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在线全文

心脏磁共振评估左心室射血分数保留肥胖者减重术后左心室结构和功能的改变*

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【摘要】 目的 应用心脏磁共振（cardiac magnetic resonance, CMR）成像探讨肥胖者行减重手术后左心室结构和功能的纵向改变与术前左心室射血分数（left ventricular ejection fraction, LVEF）的关系。**方法** 前瞻性纳入拟行胃袖状切除术的肥胖者75例和年龄、性别匹配的健康对照（对照组）46例，均行CMR检查，得到左心室结构参数、LVEF和应变参数。根据术前LVEF将肥胖者分为LVEF≥60%（n=43）和50%≤LVEF<60%（n=32）两组，比较对照组和两组肥胖者的左心室结构和功能差异。最终有38例肥胖者同时完成减重术后1个月及12个月的CMR随访。分别比较LVEF≥60%组（n=20）和50%≤LVEF<60%组（n=18）肥胖者术后左心室结构和功能的纵向改变。**结果** 减重术前，LVEF≥60%组的整体纵向应变低于对照组，差异有统计学意义〔（－18.36±1.86）% vs.（－19.50±1.53）%，P<0.05〕；50%≤LVEF<60%组的径向〔（27.70±3.52）% vs.（34.44±4.11）%，P<0.05〕、周向〔（－17.35±1.46）% vs.（－19.85±1.42）%，P<0.05〕、纵向〔（－16.22±1.81）% vs.（－19.50±1.53）%，P<0.05〕的整体应变低于对照组。减重术后12个月，LVEF≥60%组的径向〔（32.52±7.84）% vs.（30.92±4.27）%，P>0.05〕、周向〔（－19.02±2.42）% vs.（－18.63±1.49）%，P>0.05〕、纵向〔（－18.18±2.06）% vs.（－17.78±1.66）%，P>0.05〕的整体应变较减重术前的差异无统计学意义；50%≤LVEF<60%组的径向〔（32.73±5.86）% vs.（26.83±4.85）%，P<0.05〕、周向〔（－19.10±2.00）% vs.（－16.91±2.09）%，P<0.05〕的整体应变高于减重手术前，差异有统计学意义。**结论** 肥胖者减重术后左心室会发生重构逆转，左心室结构和功能的纵向改变情况因术前LVEF不同而存在差异。

【关键词】 磁共振成像 左心室 心肌应变 减肥手术

Left Ventricular Structural and Functional Changes in Obese Subjects With Preserved Left Ventricular Ejection Fraction After Bariatric Surgery: Assessment With Cardiac Magnetic Resonance Imaging

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【Abstract】 Objective To investigate the longitudinal changes in left ventricular (LV) structure and function after bariatric surgery in obese individuals and their relationship with preoperative left ventricular ejection fraction (LVEF) by cardiac magnetic resonance (CMR) imaging. **Methods** We prospectively enrolled 75 obese subjects scheduled for laparoscopic sleeve gastrectomy and 46 age and sex-matched healthy controls (the control group). All subjects underwent CMR examination to obtain LV structural parameters, LVEF, and strain parameters. According to their preoperative LVEF, the obese subjects were divided into two obesity groups, including the group of patients with LVEF≥60% (n=43) and the group of patients with 50%≤LVEF<60% (n=32). LV structural and functional differences between the control group and the two obesity groups were compared. Eventually, 38 obese subjects completed the CMR follow-up at 1 month and 12 months after bariatric surgery. The longitudinal changes in LV structure and function after surgery in the LVEF≥60% (n=20) group and the 50%≤LVEF<60% group (n=18) were compared. **Results** Before bariatric surgery, the global longitudinal strain was significantly lower in the LVEF≥60% group than that in the control group ([－18.36±1.86]% vs. [－19.50±1.53]%, P<0.05). The global radial ([27.70±3.52]% vs. [34.44±4.11]%, P<0.05), circumferential ([－17.35±1.46]% vs. [－19.85±1.42]%, P<0.05), and longitudinal ([－16.22±1.81]% vs. [－19.50±1.53]%, P<0.05) strain in the 50%≤LVEF<60% group was significantly lower than that in the control group. At 12 months after bariatric surgery, the global radial ([32.52±7.84]% vs. [30.92±4.27]%, P>0.05), circumferential ([－19.02±2.42]% vs.

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[−18.63±1.49]%, *P*>0.05), and longitudinal ([−18.18±2.06]% vs. [−17.78±1.66]%, *P*>0.05) strain in the LVEF≥60% group showed no significant difference compared with the baseline findings. In the 50%≤LVEF<60% group, the global radial ([32.73±5.86]% vs. [26.83±4.85]%, *P*<0.05) and circumferential ([−19.10±2.00]% vs. [−16.91±2.09]%, *P*<0.05) strain was significantly higher than that before surgery. **Conclusion**　LV remodeling is reversed after bariatric surgery in obese subjects, and the longitudinal changes in LV structure and function vary with the preoperative LVEF.

【Key words】　Magnetic resonance imaging　Left ventricle　Myocardial strain　Bariatric surgery

肥胖已经成为我国公共卫生的主要问题和挑战，是公认的心血管危险因素之一[1-3]。肥胖与多种合并症共存，会对心脏产生不良影响，包括心脏重构、亚临床心肌功能障碍和心衰[4]。即使没有其他心血管危险因素，肥胖者也会出现心脏结构和亚临床功能改变[5-6]。肥胖的治疗方式主要有生活方式干预、药物治疗和减重手术[7-8]。其中，减重手术被认为是重度肥胖的重要替代治疗方案，有助于改善肥胖者的生活质量，降低死亡率[9]。腹腔镜下胃袖状切除术可通过减少体内脂肪沉积来改善机体的多个系统，尤其是心血管系统，在治疗病态肥胖及其代谢并发症方面取得了显著的效果[1, 10]。减重手术后体质量的减轻和代谢的改善可能会逆转心脏重构，对肥胖者的心脏结构和功能产生有益影响[11-13]。

当左心室射血分数(left ventricular ejection fraction, LVEF)在不同水平时，LVEF保留的心衰患者在心脏重构、对治疗的反应和预后因素等方面存在一定程度的差异[14-15]。当LVEF在50%～60%时，心衰患者的心肌收缩能力降低、心肌纤维化增加；当LVEF≥60%时，心衰患者的心肌表现为过度收缩状态，左心室后负荷过大，前负荷储备减少[16]。既往研究[17-18]表明大部分肥胖者虽然LVEF保留，但已经出现了左心室亚临床功能降低，表现为心肌应变明显降低。PENG等[19]发现减重术后肥胖者的左心室亚临床功能障碍会改善。目前关于术前不同LVEF范围的肥胖者在减重术后左心室结构和功能的纵向改变情况尚不清楚。心脏磁共振(cardiac magnetic resonance, CMR)特征追踪技术可定量评估心肌形变，对肥胖者减重术后左心室亚临床功能改变敏感[20-21]。因此，本研究将利用CMR成像分析术前LVEF≥60%和50%≤LVEF<60%的肥胖者行减重术后左心室结构和功能的纵向改变，为肥胖者减重术后的管理和治疗提供影像学参考。

1　资料与方法

1.1　研究对象

前瞻性纳入2020年12月–2022年12月拟于我院行腹腔镜下胃袖状切除术的肥胖者。纳入标准：①体质量指数(body mass index, BMI)≥28.0 kg/m^2[22]；②符合肥胖手术适应症[23]。排除标准：①心血管疾病史：如心肌病、心脏瓣膜病等；②LVEF<50%；③合并慢性肝肾疾病及恶性肿瘤等可能影响心血管系统的疾病；④酒精成瘾或滥用药物；⑤磁共振检查禁忌证。所有肥胖者需在减重术前、术后1个月及12个月行CMR检查并收集临床资料。同时纳入年龄、性别匹配的健康对照。纳入标准：①18.5 kg/m^2<BMI<24.0 kg/m^2[22]；②体格检查及CMR检查正常。排除标准：①有心血管疾病史或其他可能影响心血管系统的慢性疾病；②高血压、糖尿病、血脂异常；③近3个月有手术史；④磁共振检查禁忌证。

本研究遵循2013年修订的《世界医学会赫尔辛基宣言》，由四川大学华西医院伦理审查委员会批准(批准号2016355)，所有受试者签署书面知情同意书。

1.2　图像采集

采用西门子3.0T磁共振扫描仪(Magnetom Skyra, Siemens Healthcare, Medical Solutions, Erlangen, Germany)结合18通道体部相控阵线圈进行扫描。心脏电影成像采用平衡稳态自由进动序列。扫描范围包括由左心室基底部到心尖部的连续短轴及二、三、四腔长轴图像。扫描参数如下：重复时间3.4 ms；回波时间1.3 ms；视野320～380 mm^2；层厚8 mm；层间距0 mm；翻转角40°～50°；矩阵256×144；时间分辨率37～42 ms；重建25个期相。

1.3　图像分析

1.3.1　常规心功能分析

使用CVI 42后处理软件(cvi42® version 5.13.5, Circle Cardiovascular Imaging, Canada)进行图像分析。在收缩末期和舒张末期，软件自动勾画左心室内外膜轮廓，并根据标准化后处理方案进行手动调整[24]。得到左心室舒张末期容积(left ventricular end-diastolic volume, LVEDV)、左心室收缩末期容积(left ventricular end-systolic volume, LVESV)、左心室质量(left ventricular mass, LVMASS)、LVEF。根据术前LVEF将肥胖者分为LVEF≥60%和50%≤LVEF<60%两组。

1.3.2　心肌应变及应变率分析

在舒张末期，软件自动勾画长轴和短轴图像的左心室内外膜轮廓，并进行手动调整。由短轴图像得到整体径向应变(global radial strain, GRS)、整体周向应变

(global circumferential strain, GCS)、收缩期整体径向应变率(systolic global radial strain rate, GRSR-S)、收缩期整体周向应变率(systolic global circumferential strain rate, GCSR-S)、舒张期整体径向应变率(diastolic global radial strain rate, GRSR-D)、舒张期整体周向应变率(diastolic global circumferential strain rate, GCSR-D);由长轴图像得到整体纵向应变(global longitudinal strain, GLS)、收缩期整体纵向应变率(systolic global longitudinal strain rate, GLSR-S)、舒张期整体纵向应变率(diastolic global longitudinal strain rate, GLSR-D)(图1)。

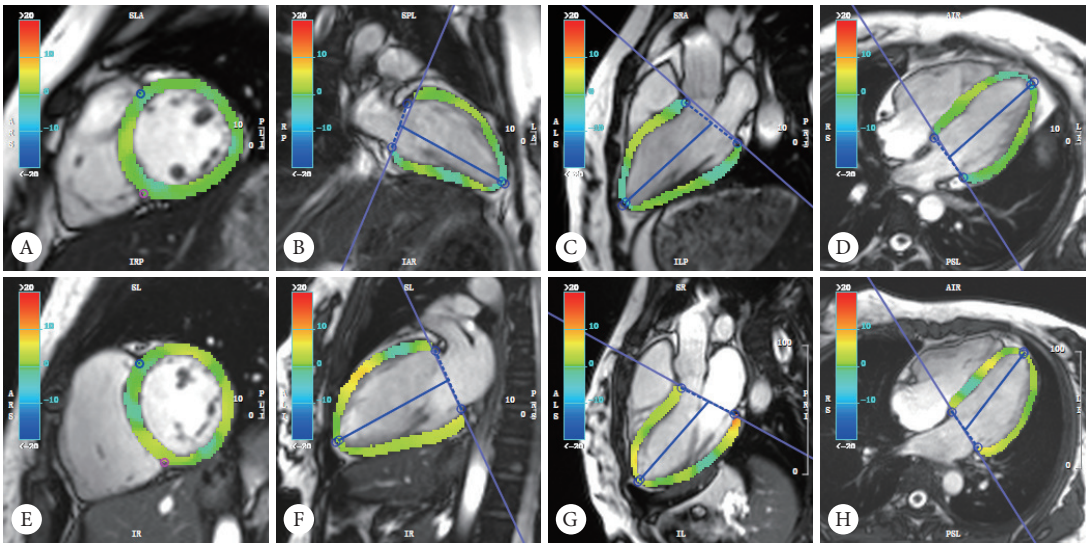

图 1 左心室心肌应变伪彩图

Fig 1 Pseudo-color maps of left ventricular myocardial strain

Short-axis (A), two-chamber (B), three-chamber (C), and four-chamber (D) cine images of an obese subject at baseline. Short axis (E), two-chamber (F), three-chamber (G), and four-chamber (H) cine images of an obese subject after bariatric surgery.

1.4 重复性分析

由两位具有3年以上图像后处理经验的放射技师进行分析。其中一位技师完成所有数据测量,并在1个月后随机选取20例图像再次进行分析,计算组内一致性。另一位技师对这20例图像进行测量,得到组间一致性。

1.5 统计学方法

统计学软件为SPSS 23.0和GraphPad Prism 10.2.2软件。采用Shapiro-Wilk检验对计量资料进行正态性检验。肥胖组基线与对照组的比较选用单因素方差分析或Kruskal-Wallis H检验,采用Bonferroni校正法进行事后两两比较。肥胖组基线与术后的比较选用单因素重复测量方差分析或Friedman检验,采用Bonferroni校正法进行事后两两比较。采用Pearson相关或Spearman秩相关进行相关性分析。采用组内相关系数(intraclass correlation coefficient, ICC)进行组内及组间一致性分析,ICC>0.75 表示重复性好。$P<0.05$为差异有统计学意义。样本量采用G*Power 3.1.9.7软件进行计算,选择重复测量方差分析组内因素,效应量取0.25,检验水准α取0.05,检验效能1–β取0.80,组数为2,测量次数为3,重复测量间的相关性为0.5,非球形性校正的值设为1。结果得出两组肥胖者的总样本量最低应为28例,每组肥胖者样本量最低应为14例。

2 结果

2.1 肥胖组基线与对照组的比较

共纳入75例拟行减重手术的肥胖者和46例年龄($t=-0.365$, $P=0.716$)、性别($\chi^2=0.126$, $P=0.832$)相匹配的健康对照(对照组)。根据术前LVEF将肥胖者分为LVEF≥60%组($n=43$)和50%≤LVEF<60%组($n=32$)。由表1可见,LVEF≥60%组的LVEDV、LVMASS大于对照组,差异有统计学意义(P均<0.05),GLS、GRSR-D、GCSR-D、GLSR-D低于对照组,差异有统计学意义(P均<0.05)。50%≤LVEF<60%组的LVEDV、LVESV、LVMASS大于对照组,差异有统计学意义(P均<0.05),LVEF、GRS、GCS、GLS、GRSR-S、GLSR-S、GRSR-D、GCSR-D、GLSR-D低于对照组,差异有统计学意义(P均<0.05)。

2.2 减重术后肥胖者体质量的改变

最终有38例肥胖者同时完成了减重术后1个月及12个月的CMR检查。根据术前LVEF将肥胖者分为

表 1　对照组与肥胖组基线的比较

Table 1　Comparison of the control and the obesity groups

Parameter	Control group (n=46)	Obesity group		F/H	P
		LVEF≥60% (n=43)	50%≤LVEF<60% (n=32)		
Age/yr.	30.24±7.51	31.30±8.76	30.13±8.50	0.188	0.910
Body mass/kg	56.35±9.07	97.46±17.91*	105.06±24.12*	82.459	<0.001
BMI/(kg/m^2)	20.89±1.82	36.10±5.38*	36.97±6.01*	85.064	<0.001
BSA/m^2	1.60±0.17	2.02±0.20*	2.12±0.26*	70.012	<0.001
SBP/mmHg	118.43±10.50	130.02±12.43*	127.97±15.38*	12.451	<0.001
DBP/mmHg	75.37±6.86	86.28±11.94*	87.38±13.26*	20.598	<0.001
HR/min^{-1}	70.36±9.48	88.04±16.10*	91.03±18.10*	30.668	<0.001
LVEDV/mL	130.15±22.89	142.44±24.47*	152.36±32.84*	13.555	0.001
LVESV/mL	48.81±9.59	52.63±9.33	66.22±16.70*,#	29.281	<0.001
LVMASS/g	67.73±17.84	90.82±21.85*	103.90±33.12*	41.059	<0.001
LVEF/%	62.45±3.87	63.06±1.57	56.75±2.82*,#	56.510	<0.001
GRS/%	34.44±4.11	33.43±4.38	27.70±3.52*,#	28.495	<0.001
GCS/%	−19.85±1.42	−19.48±1.49	−17.35±1.46*,#	30.654	<0.001
GLS/%	−19.50±1.53	−18.36±1.86*	−16.22±1.81*,#	34.184	<0.001
GRSR-S/s^{-1}	1.82±0.31	1.80±0.29	1.64±0.27*,#	4.219	0.017
GCSR-S/s^{-1}	−1.07±0.14	−1.08±0.14	−1.04±0.14	0.825	0.662
GLSR-S/s^{-1}	−1.01±0.18	−0.97±0.14	−0.88±0.13*,#	12.286	0.002
GRSR-D/s^{-1}	−2.21±0.43	−1.89±0.70*	−1.55±0.35*,#	36.584	<0.001
GCSR-D/s^{-1}	1.17±0.20	1.04±0.18*	0.89±0.19*,#	21.365	<0.001
GLSR-D/s^{-1}	1.21±0.23	1.07±0.20*	0.93±0.19*,#	18.242	<0.001

BMI: body mass index; BSA: body surface area; SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: heart rate; LVEDV: left ventricular end-diastolic volume; LVESV: left ventricular end-systolic volume; LVMASS: left ventricular mass; LVEF: left ventricular ejection fraction; GRS: global radial strain; GCS: global circumferential strain; GLS: global longitudinal strain; GRSR-S: systolic global radial strain rate; GCSR-S: systolic global circumferential strain rate; GLSR-S: systolic global longitudinal strain rate; GRSR-D: diastolic global radial strain rate; GCSR-D: diastolic global circumferential strain rate; GLSR-D: diastolic global longitudinal strain rate. * P<0.05, vs. control group; # P<0.05, vs. LVEF≥60% group.

LVEF≥60%组(n= 20)和50%≤LVEF< 60%组(n= 18)。LVEF≥60%组肥胖者术后不同时间BMI差异有统计学意义(F= 76.668, P< 0.001)。50%≤LVEF< 60%组肥胖者术后不同时间BMI差异有统计学意义(F= 104.237, P< 0.001)(表2和表3)。

2.3　LVEF≥60%组的左心室结构和功能改变

LVEF≥60%组术后不同时间的LVESV、GRS、GCS、GLS差异无统计学意义(P均> 0.05);LVEDV、LVMASS、LVEF、GRSR-S、GCSR-S、GLSR-S、GRSR-D、GCSR-D、GLSR-D差异有统计学意义(P均< 0.05)。减重术后1个月,该组的LVMASS、LVEF、GRSR-S、GCSR-S、GLSR-S小于减重术前,差异有统计学意义(P均< 0.05)。减重术后12个月,该组的LVEDV、LVMASS、LVEF、GLSR-S小于减重术前,差异有统计学意义(P均< 0.05);GRSR-D、GCSR-D、GLSR-D大于减重术后1个月,差异有统计学意义(P均< 0.05)(表2)。

2.4　50%≤LVEF<60%组的左心室结构和功能改变

50%≤LVEF< 60%组的LVEDV、LVESV、LVMASS、LVEF、GRS、GCS、GCSR-S、GRSR-D、GCSR-D、GLSR-D的时间效应具有统计学意义(P均< 0.05)。减重术后1个月,该组的LVMASS小于减重术前,差异有统计学意义(P = 0.003),GCS、GLSR-D大于减重术前,差异有统计学意义(P均< 0.05)。减重术后12个月,LVEDV、LVESV、LVMASS小于减重术前,差异有统计学意义(P均< 0.05),LVEF、GRS、GCS、GRSR-D、GCSR-D、GLSR-D大于减重术前,差异有统计学意义(P均< 0.05);GCSR-S小于减重术后1个月,差异有统计学意义(P< 0.05)(表3)。

2.5　相关性分析

减重术后12个月,LVEF≥60%组的GCSR-S改变与LVESV改变呈负相关(r= −0.499, P= 0.025)。50%≤

表 2 LVEF≥60%组的体质量和左心室改变

Table 2 Changes in body mass and left ventricular parameters in the LVEF≥60% group

Parameter	Baseline (n=20)	1 month (n=20)	12 months (n=20)	F	P
Body mass/kg	98.46±16.33	84.96±14.16*	70.06±10.75*,#	77.915	<0.001
BMI/(kg/m^2)	36.94±5.73	31.89±5.07*	26.18±3.17*,#	76.668	<0.001
BSA/m^2	2.03±0.17	1.90±0.16*	1.77±0.15*,#	79.515	<0.001
LVEDV/mL	154.35±22.36	145.87±21.31	138.76±15.01*	9.606	<0.001
LVESV/mL	56.64±8.77	58.62±12.43	55.01±7.19	2.115	0.135
LVMASS/g	92.84±21.43	77.64±19.81*	75.17±17.17*	24.400	<0.001
LVEF/%	63.25±2.91	60.00±4.61*	60.24±4.26*	19.300	<0.001
GRS/%	30.92±4.27	29.18±4.67	32.52±7.84	2.991	0.084
GCS/%	−18.63±1.49	−17.91±1.81	−19.02±2.42	3.382	0.060
GLS/%	−17.78±1.66	−17.67±1.60	−18.18±2.06	0.479	0.623
GRSR-S/s^{-1}	1.75±0.37	1.53±0.32*	1.63±0.45	9.923	0.007
GCSR-S/s^{-1}	−1.07±0.14	−0.97±0.13*	−0.97±0.16	10.831	0.004
GLSR-S/s^{-1}	−0.96±0.13	−0.87±0.13*	−0.84±0.17*	11.221	0.004
GRSR-D/s^{-1}	−1.83±0.33	−1.60±0.36	−1.98±0.67#	6.700	0.035
GCSR-D/s^{-1}	1.00±0.13	0.90±0.17	1.04±0.19#	4.835	0.013
GLSR-D/s^{-1}	1.06±0.14	0.98±0.20	1.08±0.18#	3.982	0.027

The abbreviations are explained in the note to Table 1. * P<0.05, vs. baseline; # P<0.05, vs. one month after surgery.

表 3 50%≤LVEF<60%组的体质量和左心室改变

Table 3 Changes in body mass and left ventricular parameters in the 50%≤LVEF<60% group

Parameter	Baseline (n=18)	1 month (n=18)	12 months (n=18)	F	P
Body mass/kg	111.97±22.05	99.65±19.42*	76.24±14.17*,#	88.207	<0.001
BMI/(kg/m^2)	38.11±5.29	33.92±4.64*	26.03±3.73*,#	104.237	<0.001
BSA/m^2	2.21±0.25	2.10±0.23*	1.91±0.20*,#	74.139	<0.001
LVEDV/mL	163.55±30.95	156.69±23.97	153.07±26.24*	3.889	0.030
LVESV/mL	72.03±14.95	66.96±13.41	61.92±14.44*	9.033	0.002
LVMASS/g	110.72±29.81	94.35±25.44*	92.20±23.72*	16.444	<0.001
LVEF/%	56.06±2.90	57.35±4.67	59.70±4.99*	4.873	0.014
GRS/%	26.83±4.85	28.77±5.76	32.73±5.86*	7.971	0.007
GCS/%	−16.91±2.09	−17.71±2.33*	−19.10±2.00*	7.758	0.007
GLS/%	−16.43±1.98	−16.92±1.67	−17.94±1.88	4.778	0.092
GRSR-S/s^{-1}	1.59±0.29	1.71±0.44	1.62±0.29	1.000	0.607
GCSR-S/s^{-1}	−1.03±0.18	−1.08±0.18	−0.99±0.12#	6.676	0.036
GLSR-S/s^{-1}	−0.93±0.14	−0.93±0.19	−0.87±0.14	0.778	0.678
GRSR-D/s^{-1}	−1.50±0.41	−1.68±0.53	−1.90±0.40*	5.506	0.008
GCSR-D/s^{-1}	0.87±0.22	0.92±0.24	1.00±0.16*	3.893	0.028
GLSR-D/s^{-1}	0.89±0.20	0.99±0.22*	0.99±0.22*	3.940	0.029

The abbreviations are explained in the note to Table 1. * P<0.05, vs. baseline; # P<0.05, vs. one month after surgery.

LVEF<60%组GRS(r=−0.492, P=0.038)、GRSR-S(r=−0.593, P=0.009)、GCSR-S(r=−0.647, P=0.004)、GRSR-D(r=−0.504, P=0.033)的改变与LVESV改变呈负相关; GCSR-S的改变与LVEDV改变呈负相关(r=−0.510, P=0.031)。

2.6 重复性分析

重复性分析结果显示, 所有CMR参数的组内ICC值(95%置信区间)为0.924(0.819, 0.969) ~ 0.999(0.997,

1.000), 组间ICC值为0.913(0.795, 0.965) ~ 0.989(0.972, 0.996), 重复性好。

3　讨论

本研究应用CMR成像分析了不同LVEF范围的肥胖者基线和减重术后的左心室结构和功能的纵向改变。本研究的主要发现如下: ①肥胖者存在左心室重构(左室扩大、LVMASS增加)及心肌舒缩功能降低; ②减重手术后, 肥胖者的左心室重构发生逆转(左室缩小、LVMASS减小); ③减重术后, LVEF≥60%组肥胖者的整体应变(GRS、GCS、GLS)未见明显改变; ④减重术后, 50%≤LVEF< 60%组肥胖者的整体应变(GRS、GCS)和舒张期整体应变率(GRSR-D、GCSR-D、GLSR-D)增加。

本研究发现肥胖者的左室扩大和LVMASS增加, 肥胖者存在左心室重构, 这与既往研究一致[21, 25]。肥胖者通过增加每搏输出量来实现更多的心输出量, 引起左心室充盈压和容积增加, 导致左室扩大; 由于心腔扩大, 左室壁应力增加, 心肌代偿性收缩增加, 引起左室壁增厚和LVMASS增加[26]。HOMIS等[27]指出心脏重构可能导致心肌纤维化、心室僵硬和收缩功能降低, 尽管肥胖者的LVEF正常, 但肥胖仍与左心室收缩功能障碍有关。LIU等[17]发现肥胖者的左心室应变及应变率降低, 这提示肥胖者存在左心室心肌运动功能降低。与上述研究一致, 本研究肥胖者的LVEF保留, 但其左心室亚临床舒缩功能降低。肥胖可增加左室前、后负荷, 引起左室壁应力增加, 导致左室扩张和代偿性左心室肥厚, 这一过程会增加心肌硬度, 从而导致左心室舒缩功能障碍[28]。

一篇荟萃分析[29]评价了减重手术后心脏结构的早期变化, 减重术后左室大小和LVMASS减小。减重手术改善肥胖者的左心室结构和功能, 有助于预防未来不良心血管事件的发生[30-32]。与上述研究一致, 本研究发现肥胖者行减重手术后, 左室缩小、LVMASS减小, 提示左心室重构发生逆转。减重手术不仅可以改善左心室结构, 还可以通过诱导代谢和血流动力学的改变, 降低肥胖者心血管疾病的发病率和死亡率[33-34]。

在本研究中, 减重术后1个月, LVEF≥60%组的LVEF、GRSR-S、GCSR-S、GLSR-S均减小。这可能是因为肥胖者需要更多的心输出量, 该组肥胖者心肌代偿性运动增加, 减重术后1个月, 肥胖状态改善, 心脏代偿性做功减少, 因此, LVEF和收缩期整体应变率减小。减重术后12个月的舒张期应变率(GRSR-D、GCSR-D、GLSR-D)较术后1个月明显改善, GCS、GRS、GLS、GRSR-S较术后1个月有改善趋势, 这提示肥胖者的亚临床舒张功能得到改善, 但未来需要更长时间的随访来证明减重手术会改善术前LVEF≥60%的肥胖者的亚临床收缩功能。研究[35-36]指出减重术后肥胖者的整体应变及应变率增加, 左心室亚临床舒缩功能改善。本研究50%≤LVEF< 60%组的结果与既往研究一致, 减重术后1个月, 该组的GCS较基线明显改善; 术后12个月, 该组的GRS、GCS、GRSR-D、GCSR-D、GLSR-D较基线明显改善。既往研究[36-37]指出体质量减轻有利于肥胖者的亚临床收缩功能改善, 对降低心力衰竭风险有重要价值。减重手术使得肥胖者脂肪组织减少, 有效调节脂肪组织的分泌效应, 发挥心脏保护作用, 同时, 减重手术可通过改善代谢状况来促进心脏功能的改善, 降低心血管风险[38-40]。

本研究存在一定局限性。第一, 本研究样本量较小, 随访时间仅为1年, 未来需在大样本多中心研究中进行更长期的随访研究。第二, 本研究未对术前LVEF< 50%的肥胖者进行分析。第三, 本研究仅探讨了肥胖者左心室结构和功能的纵向改变, 未对其他心腔的结构和功能进行分析。第四, 本研究纳入健康对照时仅考虑了年龄和性别, 未考虑其他混杂因素, 可能存在残余混杂偏倚风险。第五, 本研究共纳入了75例肥胖者, 但由于随访问题只分析了38例肥胖者减重术后的改变, 存在较大选择偏倚风险, 在未来研究中将采取相应措施减少偏倚风险。

综上所述, 减重术后, 肥胖者左心室结构和功能的改变是一个渐进的动态过程, 其结构和功能的改变情况与术前LVEF有关。

*　　*　　*

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All authors approved the final version to be published and agreed to take responsibility for all aspects of the work.

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