

◁心脏、血管影像学▷

应用二维斑点追踪技术评估阻塞性睡眠呼吸暂停综合征患者右心室功能

许丹, 王华, 霍换换, 韩东刚, 周琦, 孙蕾

(西安交通大学第二附属医院医用超声研究室, 陕西 西安 710004)

[摘要] 目的:应用二维斑点追踪技术(2D-STI)技术评价阻塞性睡眠呼吸暂停综合征(OSAS)患者右心室收缩功能的改变。方法:纳入经多导睡眠监测确诊 OSAS 患者 49 例为 OSA 组,根据睡眠呼吸暂停低通气指数(AHI)进行分度,轻度 12 例,中度 9 例,重度 28 例,同期选择年龄、性别相匹配无打鼾史的健康志愿者 40 例为对照组。应用常规超声心动图和 2D-STI 技术测量所有受试者的超声心动图参数,比较两组参数的差异。结果:与对照组相比,OSA 组右房容积指数(RAVI)显著增大($P=0.04$),三尖瓣口舒张晚期血流峰值速度(A-tv)显著升高($P=0.025$),三尖瓣口舒张早期血流峰值速度/三尖瓣口舒张晚期血流峰值速度(E/A)减低($P=0.047$),组织多普勒(TDI)三尖瓣环舒张早期峰值速度(Ea)显著减低($P=0.014$)。OSA 组右心室整体纵向应变(RV-GLS)($P=0.036$)和右心室游离壁纵向应变(RV-FWLS)($P=0.039$)显著减低。轻中度组与重度组比较,重度组 RV-GLS($P=0.002$)、RV-FWLS($P=0.030$)显著减低,重度组 RVFW 基底段纵向应变($P=0.033$)、心尖段纵向应变($P=0.028$)显著减低,两组 RVFW 中间段纵向应变差异无统计学意义($P>0.05$)。结论:OSAS 患者右心室舒张和收缩功能均出现异常改变,2D-STI 可早期发现 OSAS 患者右心室收缩功能的改变,且随着病情严重程度增加,收缩功能呈减低趋势,右心室纵向应变可作为临床重要的参数,为临床治疗和预后提供有价值的信息。

[关键词] 睡眠呼吸暂停,阻塞性;心室功能,右;超声心动描记术

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Evaluation of right ventricular function in patients with obstructive sleep apnea syndrome by two-dimensional speckle tracking imaging

XU Dan, WANG Hua, HUO Huan-huan, HAN Dong-gang, ZHOU Qi, SUN Lei

(Department of Ultrasound, Second Affiliated Hospital, Xi'an Jiaotong University, Xi'an 710004, China)

Abstract: Objective: To evaluate the changes of right ventricular systolic function in patients with obstructive sleep apnea syndrome (OSAS) using the two-dimensional speckle tracking imaging (2D-STI) technique. **Methods:** Forty-nine patients with OSAS diagnosed by polysomnography were divided as the OSA group. Based on the sleep AHI, there were 12 cases classified as mild, 9 as moderate, and 28 as severe. Forty healthy volunteers with matching age and gender and without a history of snoring were selected as the control group. They underwent conventional echocardiography and 2D-STI to complete the analysis of right ventricular, and variables were compared between the two groups. **Results:** Compared with the control group, the OSA group showed significantly higher right atrial volume index (RAVI)($P=0.04$), and the peak of late diastolic flow velocity of tricuspid orifice (A-tv) was significantly increased ($P=0.025$). The value of E/A was decreased ($P=0.047$), and early peak diastolic velocity (Ea) of tricuspid annulus by TDI was significantly decreased ($P=0.014$). The global longitudinal strain of right ventricle (RV-GLS)($P=0.036$) and longitudinal strain of right ventricular free wall (RV-FWLS)($P=0.039$) in the OSA group were significantly reduced. Compared to the mild and moderate OSA, RV-GLS of the severe OSA showed a notable reduction ($P=0.002$), as well as RV-FWLS($P=0.030$). Meanwhile RVFW basal longitudinal strain($P=0.033$) and apex longitudinal strain($P=0.028$) of severe OSA were significantly reduced, and RVFW middle longitudinal strain was not significantly different between two groups ($P>0.05$). **Conclusion:** The diastolic and systolic functions of right ventricular are changed in patients with OSAS. 2D-STI can detect the changes in right ventricular systolic function at an early stage, related to the severity of the syndrome. RVLS can be used as an important clinical parameter and provides valuable information for clinical treatment and prognosis.

Key words: Sleep Apnea, Obstructive; Ventricular Function, Right; Echocardiography

阻塞性睡眠呼吸暂停综合征(Obstructive sleep apnea syndrome, OSAS)是睡眠时上呼吸道部分或完全塌陷引起的一种慢性睡眠呼吸暂停综合征,最常见于成年人,长期慢性缺血缺氧的表现会损害心脏

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[作者简介] 许丹(1990-),女,陕西西安人,医师。E-mail:xulingyi0612@163.com

[通信作者] 孙蕾,西安交通大学第二附属医院医用超声研究室,710004。E-mail:xjtusunlei@126.com

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结构和功能^[1]。OSAS 与心血管系统疾病密切相关,是心脑血管事件发生和死亡的独立危险因素,如心肌梗死、心力衰竭、心律失常和传导障碍(特别是心房颤动)和中风^[2-3]。右心室功能损害在 OSAS 患者中很常见,但对右心室重塑和功能改变的研究很少。由于右心室结构复杂,常规超声心动图对右心室的评价不足^[4]。本研究应用常规超声心动图和二维斑点追踪技术(2D-STI)评估 OSA 组和对对照组的超声心动图参数,旨在探究 OSAS 患者早期右心室功能的改变,对临床治疗和早期预防提供有价值的信息。

1 资料与方法

1.1 研究对象

选取 2022 年 1—10 月就诊于我院耳鼻喉睡眠障碍门诊,经多导睡眠监测确诊为 OSAS 患者 49 例,平均年龄(41±9)岁,其中男 42 例,女 7 例。根据睡眠呼吸暂停低通气指数(Apnea hypopnea index, AHI)对疾病严重程度分级,轻度(AHI>5~15),中度(AHI>15~30),重度(AHI>30),其中轻度组 12 例,中度组 9 例,重度组 28 例。另外选取年龄、性别相匹配的无打鼾史的健康志愿者 40 例为对照组。排除慢性阻塞性肺疾病、高血压、冠心病、糖尿病、心脏瓣膜病、心律失常等疾病。本研究经我院医学伦理委员会批准实施,所有研究对象均签署患者知情同意书。

1.2 仪器与方法

仪器:采用 Philips EPIQ 7C 超声诊断仪,S5-1 相控阵探头,频率为 1.0~5.0 MHz,QLAB 13.0 脱机定量分析软件。

图像采集:受检者取左侧卧位,平静呼吸,同步记录心电图。首先进行常规超声心动图检查,于胸骨旁大血管短轴切面二维图像测量右室流出道远端内径(RVOTd),肺动脉内径(PAd),脉冲多普勒测量右室流出道血流峰值速度(RVOTV)、肺动脉血流峰值速度(PV);于心尖四腔心切面脉冲多普勒测量三尖瓣口舒张早期血流峰值速度(E-tv)及三尖瓣口舒张晚期血流峰值速度(A-tv),E 峰减速时间(EDT),脉冲组织多普勒模式下测量三尖瓣环收缩期峰值速度(Sa)、舒张早期峰值速度(Ea)、舒张晚期峰值速度(Aa);于聚焦右心室的心尖四腔心切面舒张末期测量右心室基底横径(RV-b)、右心室长径(RV-l),收缩末期测量右心房横径(RA-t)、右心房长径(RA-l)、描记右心房内膜面计算出右心房容积指数(RAVI),分别于舒张末期和收缩末期描记右心室内膜边界,计算右心室面积变化分数(RVFAC),M 型测量三尖瓣环从舒张末期至收缩末期向心尖方向的位移(TAPSE)。取聚焦右心室的心尖四腔心切面

(图 1),调节图像质量,使右心室内膜边界显示清晰,微调探头位置和方向,待图像满意后,嘱受检者屏住呼吸,连续采集 4 个心动周期的二维动态图像,存储供脱机分析。

图像分析:将原始数据导入 QLAB 13.0 分析软件,选取心内膜清晰的二维图像,启动 RV-strain Analysis,调整好右室心尖和三尖瓣环水平基线后,软件自动识别并生成右室舒张末期心内膜轮廓、右室收缩末期心内膜轮廓,如不满意可手动校准心内膜边界,获取满意图像后软件自动计算出右室收缩期二维整体及节段纵向应变参数:右室整体纵向应变(RV-GLS)、右室游离壁纵向应变(RV-FWLS)、RVFW 基底段纵向应变、中间段纵向应变、心尖段纵向应变,将数据导出以供后续分析。所有的数据参数均取 3 个心动周期的平均值(图 2)。

1.3 统计学分析

采用 SPSS 22.0 统计软件,计量资料经 K-S 方法检验呈正态分布,以 $\bar{x} \pm s$ 表示,两组间比较采用独立样本 *t* 检验。计数资料以频数和百分比表示,两组间比较采用 χ^2 检验, $P < 0.05$ 为差异有统计学意义。

2 结果

2.1 一般资料比较

两组年龄、性别构成比和心率的差异均无统计学意义($P > 0.05$),OSA 组 BMI、BSA、AHI 均高于对照组,夜间平均 SaO₂ 低于对照组,差异有统计学意义($P < 0.05$)。

2.2 常规超声心动图参数比较

两组右房室腔大小、PAd、PV、RVOTV、EDT、E-tv、TASPE、Sa、RVFAC 差异均无统计学意义($P > 0.05$)。与对照组相比,OSA 组 RAVI 显著增大($P = 0.04$),A-tv 峰显著升高($P = 0.025$),E/A 值显著减低($P = 0.047$),Ea 显著减低($P = 0.014$)。

2.3 右心室二维纵向应变参数比较

OSA 组 RV-GLS($P = 0.036$)以及 RV-FWLS($P = 0.039$)较对照组显著减低(表 1)。

表 1 OSA 组与对照组右心室二维纵向应变参数比较($\bar{x} \pm s$)

参数	OSA 组(n=49)	对照组(n=40)	P 值
RV-GLS	-19.57%±0.04%	-21.38%±0.02%	0.036
RV-FWLS	-23.94%±0.05%	-26.15%±0.03%	0.039

2.4 轻中度组与重度组右心室二维纵向应变参数比较

OSAS 患者轻中度组与重度组相比,重度组 RV-GLS($P = 0.002$)、RV-FWLS($P = 0.030$)显著减低,重度组 RVFW 基底段纵向应变($P = 0.033$)、心尖段纵向应变($P = 0.028$)显著减低,两组 RVFW 中间段

纵向应变差异无统计学意义($P>0.05$)(表 2, 图 3)。

表 2 轻中度组与重度组右心室二维纵向应变参数比较($\bar{x}\pm s$)

参数	重度组(n=28)	轻中度组(n=21)	P 值
RV-GLS	-18.05%±0.03%	-21.37%±0.04%	0.002
RV-FWLS	-22.63%±0.05%	-25.57%±0.05%	0.030
Basal FWLS	-26.60%±0.04%	-29.51%±0.05%	0.033
Mid FWLS	-21.47%±0.05%	-24.33%±0.05%	0.072
Apical FWLS	-18.55%±0.05%	-21.68%±0.05%	0.028

3 讨论

OSAS 是一种呼吸睡眠调节障碍性疾病, 研究结果表明 OSAS 患者右心室舒张功能已出现异常, 表现为 RAVI 显著增大, A-tv 峰显著升高, E/A 值显著减低, Ea 显著减低。Altiparmak 等^[5]研究发现 OS-AS 患者三尖瓣口血流频谱较对照组 E/A 值减低, A 峰升高, 提示右心室存在舒张功能受损。多项研究提

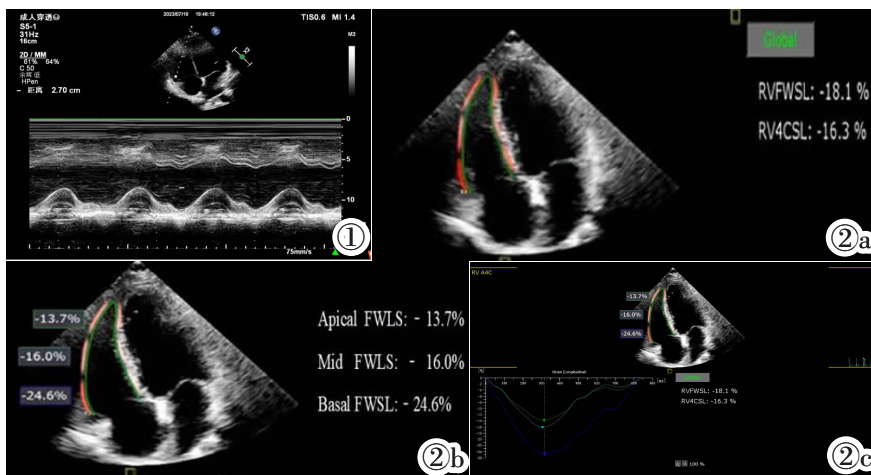


图 1 M 型超声获得右心室游离壁三尖瓣环位移。图 2 应用二维斑点追踪技术评估右心室收缩功能。图 2a: 描记 OSAS 患者右心室内膜边界, 软件自动计算出右心室整体纵向应变及右心室游离壁纵向应变值; 图 2b: 软件自动计算出右心室游离壁基底段、中间段、心尖段纵向应变值; 图 2c: 自动生成右心室游离壁各节段纵向应变-时间曲线图, 深蓝色代表游离壁基底段应变值, 淡蓝色代表中间段应变值, 绿色代表心尖段应变值。

Figure 1. M-model measurement of tricuspid annulus displacement at the free wall of the right ventricle. Figure 2. Evaluation of right ventricular systolic function by two-dimensional speckle tracking imaging. Figure 2a: The 2D-STI technique was used to trace the endocardial boundary of the right ventricle in a patient with OSAS, and the software automatically calculated the global and the free wall of the right ventricle longitudinal strain. Figure 2b: The software automatically calculated the longitudinal strain values of the base segment, middle segment and apex segment of the right ventricular free wall. Figure 2c: The software generates longitudinal strain curves for each segment of the right ventricular free wall. Dark blue curve represents strain value at the basal free wall of the right ventricle, light blue curve represents the strain value at the middle segment, and the green curve represents the strain value at the apex segment.

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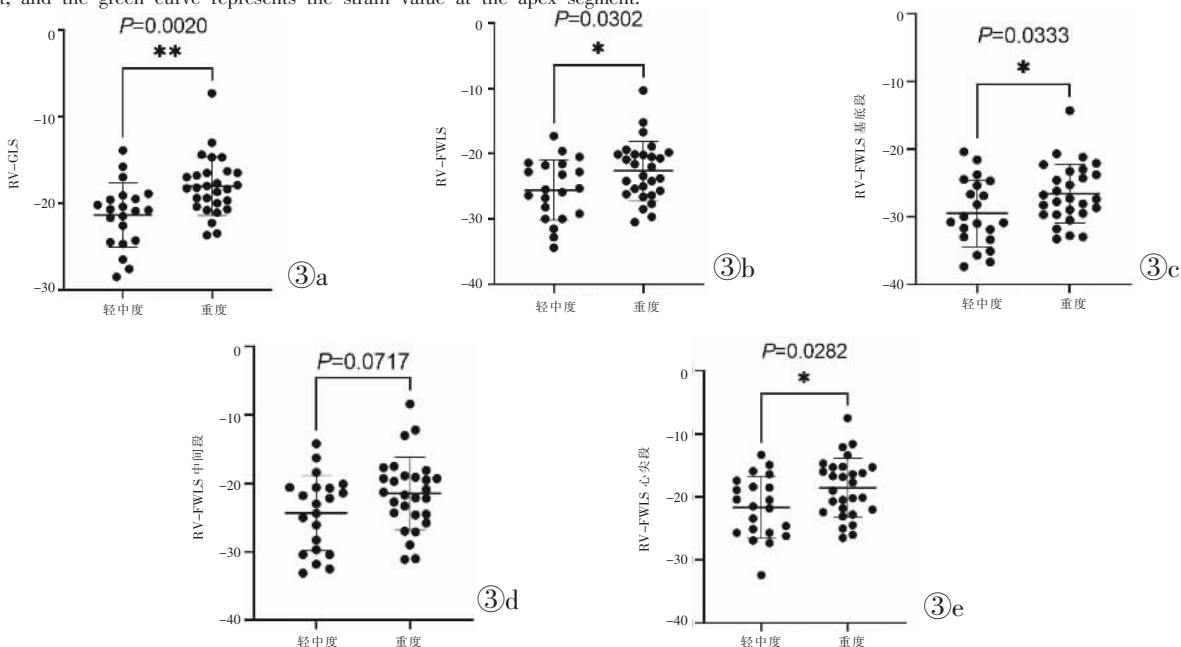


图 3 轻中度组与重度组右心室二维纵向应变参数比较。图 3a: 两组右心室整体纵向应变比较, $P<0.001$; 图 3b: 两组右心室游离壁纵向应变比较, $P<0.05$; 图 3c: 两组右心室游离壁基底段纵向应变比较, $P<0.05$; 图 3d: 两组右心室游离壁中间段纵向应变比较, $P>0.05$; 图 3e: 两组右心室游离壁心尖段纵向应变比较, $P<0.05$ 。

Figure 3. Comparison of the two-dimensional longitudinal strain parameters of the right ventricle between the mild to moderate group and the severe group. Figure 3a: Comparison of the global longitudinal strain of the right ventricle between the two groups, $P<0.001$. Figure 3b: Comparison of longitudinal strain of right ventricular free wall between two groups, $P<0.05$. Figure 3c: Comparison of basal right ventricular free wall longitudinal strain between two groups, $P<0.05$. Figure 3d: Comparison of mid right ventricular free wall longitudinal strain between two groups, $P>0.05$. Figure 3e: Comparison of apical right ventricular free wall longitudinal strain between two groups, $P<0.05$.

示 OSAS 患者在肺动脉压尚未升高前右心室已经出现舒张功能减低,与对照组比较,OSA 组 Ea 显著减低^[6-7],均与本研究结果一致。

常规超声心动图可初步评估 OSAS 患者心脏结构和功能的改变,但检查结果易受多种因素的影响,且 OSAS 患者多为肥胖的男性患者,二维图像常受肺气干扰显示欠佳,常规超声心动图尚不能系统全面准确的评估 OSAS 患者早期改变。2D-STI^[8]其重复性好、操作简便,解决了 TDI 图像获取受角度依赖的问题,相对不受心脏节律的影响,能够对心脏整体及局部心肌收缩做出精确的定量分析。Wu 等^[9]研究发现 2D-STI 技术能够更早期的识别出右心室结构和力学的细微改变,但常规超声心动图参数 RV-FAC、TAPSE、Sa 却无法识别出。在临床工作中,早期发现右心室亚临床功能障碍能够帮助预防和监测 OSAS 的常见并发症,比如右心衰竭和肺动脉高压^[10]。Chu 等^[11]发现与对照组比较,OSAS 患者右室二维纵向应变较对照组显著性减低,且右室二维纵向应变参数与 AHI 具有良好的相关性。Esposito 等^[12]应用 2D-STI 技术研究 59 例 OSAS 患者,与对照组相比,RV-GLS、RV-FWLS 均显著性减低,且这两个参数与 AHI 具有相关性,随着病情的严重程度的加重,RV-GLS、RV-FWLS 呈逐渐减低的趋势。本研究应用 2D-STI 技术发现 OSAS 患者 RV-GLS、RV-FWLS 减低,提示 OSAS 患者右心室早期收缩功能出现异常;OSAS 患者轻中度组与重度组相比,重度组 RV-GLS、RV-FWLS 显著减低,说明随着 AHI 增加,右心室纵向应变值减低,对右心室收缩功能影响越大;与轻中度组相比,重度组 RVFW 基底段纵向应变、心尖段纵向应变显著减低,两组 RVFW 中间段纵向应变差异无明显统计学,提示 OSAS 患者右室游离壁节段性收缩功能异常,心尖段和基底段对缺血缺氧更加敏感,虽然中间段纵向应变值统计学差异不明显,但两组相比,重度组右室游离壁中间段纵向应变值有减低的趋势。OSAS 引起心脏结构和功能改变主要是由于心肌缺血缺氧性损害,患者睡眠期用力吸气使胸腔负压增加,导致回心血量增加,加大心脏的前负荷,反复缺氧刺激交感神经兴奋,导致肺动脉压力升高,加大心脏后负荷。缺氧亦可引起氧化应激及系统性的炎症反应,造成心肌细胞内皮功能损害,故相互协同造成心肌收缩功能的损伤^[13]。且随着 AHI 增加,心肌缺血缺氧程度越严重,对心肌整体和节段性收缩功能损害则更加严重。宏观上,心脏的心肌纤维排列分为三层,内层心肌纤维为纵行,中层心肌纤维为环形,外层则为斜行走行。而心内膜下心肌纤维对心肌缺血缺氧最为敏感且心内膜

下心肌纤维主要沿长轴方向走行^[14],因此最先出现纵向应变的降低。本研究的局限性:OSA 组轻度和中度组样本量较少,故没有展开进行组间分析,今后还需进一步扩大样本量深入探讨研究。

综上所述,OSAS 患者右心室舒张和收缩功能均出现异常改变,应用 2D-STI 可早期发现 OSAS 患者右心室收缩功能的改变,且证实随着病情严重程度的增加,收缩功能呈减低趋势,2D-STI 提供的 RVLS 参数可为临床治疗和预后提供有价值的信息。

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