间歇高强度有氧运动对脑卒中合并冠心病患者运动耐力的影响

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摘要 目的:观察间歇高强度有氧运动强度对脑卒中合并冠心病患者运动耐力及日常生活能力的影响。**方法:**选择上海市第四康复医院 2015 年 2 月—2017 年 12 月收治的脑卒中合并冠心病患者 180 例,按照随机数字表法分为对照组、中强度组和高强度组,每组 60 例。3 组均给予脑卒中合并冠心病的常规药物治疗,对照组只给予常规康复治疗,主要包括:脑卒中肢体运动功能锻炼、心脏康复训练以及物理治疗等,每周训练 5 次,每次持续 1~2 h,共持续治疗 3 个月。中强度组在对照组基础上接受以 CPET 评估结果为指导的中等强度的有氧运动训练,患者在放松及热身 5 min 后,使用 C580R 坐靠式脚踏车进行功率踏车训练,运动强度:60% 峰值功率(PP),每天训练 1 次,每次 10 组,3 min/组,组间休息 1 min,共 40 min,隔天训练 1 次,3 次/周,共治疗 3 个月。高强度组在对照组基础上接受以 CPET 评估结果为指导的高强度有氧运动训练,运动强度调整为 80% PP,训练方式同中强度组。在治疗前、治疗 3 个月采用最大代谢当量(METs)、左心室射血分数(LVEF)评估心肺功能;采用 CPET 峰值功率(PP)、运动持续时间(ED)、峰值摄氧量(peak VO₂)、无氧阈值(AT)评价患者运动耐力;采用 Barthel 指数评价患者日常生活活动能力。**结果:**治疗前,3 组 PP、ED、peak VO₂、AT、LVEF、METs 及 Barthel 评分均无明显区别,差异无统计学意义($P>0.05$)。与治疗前比较,3 组治疗 3 个月后 PP、ED、peak VO₂、AT、LVEF、METs、Barthel 均明显升高,差异具有统计学意义($P<0.05$);与对照组比较,中、高强度组治疗 3 个月后 PP、ED、peak VO₂ 均明显更高,高强度组治疗 3 个月后 AT、LVEF 均明显更高,差异具有统计学意义($P<0.05$),而中强度组治疗 3 个月后 AT、LVEF 则无明显差别,差异无统计学意义($P>0.05$);与中强度组比较,高强度组治疗 3 个月后 PP、ED、peak VO₂、METs、LVEF 均明显更高,差异具有统计学意义($P<0.05$)。**结论:**高强度间歇有氧运动能有效改善脑卒中合并冠心病患者心功能及运动耐力,提高患者日常生活活动能力,改善患者预后,值得临床推广。

关键词 脑卒中;冠心病;有氧运动;高强度;运动耐力

脑卒中与冠心病均属心脑血管疾病且有着相似的危险因素(包括高血压、高血脂、吸烟、缺乏运动、肥胖、糖尿病等),对于该类患者而言,单纯药物或手术治疗无法完全解除危险因素,提高患者生活质量及预后的关键在于躯体心理等一体的综合康复治疗^[1]。脑卒中(包括无合并心血管疾病的初发脑

卒中)会导致心、肺功能下降已成为共识,而冠心病合并脑卒中患者心、肺功能下降情况则更为严重^[2]。有研究显示,传统单一的康复模式无法提供充足的训练量以抵抗患者体力的减退,也无法通过足够的重复性活动达到运动学习最佳化的目标,从而有效促进脑卒中患者恢复健康^[3]。

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有研究显示,运动康复特别是有氧运动可有效改善心肌缺血,增加脑组织氧供,降低心脑血管事件发生率^[4]。但有关于脑卒中合并冠心病患者有氧运动强度的选择尚无形成统一共识,多数学者认为脑卒中合并冠心病患者更适合进行低、中强度的运动训练,仅有少部分学者认为高强度间歇运动康复效果更佳^[5]。关于脑卒中合并冠心病患者进行有氧运动康复的相关研究较少,且存在样本量少、观察周期偏短等问题,临床循证学依据等级不高。本研究观察不同有氧运动强度对脑卒中合并冠心病患者运动耐力的影响,旨在为临床有氧运动强度的选择提供参考。

1 临床资料

1.1 病例选择标准

1.1.1 诊断标准

1.1.1.1 脑卒中诊断标准 参照《中国脑血管病一级预防指南 2015》中有关脑卒中的诊断标准^[6],并经头颅 CT 或 MRI 证实。

1.1.1.2 冠心病诊断标准 参照中华医学会心血管病学分会制定的《慢性稳定性心绞痛诊断与治疗指南》中有关冠心病的诊断标准^[7]。

1.1.2 纳入标准 ① 脑梗死或脑出血首次发病,病程 2~6 个月;② 合并有包括稳定型心绞痛、无症状性心肌缺血血运重建术后[经皮冠状动脉介入治疗(percutaneous coronary intervention, PCI)术后、经皮冠状动脉腔内血管成形术(percutaneous transluminal coronary angioplasty, PTCA)术后、冠脉搭桥术(coronary artery bypass grafting, CABG)术后]、已控

制的心衰在内的冠心病,左心室射血分数(left ventricular ejection fraction, LVEF) $\geq 40\%$,且心脏康复危险分层为低、中危^[8];③ 年龄 50~70 岁;④ 有肢体偏瘫,Brunnstrom 运动功能分级Ⅲ级以上、坐位平衡 ≥ 2 级、可完成 6 min 步行测试和四肢联动训练;⑤ 患者及家属自愿签署知情同意书。

1.1.3 排除标准 ① 患者存在认知或精神障碍;② 发病时间 < 2 周;③ 存在严重心律失常,心功能分级 4 级;④ 静息收缩压 > 160 mmHg 或静息舒张压 > 100 mmHg;⑤ 中度及以上主动脉狭窄;⑥ 冠心病伴有急性并发症(如冠脉动脉撕裂、急性血管闭塞包括支架内血栓形成等);⑦ 心包炎或心肌炎活动期;⑧ 严重感染,水电解质和代谢明显异常;⑨ 合并慢性阻塞性肺疾病;⑩ 有新的深静脉血栓、血栓性静脉炎、下肢闭塞性动脉硬化、主动脉夹层及其他部位动脉瘤。

1.1.4 中止和脱落标准 ① 治疗依从性差,无法进行观察;② 治疗过程中发生严重并发症或病情恶化;③ 患者转院或其他原因主动退出。

1.2 一般资料

选择上海市第四康复医院 2015 年 2 月—2017 年 12 月收治的脑卒中合并冠心病患者 180 例。采用随机数字表法分为对照组、中强度组、高强度组,每组 60 例。3 组年龄、性别、LVEF、脑卒中类型等基线临床资料比较无明显区别,差异无统计学意义($P > 0.05$),具有可比性,见表 1。本研究方案经上海市第四康复医院医学伦理委员会批准通过(批号:伦 2017-05)。

表 1 3 组一般资料比较($\bar{x} \pm s$)

Table 1 Comparison of general data in three groups ($\bar{x} \pm s$)

组别	n	性别		年龄/岁	LVEF/%	脑卒中类型	
		男	女			脑出血	脑梗死
对照组	60	41	19	60.20 $\pm$ 4.964	53.03 $\pm$ 3.953	8	52
中强度组	60	40	20	59.00 $\pm$ 4.643	53.60 $\pm$ 4.267	11	49
高强度组	60	43	17	58.90 $\pm$ 5.294	52.97 $\pm$ 4.146	9	51

2 方法

2.1 治疗方法

3 组干预前均使用 K4B2 心肺运动测试训练系统(意大利 COSME 公司)进行心肺功能试验(cardiopulmonary exercise test, CPET)评估。患者先使用功率车(台湾时保雅公司, C580R 坐靠式脚踏车)进行

空载踏车热身 5 min,休息 3 min,初始功率为 5 W,以 10 W/min 速率递增,训练过程中要注意监测心电图、血压、血氧饱和度等指标。患者进行踏车训练时速度保持 50~60 r/min,当患者出现胸痛、乏力、呼吸困难等不适症状和/或心电图、血压监测达到试验中止指征时,中止评估并记录峰值功率(peak power, PP)^[9]。

2.1.1 对照组 给予脑卒中合并冠心病的常规内科药物治疗和康复干预,包括脑卒中肢体运动功能锻炼、心脏康复训练以及物理治疗等。常规康复干预每周 5 次,每次持续 1~2 h,训练过程中若出现明显不适症状或达最大运动负荷时停止训练,共持续治疗 3 个月^[10]。

2.1.2 中强度组 在对照组基础上接受以 CPET 评估结果为指导的有氧运动训练,嘱患者在放松及热身 5 min 后,使用 C580R 坐靠式脚踏车进行功率踏车训练,有氧运动强度为 60% PP,每次训练 10 组,每组 3 min,组间休息 1 min,共计 40 min,1 次/d,隔天训练 1 次,每周训练 3 次,共持续治疗 3 个月。

2.1.3 高强度组 在对照组基础上接受以 CPET 评估结果为指导的有氧运动训练,训练方式同中强度组,仅有氧运动强度调整为 80% PP。

2.2 观察指标

2.2.1 心肺功能评价 采用最大代谢当量(metabolic equivalents, METs)、LVEF 评估心脏功能^[11]。

2.2.2 运动耐力评价 采用 CPET 峰值功率(PP)、运动持续时间(exercise duration, ED)、峰值摄氧量(peak oxygen uptake, peak VO₂)、无氧阈值(anaerobic threshold, AT)评价患者运动耐力^[12]。① PP 是指患者所能耐受的最大运动负荷,反映运动强度;② ED 是指运动持续时间,反映运动耐力;③ peak VO₂ 是指运动过程中患者能耐受的最大运动负荷时的摄

氧量,主要反映其心肺储备功能、骨骼肌整体情况以及疾病严重程度;④ AT 指患者进行递增负荷运动时,机体由有氧代谢为主向无氧代谢为主过渡的临界点,可反映机体有氧代谢能力且不受运动强度影响。

2.2.3 日常生活能力评价 采用 Barthel 指数进行患者日常生活活动能力评价^[13]。总分 100 分,得分越高,表示独立性越强,依赖性越小。① 生活基本可以自理:>60 分;② 生活需要帮助:40~60 分;③ 生活需要很大帮助:20~40 分;④ 生活完全需要帮助:<20 分。

分别于治疗前、治疗 3 个月进行以上项目评价。

2.3 统计学方法

采用 SPSS 20.0 统计软件进行数据分析。计量资料以($\bar{x} \pm s$)表示,数据符合正态分布,组内治疗前后比较采用配对样本 *t* 检验;组间比较采用方差分析,两两比较采用 SNK-*q* 检验。计数资料采用 χ^2 检验。*P*<0.05 为差异具有统计学意义。

3 结 果

3 组在治疗过程中均无中止和脱落病例,每组各纳入 60 例。

3.1 3 组治疗前后 METs、LVEF 比较

见表 2。

表 2 3 组治疗前后 METs、LVEF 比较($\bar{x} \pm s$)

Table 2 Comparison of METs and LVEF in three groups before and after treatment ($\bar{x} \pm s$)

组 别	<i>n</i>	METs		LVEF/%	
		治疗前	治疗后	治疗前	治疗后
对 照 组	60	4.09±0.52	4.63±0.39 ¹⁾	53.03±3.95	62.68±6.59 ¹⁾
中强度组	60	4.11±0.50	4.75±0.42 ¹⁾²⁾	53.60±4.27	66.37±7.31 ¹⁾
高强度组	60	4.06±0.43	5.19±0.55 ¹⁾²⁾³⁾	52.97±4.15	69.15±7.62 ¹⁾²⁾³⁾

注:与治疗前比较,1) *P*<0.05;与对照组比较,2) *P*<0.05;与中强度组比较,3) *P*<0.05。

Note: Compared with before treatment, 1) *P*<0.05; Compared with the control group, 2) *P*<0.05; Compared with the medium intensity group, 3) *P*<0.05.

3.2 3 组治疗前后运动耐力指标比较

见表 3。

3.3 3 组治疗前后 Barthel 评分比较

见表 4。

4 讨 论

有研究发现,脑卒中与冠心病的共同危险因素是缺乏体力活动,长期缺乏体力活动可能会导致心肺功能适应性下降^[14],进而影响患者生活质量。运

动康复锻炼特别是有氧运动可有效改善脑卒中合并冠心病患者心肺功能^[15],但如何选择合适的有氧运动训练强度是临床康复训练过程中应重点关注的问题之一。在临床康复训练中,往往考虑安全的因素,多以低、中强度的有氧运动为主。有研究显示,长期规律的低、中强度有氧运动在降低安静状态下心率、血压方面具有积极意义,对于改善心肌、脑组织供氧以及提高外周肌肉有氧代谢功能亦有着重要作用^[16]。但在临床实践中发现过低的运动强

表 3 3组治疗前后运动耐力指标比较($\bar{x}\pm s$)Table 3 Comparison of exercise endurance indexes in three groups before and after treatment ($\bar{x}\pm s$)

组别	n	PP/W		ED/S	
		治疗前	治疗后	治疗前	治疗后
对照组	60	70.10±10.07	72.27±10.24 ¹⁾	369.13±24.98	367.80±26.11 ¹⁾
中强度组	60	72.07±10.39	80.80±10.33 ¹⁾²⁾	361.07±25.04	413.37±25.60 ¹⁾²⁾
高强度组	60	68.97±9.63	88.63±10.65 ¹⁾²⁾³⁾	359.20±26.39	450.77±28.47 ¹⁾²⁾³⁾

组别	n	peak VO ₂ /(mL·min ⁻¹ ·kg ⁻¹)		AT/(mL·min ⁻¹ ·kg ⁻¹)	
		治疗前	治疗后	治疗前	治疗后
对照组	60	16.67±1.31	17.70±1.33 ¹⁾	14.00±0.88	14.20±0.71 ¹⁾
中强度组	60	16.57±1.16	18.77±1.21 ¹⁾²⁾	13.95±0.91	14.50±0.93 ¹⁾
高强度组	60	16.90±1.29	21.53±1.91 ¹⁾²⁾³⁾	13.72±1.03	14.73±0.94 ¹⁾²⁾

注:与治疗前比较,1) $P<0.05$;与对照组比较,2) $P<0.05$;与中强度组比较,3) $P<0.05$ 。

Note: Compared with before treatment, 1) $P<0.05$; Compared with the control group, 2) $P<0.05$; Compared with the medium intensity group, 3) $P<0.05$.

表 4 3组治疗前后 Barthel 评分比较($\bar{x}\pm s$)Table 4 Comparison of Barthel scores in three groups before and after treatment ($\bar{x}\pm s$)

组别	n	治疗前	治疗后
对照组	60	60.63±6.80	62.68±6.59 ¹⁾
中强度组	60	58.44±6.36	66.37±7.31 ¹⁾²⁾
高强度组	60	59.25±6.47	69.15±7.62 ¹⁾²⁾³⁾

注:与治疗前比较,1) $P<0.05$;与对照组比较,2) $P<0.05$;与中强度组比较,3) $P<0.05$ 。

Note: Compared with before treatment, 1) $P<0.05$; Compared with the control group, 2) $P<0.05$; Compared with the medium intensity group, 3) $P<0.05$.

度常存在康复效果不佳的情况,脑卒中患者肢体功能障碍情况常无法得到持续改善,脑卒中合并冠心病患者运动耐力也未明显提升,患者康复效果不佳,康复信心不足,治疗依从性得不到保证。有研究显示高强度、间歇性有氧运动,可增加患者最大摄氧量,逆转心室重构,提高左室心肌功能^[15],但由于有氧运动强度较大存在一定风险,还存在较大争议^[17]。

4.1 高强度间歇有氧运动可改善脑卒中合并冠心病患者运动耐力

本研究以 CPET 评估结果为指导开展不同强度间歇有氧运动训练,结果显示,与治疗前比较,3组治疗3个月后峰值功率(PP)、运动持续时间(ED)、峰值摄氧量(peak VO₂)、无氧阈值(AT)、左心室射血分数(LVEF)均明显升高;与对照组比较,中、高强度组治疗3个月后 PP、ED、peak VO₂ 均明显更高,高强度组治疗3个月后 AT、LVEF 均明显更高,而中强度组治疗3个月后 AT、LVEF 则无明显差别;

与中强度组比较,高强度组治疗3个月后 PP、ED、peak VO₂、LVEF 均明显更高。这提示,高强度间歇有氧运动更能有效提高脑卒中合并冠心病患者的心肺功能和运动耐力,改善预后,并使其在递增负荷运动中保持较高的工作效率。这可能是高强度间歇运动能带来更强的运动刺激,从而更好地促进心血管及骨骼肌系统的结构、功能和调节能力的适应性改变,增强训练的中心效应及外周效应。这与 SHIRAEV T 等^[18-19]研究发现,高强度间歇运动可降低心血管患者血压,改善血管内皮功能,调节血脂,增加最大摄氧量,提高左室心肌功能以及逆转心力衰竭患者的心室重构等,且运动强度越大,心衰患者的心肺功能适应性也越高的结果一致。

4.2 高强度间歇有氧运动可改善脑卒中合并冠心病患者日常生活活动能力

有研究显示,每增加 1 METs,患者校正死亡风险可降低 12%,与 4 METs 比较,9 METs 时的死亡风险可降低 61%^[20]。这说明随着有氧代谢能力的提高,脑卒中合并冠心病患者的运动能力也得到明显改善,这样有助于控制心脑血管疾病并发症发生风险。本研究高强度组有氧运动训练方案患者能较好地配合完成训练,经过3个月训练患者有氧代谢能力明显得到提升,Barthel 评分明显提高;此外,高强度间歇有氧运动会一定程度上消除患者肥胖等心脑血管疾病危险因素^[21],帮助患者逐步恢复日常生活活动能力,提高生存质量。

5 小结

高强度间歇有氧运动能有效改善脑卒中合并

冠心病患者心功能、运动耐力和日常生活活动能力,有助于改善患者预后,值得临床推广应用。

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大医精诚 止于至善

Effects of Yanghe Decoction on IL-1 and TNF- α of Papain in Rabbit Knee Osteoarthritis

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ABSTRACT Objective: To observe the effect of Yanghe decoction on interleukin 1 (IL-1) and tumor necrosis factor- α (TNF- α) in rabbit knee osteoarthritis model, and to explore the mechanism of Yanghe decoction in the prevention and treatment of osteoarthritis. **Methods:** The 32 healthy New Zealand rabbits aged 4-6 months, half male and female, body weight (2.25 ± 0.25) kg, were randomly divided into the control group, the model group, the Yanghe decoction group and the Jingu Tongxiao pill group according to the method of random number table, with 8 cases in each group. After two weeks of adaptive feeding, in addition to the control group, the remaining three groups were injected with papain into the articular cavity to replicate the rabbit model of knee osteoarthritis. The rabbit knee joint was slightly bend, insert the needle through the middle or both sides of the joint, and 0.5 mL 1.6% Papain saline solution was injected into the knee joint cavity through the superior patellar ligament, all were injected every three days, three consecutive times. The control group and the model group were given 0.9% saline, the Yanghe decoction group was given 6 g/(kg·d) Yanghe decoction, the Jingu Tongxiao pill group was given 6 g/(kg·d) Jingu Tongxiao pills. All groups were intervened once a day, seven times a week, continuous intervention for five weeks. One week after drug withdrawal, all experimental animals were sacrificed, and the rabbit femoral medial condyle articular cartilage was taken. The morphological changes of articular cartilage stained with hematoxylin-eosin were further observed by naked eye and light microscope, and the degree of cartilage degeneration was evaluated by modified Mankin's score standard. The levels of interleukin-1 (IL-1) and tumor necrosis factor- α (TNF- α) in serum and synovial fluid were detected by enzyme-linked immunosorbent assay (ELISA). **Results:** Compared with the control group, the model group's cartilage surface was uneven and local defects, the morphology and structure of cartilage was disordered, the number of chondrocytes decreased, the tidal line disorder disappeared, the Mankin's score increased, and the contents of IL-1 and TNF- α in serum and synovial fluid increased, and the difference was statistically significant ($P < 0.05$). Compared with the model group, the cartilage defects in the Yanghe decoction group and the Jingu Tongxiao pill group were alleviated, the morphology and structure of cartilage was neat, the number of chondrocytes increased, the tidal line was clear, the Mankin's score decreased, and the levels of IL-1 and TNF- α in serum and synovial fluid decreased, and the difference was statistically significant ($P < 0.05$). Compared with the Jingu Tongxiao pill group, there was no significant difference in the morphology and structure of cartilage and the contents of IL-1 and TNF- α in serum and synovial fluid in Yanghe decoction group ($P > 0.05$). **Conclusion:** Yanghe decoction can repair the cartilage injury of osteoarthritis and effectively delay the degeneration of articular cartilage, and its mechanism may be related to the inhibition of the expression of inflammatory factors such as IL-1 and TNF- α .

KEY WORDS knee osteoarthritis; papain model; Yanghe decoction; interleukin-1; tumor necrosis factor- α ; mechanism

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Effect of Intermittent High Intensity Aerobic Exercise on Exercise Endurance of Patients with Stroke Complicated with Coronary Heart Disease

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ABSTRACT Objective: To observe the effect of intermittent high intensity aerobic exercise on exercise endurance and activities of daily living in patients with stroke complicated with coronary heart disease. **Methods:** A total of 180 patients with stroke complicated with coronary heart disease, were treated in Shanghai Fourth Rehabilitation Hospital, from February 2015 to December 2017. The patients were randomly divided into the control group, the medium intensity group and the high intensity group according to the method of random number table, with 60 cases in each group. All the three groups were given routine drug treatment of stroke complicated with coronary heart disease. The control group was only given routine rehabilitation treatment, including stroke limb motor function exercise, cardiac rehabilitation training and physiotherapy, five times a week, treatment for 1 to 2 hours each time, continuous treatment for three months. On the basis of the control group, the patients in the medium intensity group were given the aerobic exercise training guided by the results of cardiopulmonary exercise test (CPET) evaluation. After 5 minutes of relaxation and warm-up, the patients used C580R riding bicycle for power treadmill training. The aerobic exercise intensity was 60% peak power (PP), 10 groups were trained each time, 3 minutes for each group, and 1 minute for rest in different groups, continuous training for 40 minutes, once a day, once every other day, three times a week, continuous treatment for three months. On the basis of the control group, the patients in the high intensity group were given the aerobic exercise training guided by the results of CPET evaluation, the training method was the same as the medium intensity group, but only the intensity of aerobic exercise was adjusted to 80% PP. The cardiopulmonary function was evaluated by maximum metabolic equivalents (METs) and left ventricular ejection fraction (LVEF), and the exercise endurance was evaluated by CPET peak power (PP), exercise duration (ED), peak oxygen uptake (peak VO_2) and anaerobic threshold (AT). The activities of daily living of the patients was evaluated by Barthel index. **Results:** There was no significant difference in the scores of PP, ED, peak VO_2 , AT, LVEF, METs and Barthel index in the three groups before treatment ($P > 0.05$). Compared with before treatment, the PP, ED, peak VO_2 , AT, LVEF, METs and Barthel index in the three groups increased significantly after treatment for three months, and the difference was statistically significant ($P < 0.05$). Compared with the control group, the PP, ED and peak VO_2 in the medium and high intensity groups were significantly higher after treatment for three months, the AT and LVEF in the high intensity group were significantly higher after treatment for three months, and the difference was statistically significant ($P < 0.05$), but there was no significant difference in AT and LVEF in the medium intensity group after treatment for three months ($P > 0.05$). Compared with the medium intensity group, the PP, ED, peak VO_2 , METs and LVEF in the high intensity group were significantly higher after treatment for three months, and the difference was statistically significant ($P < 0.05$). **Conclusion:** Intermittent high intensity aerobic exercise can effectively improve the cardiac function and exercise endurance of stroke patients with coronary heart disease, improve the activities of daily living, and improve the prognosis of patients, which is worthy of clinical application.

KEY WORDS stroke; coronary heart disease; aerobic exercise; high intensity; exercise endurance

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