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速度向量成像技术对肥厚型心肌病左心室扭转功能和收缩功能的影响 *

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摘要 目的:研究速度向量成像技术对肥厚型心肌病(HCM)左心室扭转功能和收缩功能的影响。**方法:**纳入我院从2018年1月~2019年1月收治的HCM患者30例进行研究,记作病变组,另取同期于我院进行体检的健康志愿者30例作为对照组。比较两组常规左心功能超声心动图指标、左室整体扭转和解旋运动指标、左室局部扭转和解旋运动指标、圆周应变以及应变率。**结果:**病变组舒张末期容积(EDV)、收缩末期容积(ESV)、每搏量(SV)均较对照组更低($P<0.05$),而两组左室射血分数(LVEF)比较差异不显著($P>0.05$)。病变组心内膜的左心室扭转角度(LVtw)以及左心室扭矩(LVtor)均显著高于对照组,而心内膜及心外膜解扭转率(UntwR)显著低于对照组($P<0.05$)。病变组基底部心内膜旋转速率、心尖部心外膜旋转速率均显著低于对照组,心尖部心内膜旋转速率显著高于对照组,心尖部心外膜解旋速率显著高于对照组($P<0.05$)。病变组基底部心内膜圆周应变低于对照组,基底部、心尖部心外膜圆周应变高于对照组($P<0.05$);病变组基底部、心尖部心外膜应变率均高于对照组($P<0.05$)。**结论:**HCM患者收缩功能降低,且局部心肌圆周方向的形变能力明显下降。

关键词:肥厚型心肌病;速度向量成像技术;左心室;扭转功能;收缩功能

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Effects of Velocity Vector Imaging on Left Ventricular Torsion and Systolic Function in Hypertrophic Cardiomyopathy*

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ABSTRACT Objective: To study the effects of velocity vector imaging on left ventricular torsion and systolic function in hypertrophic cardiomyopathy (HCM). **Methods:** 30 patients with HCM admitted to our hospital from January 2018 to January 2019 were included in the study, and were recorded as pathological group. Another 30 cases of healthy volunteers who underwent physical examination in our hospital during the same period were taken as the control group. Two groups of conventional left ventricular functional echocardiography indexes, left ventricular total torsion and rotational motion indexes, left ventricular local torsion and rotational motion indexes, peripheral strain and strain rate were compared. **Results:** The end-diastolic volume (EDV), end-systolic volume (ESV) and pulsation (SV) levels in the lesion group were significantly lower than those in the control group ($P<0.05$), left ventricular ejection fraction (LVEF) was not significantly compared between the two groups ($P>0.05$). The left ventricular torsion Angle (LVtw) and left ventricular torque (LVtor) of the endocardium and epicardium in the lesion group were significantly higher than those in the control group, while the endocardium and epicardium Torsion rate (UntwR) were significantly higher than those in the control group ($P<0.05$). The rate of endocardium rotation at the base and epicardium rotation at the apex in the lesion group was significantly lower than that in the control group, and the rate of epicardium rotation at the apex was significantly higher than that in the control group ($P<0.05$). The peripheral strain of epicardium in the lesion group was lower than that in the control group, and the peripheral strain of epicardium in the base and apex was higher than that in the control group ($P<0.05$). The strain rate of epicardium in the base and apex of the diseased group was higher than that in the control group ($P<0.05$). **Conclusion:** The HCM patients systolic function was significantly lower than that in normal patients, and the deforming capacity in the circumferential direction of the local myocardium was significantly reduced.

Key words: Hypertrophic cardiomyopathy; Velocity vector imaging; Left ventricle; Torsion function; Systolic function

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前言

肥厚型心肌病(Hypertrophic cardiomyopathy, HCM)是临床上较为常见的常染色体遗传性疾病^[1,2]。相关研究报道显示,心脏的空间运动包括纵向运动、径向运动、旋转运动以及扭转运动等,其中扭转运动相较于传统的心脏功能指标而言,可更为敏感的评估左室功能,其测量值具有成为评估左心室功能的潜在诊断指标^[3,4]。另有研究报道显示,心动周期中心室的扭转运动能够较好地提升心室的有关收缩功能,并与在舒张早期充盈时的常规抽吸等作用存在相关性,而异常的扭转模式可反映病变心肌的病理特性以及功能的改变^[5,6]。速度向量成像技术是在斑点追踪原理的基础上所开展的一种超声新技术,可实现对心肌长/短轴及圆周方位的运动速度和位移等指标的测量^[7,8]。鉴于此,本文通过研究速度向量成像技术对 HCM 左心室扭转功能和收缩功能的影响,旨在为临床治疗提供资料支持,现作以下报道。

1 对象与方法

1.1 一般资料

纳入我院从 2018 年 1 月~2019 年 1 月收治的 HCM 患者 30 例,记作病变组。其中有男性患者 19 例,女性 11 例,年龄 26~59 岁,平均年龄(38.24±10.19)岁;疾病类型:左心室流出道梗阻型 14 例,非梗阻型 16 例;受教育程度:初中及初中以下 12 例,高中及高中以上 18 例。纳入标准:(1)所有患者均经心电图、超声心动图等方式确诊是 HCM。主要表现在左心室壁呈非对称性的肥厚,且室间隔与左心室后壁的厚度比值>1.5,左室射血分数(left ventricular ejection fraction, LVEF)均在 50%以上^[9];(2)年龄在 18 周岁以上;(3)入院前尚未接受相关治疗。排除标准:(1)肝、肾等重要脏器功能受损严重者;(2)意识障碍或伴有精神疾病者;(3)正参与其他研究者;(4)原发型高血压亦或是主动脉瓣的狭窄等能导致左室继发型肥厚者。另取同期于我院行体检的健康志愿者 30 例为对照组,其中有男性 20 例,女性 10 例,年龄 24~59 岁,平均年龄(38.27±10.21)岁;受教育程度:初中及初中以下 12 例,高中及高中以上 18 例。两组的资料数据比较,差异不显著($P>0.05$)。所有受试者均在知情同意书上签字,并获批于医院伦理委员会。

1.2 研究方法

使用仪器是西门子公司生产的 ACUSON Sequoia512 型彩超仪,3V2C 探头,以 2.0~4.0MHz 设置成探头频率。应用

SyngoUS workplace 2.0 型工作站处理图像。检查时先取患者的左侧卧位,再连好心电图。选择速度向量成像模式获取以下数据:① 心尖部区域短轴;② 左室中部;③ 胸骨旁左室的基底部;④ 心尖部区域四腔心的切面;⑤ 两腔心的切面。在患者屏息状态下采集图像,其中基底部的短轴切面是二尖瓣瓣尖与腱索之间的相交水平。而中部的短轴切面则以高位的乳头肌水平作为水准。心尖部区域短轴是将不显示乳头肌和收缩期心腔近似闭塞状时的有关水平作为水准。在四腔心的切面检测舒张末期的左室长径,通过 Simpson 法(双平面)对以下数据实施检测:① LVEF;② 舒张末期的容积(End-diastolic volume, EDV);③ 收缩末期的容积(End-systolic volume, ESV);④ 每搏量(Stroke volume, SV)。

1.3 图像分析

通过工作站选择心内/外膜的清晰短轴图像,将舒张中期记为可手动勾画患者心内膜下心肌的有关时机,再选择隔点≥8 个,于各水平短轴的切面常规获取节段 6 个(① 前间隔;② 前壁;③ 侧壁;④ 后壁;⑤ 下壁;⑥ 后间隔)。通过速度向量软件检测以下指标:① 心内/外膜心肌的正常旋转速率;② 旋转角;③ 圆周应变;④ 应变率。统计勾画 3 次之后的平均值。计算以下指标:① 左室扭转角度(Left ventricular twist Angle, LVtw)=心尖部和心底部旋转角度二者的绝对值之和;② 左室扭矩(Left ventricular torque, LVtor)=LVtw 与舒张末期时左室长径二者的比值;③ 解扭转率(UntwR)=[(收缩期时的最大扭转角度-等容舒张末期时的扭转角度)/收缩末期时的最大扭转角度]×100%/等容舒张的时间^[10]。

1.4 评价指标

比较两组常规左心功能超声心动图指标、左室整体扭转和解旋运动指标、左室局部扭转和解旋运动指标、圆周应变以及应变率。

1.5 统计学处理

数据通过 SPSS 22.0 软件加以分析,选择($\bar{x} \pm s$)表示计量资料,实施 t 检验,采用[n(%)]表示计数资料,实施 χ^2 检验,检验水准 $\alpha=0.05$ 。

2 结果

2.1 两组常规左心功能超声心动图指标对比

病变组 EDV、ESV、SV 水平均显著低于对照组($P<0.05$),两组 LVEF 比较差异无统计学意义($P>0.05$),见表 1。

表 1 两组常规左心功能超声心动图指标对比($\bar{x} \pm s$)

Table 1 Two groups of conventional left heart function echocardiography index comparison($\bar{x} \pm s$)

Groups	n	EDV(mL)	ESV(mL)	SV(mL)	LVEF(%)
Lesion group	30	96.09±10.23	34.01±5.28	62.54±7.12	63.12±2.38
Control group	30	119.75±20.10	44.67±7.61	75.29±13.92	62.32±2.38
t		5.746	6.304	4.466	1.302
P		0.000	0.000	0.000	0.198

2.2 两组左室整体扭转和解旋运动指标对比

病变组心内膜的 LVtw 以及 LVtor 均显著高于对照组,而心内膜及心外膜 UntwR 显著低于对照组($P<0.05$),见表 2。

2.3 两组左室局部扭转和解旋运动指标对比

病变组基底部心内膜旋转速率、心尖部心外膜旋转速率均显著低于对照组,心尖部心内膜旋转速率显著高于对照组,心

尖部心外膜解旋速率显著高于对照组($P<0.05$),见表3。

部心外膜圆周应变高于对照组($P<0.05$);病变组基底部、心尖

2.4 两组圆周应变以及应变率对比

部心外膜应变率均高于对照组($P<0.05$),见表4。

病变组基底部心内膜圆周应变低于对照组,基底部、心尖

表2 两组左室整体扭转和解旋运动指标对比($\bar{x} \pm s$)

Table 2 Two groups of left ventricular total torsion and rotation work movement index comparison($\bar{x} \pm s$)

Groups	n	LVtw(%)		LVtor(°/cm)		UntwR(°/ms)	
		Endocardium	Epicardium	Endocardium	Epicardium	Endocardium	Epicardium
Lesion group	30	25.91± 3.12	8.50± 1.94	0.33± 0.05	0.11± 0.03	0.31± 0.15	0.19± 0.07
Control group	30	20.34± 3.28	8.51± 1.96	0.24± 0.04	0.10± 0.03	0.51± 0.14	0.31± 0.08
t	-	6.739	0.020	7.699	1.291	5.339	6.183
P	-	0.000	0.984	0.000	0.202	0.000	0.000

表3 两组左室局部扭转和解旋运动指标对比($\bar{x} \pm s$)

Table 3 Comparison of left ventricular local torsion and rotational motion in two groups($\bar{x} \pm s$)

Groups	Position	Rotation angle(°)		Rotation rate(°/s)		Unwinding rate(°/s)	
		Endocardium	Epicardium	Endocardium	Epicardium	Endocardium	Epicardium
Lesion group (n=30)	Basal part	-8.01± 3.18	-3.56± 1.74	-59.12± 25.34*	-30.20± 11.68	60.23± 23.25	28.14± 8.28
	Apical part	12.58± 2.58	4.81± 2.08	91.84± 37.61*	38.51± 11.62*	-89.65± 33.25	-40.02± 15.23*
Control group (n=30)	Basal part	-9.45± 3.10	-3.35± 2.83	-50.47± 21.39	-30.15± 11.72	64.91± 24.84	33.15± 11.42
	Apical part	12.95± 5.34	4.56± 2.06	79.58± 28.45	47.91± 23.52	-92.74± 34.25	-53.04± 31.29

Note: compared with the control group, * $P<0.05$.

表4 两组圆周应变以及应变率对比($\bar{x} \pm s$)

Table 4 The circumferential strain and strain rate of the two groups were compared($\bar{x} \pm s$)

Groups	Position	Circular strain(%)		Strain rate(s ⁻¹)	
		Endocardium	Epicardium	Endocardium	Epicardium
Lesion group(n=30)	Basal part	-23.15± 6.88*	-7.61± 2.90*	-2.12± 0.78	-0.54± 0.62*
	Apical part	-27.29± 10.26	-8.01± 4.01*	-1.56± 0.49	-0.35± 0.24*
Control group(n=30)	Basal part	-19.50± 5.48	-11.52± 3.31	-2.05± 1.22	-0.80± 0.32
	Apical part	-27.51± 9.52	-13.29± 7.15	-1.51± 0.46	-0.56± 0.25

Note: compared with the control group, * $P<0.05$.

3 讨论

HCM 主要是以心肌非对称性肥厚以及心室腔变小为主要特征,伴随左心室充盈受阻以及舒张期顺应性降低^[11-13]。心肌细胞肥大以及周围疏松结缔组织增多是其典型形态学变化,当心肌于正常负荷状态下无法达到正常心肌功能时,机体便会启动代偿机制,而长期的代偿会促进心肌肥厚的发生^[14-16]。速度向量技术主要是基于对心肌运动的实施跟踪运算,分析每帧图像的像素点,从而掌握受试者的运动情况,并将速度矢量叠加至二维图像上^[17-19],且该成像技术不会受超声入射角度,心脏整体运动等因素影响^[20-22]。

本结果发现,病变组 EDV、ESV、SV 水平均显著低于对照组,说明了病变组患者的心功能存在明显下降,HCM 主要是由编码心肌肌小节蛋白的基因发生突变导致,特别是 β 肌球蛋白重链基因的突变与其发生、发展密切相关^[23-25]。基因突变会导致肌小节蛋白功能区域的氨基酸发生改变,进一步导致肌小节以及肌纤维的排列紊乱,从而导致其结构与功能的损伤,最终引起心脏功能的下降。此外,病变组心内膜的 LVtw 以及 LVtor

均显著高于对照组,而心内膜及心外膜 UntwR 显著低于对照组,HCM 患者心脏旋转主要表现在收缩期基底部的顺时针转动、心尖部时的逆时针转动,且在舒张期截然相反。究其原因,可能和患者心室壁圆周方向的运动代偿性增强密切相关,进一步提示了速度向量成像技术可敏感地反映 HCM 心尖部心肌局部功能变化情况。另有相关研究报道显示^[26],正常左室室壁收缩以心内膜增厚为主,由此可见,在局部心肌收缩功能发生损伤时,心肌代偿性肥厚时,心内膜下心肌的收缩功能会发生较为明显的损伤。同时,HCM 患者自身的心肌表现是中层及心外膜下有关心肌的非正常增厚,以及后者圆周方向上的形变速度及能力均明显下降^[27,28]。另外,圆周应变主要是指心肌形变的能力,属于应变率对时间的计分,亦是心肌空间改变的体现,负值说明心肌纤维缩短或变薄,正值说明心肌纤维延长或增厚。应变率则是表示心肌形变速度,亦是心肌时间上的变化^[29,30]。两者成像分析可定量分析同一心动周期中各阶段心肌形变程度以及速率,且不受心脏整体运动、扭动以及相邻阶段心肌牵拉运动的影响,可更加客观地评价心功能,进一步更为准确地判断出心肌运动。而本研究结果表明,病变组基底部心内膜圆

周应变低于对照组,基底部、心尖部心外膜圆周应变高于对照组,病变组基底部、心尖部心外膜应变率均高于对照组,这充分说明了 HCM 患者存在纵向收缩功能严重受损。

综上所述,HCM 患者收缩功能降低,且局部心肌圆周方向的形变能力明显下降,临床实际工作中可通过速度向量成像技术对 HCM 患者的病情进行评价。

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