭窄组中单支病变5例，双支病变10例，三支病16例；冠脉重度狭窄组中单支病变7例，双支病变8例，三支病12例。经CAG检查确认病变位置，详见表1。

表1 冠状动脉造影术检查结果（例）

Tab.1 Results of coronary angiography examination (case)

Group	*n*	Left anterior descending branch	Left circumflex artery	Right coronary artery
Mild coronary stenosis	27	24	19	15
Moderate coronary stenosis	31	28	25	20
Severe coronary stenosis	27	25	18	16

2.2 各组临床资料和超声检测结果比较

各组性别组成、年龄、左房内径（Left Atrial Diameter, LAD）、舒张期室间隔厚度（Interventricular Septum Thickness, IVST）等比较无显著性差异（$P>0.05$）。冠脉重度狭窄组左室舒张末期内径（Left Ventricular End-Diastolic Diameter, LVEDD）显著高于其他3组，左室质量（Left Ventricular mass, LVmass）显著高于冠脉正常和冠脉轻度狭窄组，左室射血分数（LVEF）和三维超声测量的左室射血分数（Left Ventricular Ejection Fraction measured by three-dimensional echocardiography, 3D-LVEF）显著低于其他3组（$P<0.05$），详见表2。

2.3 各组3D-STI参数比较

冠脉重度狭窄组各项3D-STI参数均显著低于其余3组（$P<0.05$）；冠脉中度狭窄组患者GLS、GRS、GCS、GAS和3D-Strain均低于冠脉轻度狭窄组和冠脉正常组患者（$P<0.05$）；冠脉轻度狭窄组各项参数与冠脉正常组无显著差异（$P>0.05$），详见表3。

2.4 3D-STI参数对不同狭窄程度冠心病患者心肌缺血情况的预测

以CAG结果为冠心病诊断金标准，应用GLS、GRS、GCS、GAS和3D-Strain等3D-STI参数诊断不同狭窄程度冠心病患者，建立ROC曲线，结果（表4）表明，各参数对冠脉中-重度狭窄诊断的曲线下面积（AUC）为0.698~0.972，其中GAS和GLS的AUC值最大，敏感度和特异度均高于其他参数。

表2 各组临床资料和超声检测结果比较（$\bar{x}\pm s$）

Tab.2 Comparison of clinical data and ultrasonic detection results in each group (*Mean±SD*)

Group	*n*	Gender (male/female)	Age (years)	LVEDD/mm	LAD/mm	IVST/mm	LVEF/%	3D-LVEF/%	LV_{mass}/g
Normal coronary artery	23	18/5	65.7±8.4	45.8±1.7	32.8±1.3	9.5±0.4	64.3±5.6	64.5±5.6	125.6±7.9
Mild coronary stenosis	27	19/8	63.6±7.3	46.5±4.3	33.1±1.5	10.2±0.7	66.1±7.1	66.2±7.1	134.6±8.5
Moderate coronary stenosis	31	18/13	62.6±7.2	49.4±2.8$^{*\#}$	33.3±1.6	9.8±0.6	59.5±7.7$^{*\#}$	52.3±7.4$^{*\#}$	176.8±14.3$^{*\#}$
Severe coronary stenosis	27	14/13	64.0±6.4	52.3±6.2$^{*\#\triangle}$	33.5±1.4	9.7±0.5	54.6±8.8$^{*\#\triangle}$	43.8±8.6$^{*\#\triangle}$	183.7±15.2$^{*\#}$

Compared with normal coronary artery group, $^{*}P$<0.05; compared with mild coronary stenosis group, $^{\#}P$<0.05; compared with the moderate coronary stenosis group, $^{\triangle}P$ <0.05. LVEDD: Left ventricular end-diastolic diameter; LAD: Left atrial diameter; IVST: Interventricular septum thickness; LVEF: Left ventricular ejection fraction; 3D-LVEF: Left ventricular ejection fraction measured by three-dimensional echocardiography; LV_{mass}: Left ventricular mass

表3 各组3D-STI参数比较

Tab.3 Comparison of 3D-STI parameters in each group

Group	*n*	GLS	GRS	GCS	GAS	GAS rate	3D-Strain
Normal coronary artery	23	-25.6±6.8	45.9±9.8	-29.8±2.1	-43.1±17.6	-2.1±0.9	45.1±4.1
Mild coronary stenosis	27	-23.3±6.2	45.1±7.9	-27.2±3.2	-41.2±12.6	-1.9±0.8	42.8±4.8
Moderate coronary stenosis	31	-14.2±2.9$^{*\#}$	28.8±6.1$^{*\#}$	-22.8±4.8$^{*\#}$	-35.1±7.8$^{*\#}$	-1.7±0.7	30.2±6.8$^{*\#}$
Severe coronary stenosis	27	-10.9±2.6$^{*\#\triangle}$	20.9±5.8$^{*\#\triangle}$	-19.1±6.5$^{*\#\triangle}$	-27.9±7.2$^{*\#\triangle}$	-1.3±0.3$^{*\#\triangle}$	22.8±5.7$^{*\#\triangle}$

Compared with normal coronary artery group, $^{*}P$<0.05; compared with mild coronary stenosis group, $^{\#}P$<0.05; compared with the moderate coronary stenosis group, $^{\triangle}P$ <0.05. GLS: Global long axis systolic peak strain; GRS: Global radial axis systolic peak strain; GCS: global circumferential axis systolic peak strain; GAS: Global area axis systolic peak strain; GAS rate: Global area axis systolic peak strain rate

表4 3D-STI参数对不同狭窄程度冠心病患者心肌缺血情况的预测

Tab.4 Prediction of myocardial ischemia in coronary heart disease patients with different degrees of stenosis by 3D-STI parameters

Detection index	Severe coronary stenosis				Moderate coronary stenosis			
	AUC	Cut-off point	Sensitivity/%	Specificity/%	AUC	Cut-off point	Sensitivity/%	Specificity/%
GLS	0.956	-16.3	97.3	89.2	0.874	-20.8	88.3	79.8
GRS	0.928	27.4	81.1	86.9	0.778	33.8	80.1	75.8
GCS	0.853	-25.4	81.2	78.2	0.769	-29.8	81.9	62.9
GAS	0.972	-28.9	91.8	89.1	0.932	-39.8	91.6	69.8
3D-Strain	0.871	32.1	72.3	79.5	0.698	36.9	65.7	54.8

AUC: Area under curve

3 讨 论

近年来，随着我国老龄化进程的加剧和人们生活习惯的改变，冠心病发病率逐年升高。对冠心病患者心功能变化进行早期准确评估对于冠心病治疗和预后评价具有重要的临床应用价值[4]。尽管冠状动脉螺旋CT、CAG等技术在冠心病等疾病诊断中已经得到较为普遍的应用，且效果较好[5-6]，但仍存在价格高、有创性、放射性损害等缺点，如CAG是目前筛查和诊断的“金标准”，但该方法属于有创检查，检查过程中需要使用造影剂并且在放射线条件下进行，对人体损害较大，同时甲亢或者对碘过敏的患者不能进行CAG，使得该方法应用受限，并可能造成误诊和漏诊。因此临床迫切需求一种无创、简便、低廉的诊断技术[7]。3D-STI是在二

维斑点追踪成像技术(2D-STI)基础上发展起来的一种能够充分反映心肌三维运动的技术,能够一次性完成左心室节段应变参数的测量。已有研究表明,3D-STI较2D-STI更能准确且敏感地检测心肌缺血[8]。本研究结果表明,冠脉重度狭窄组LVEDD显著高于其他3组,LVmass显著高于冠脉正常和冠脉轻度狭窄组,LVEF和3D-LVEF显著低于其他3组(P<0.05),这表明冠脉重度狭窄组患者心肌缺血和缺氧更为严重,与其他研究结果一致[9]。这与冠状动脉供血出现障碍进而导致左心室形变能力降低,影响收缩和舒张有关,这种改变与冠脉狭窄程度具有显著相关性。

各组3D-STI参数比较结果显示,冠脉重度狭窄组各项3D-STI参数均显著低于其余3组(P<0.05);冠脉中度狭窄组患者GLS、GRS、GCS、GAS和3D-Strain均低于冠脉轻度狭窄组和冠脉正常组患者(P<0.05);冠脉轻度狭窄组各项参数与冠脉正常组患者无显著差异(P>0.05)。这表明,3D-STI可以全面检测左室各个阶段室壁运动情况,能更为灵敏评价心肌功能变化情况,帮助临床鉴别冠脉中-重度狭窄。与丁晓明[10]、黄红梅[11]等研究结果一致。冠脉狭窄超过50%时,随狭窄程度加重,心肌应变的绝对值出现不同程度降低。心内膜是冠脉供血的末端,冠脉狭窄时心内膜下心肌最先出现供血不足,临床表现为纵向运动减弱,缺血程度进一步加深后则累及中心环形心肌,造成圆周和径向运动减弱。

采用ROC曲线分析3D-STI参数对不同狭窄程度冠心病患者心肌缺血情况的预测,结果表明,各参数对冠脉中-重度狭窄诊断的AUC为0.698~0.972,其中GAS和GLS的AUC值最大,敏感度和特异度均高于其他参数。与刘佳霓等[12]研究结果一致。

综上所述,3D-STI为冠状动脉狭窄患者左心室局部功能和冠脉中-重度狭窄患者评价和诊断提供了一种准确、方便、无创的方法,具有较好的临床应用价值。

【参考文献】

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