

体外膈肌起搏联合四点跪位训练 对缺血性脑卒中患者肺功能的影响

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摘要 **目的** 观察体外膈肌起搏联合四点跪位训练对缺血性脑卒中患者肺功能的影响。**方法** 选择2023年1月1日—6月30日在苏州市独墅湖医院康复科收治的60例缺血性脑卒中患者,按照随机数字表法分为对照组和治疗组,每组30例。2组均接受常规的基础训练,对照组予体外膈肌起搏器治疗,治疗组给予体外膈肌起搏器联合四点跪位训练治疗。连续治疗8周后,评估治疗前后患者健侧及患侧平静呼气末膈肌厚度(CEEDT)、最大吸气末膈肌厚度(MEIDT)、平静呼吸膈肌移动度(QBDM)、深呼吸膈肌移动度(DBDM)、用力肺活量(FVC)、第1秒用力呼气容积(FEV₁)、FEV₁/FVC、最大呼气流量(PEF)、6分钟步行距离(6MWD)和Borg评分。**结果** 2组一般资料及治疗前各项评估结果比较,差异均无统计学意义($P>0.05$)。与治疗前相比,对照组治疗8周后健侧CEEDT提高($P<0.05$),治疗4、8周后患侧CEEDT均提高($P<0.05$),治疗组治疗4、8周后健侧和患侧的CEEDT均提高($P<0.05$);与对照组相比,治疗组治疗8周后健侧和患侧的CEEDT均提高($P<0.05$)。治疗4、8周后2组健侧和患侧的MEIDT、QBDM和DBDM,以及患者FEV₁、FVC、PEF、6MWD均优于治疗前,Borg评分低于治疗前($P<0.05$);且治疗组治疗4、8周后健侧和患侧的MEIDT、QBDM、DBDM,以及患者的FEV₁、FVC和PEF明显高于对照组($P<0.05$);治疗组治疗8周后FEV₁/FVC、6MWD均提高,Borg评分降低($P<0.05$)。**结论** 体外膈肌起搏联合四点跪位训练能够改善缺血性脑卒中患者的肺功能。

关键词 缺血性脑卒中;肺功能;体外膈肌起搏;四点跪位;呼吸功能

在过去的30年里,缺血性脑卒中给世界范围内特别是发展中国家造成的负担显著增加^[1-2]。缺血性脑卒中患者常出现肺功能障碍,临床表现包括呼吸肌麻痹、肌力降低、肺通气和换气功能减弱等,存在加重脑卒中肺炎和复发的可能性^[1]。因此,寻找有效的康复治疗手段改善缺血性脑卒中患者肺功能具有重要的临床意义。

目前,临床上除了吸气肌训练和气道清除技术等常规治疗手段外,体外膈肌起搏已被广泛应用于肺部康复。体位是控制呼吸的技术之一,通过改善呼吸肌功能,从而减轻呼吸困难^[3]。研究发现四点跪式支撑改变了胸腹的形状和运动^[4-5],影响胸腹顺应性和肺功能性剩余容量,从而改变呼出潮气量的限制^[6]。与有意识的俯卧位相比,四点跪式对改善

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胸腹呼吸辅助肌有重要作用,但目前有关于外膈肌起搏联合四点跪位训练对缺血性脑卒中患者的肺功能的临床疗效鲜有报道。本研究将探讨体外膈肌起搏联合四点跪位训练对缺血性脑卒中患者的肺功能的影响,为体外膈肌起搏联合四点跪位训练的推广应用提供依据。

1 临床资料

1.1 病例选择标准

1.1.1 诊断标准 缺血性脑卒中符合《中国急性缺血性脑卒中诊治指南2018》^[7]中的诊断标准,并经MRI或CT检查确诊。

1.1.2 纳入标准 ① 年龄18~65岁,无严重认知障碍者;② 用力肺活量(forced vital capacity, FVC) < 正常期望值80%者;③ 病程<3个月,无重症肌无力或膈神经麻痹者;④ 生命体征稳定,可以配合训练者;⑤ 患者临床资料完整,签署知情同意书,积极配合治疗者。

1.1.3 排除标准 ① 有肺部、胸部和腹部疾病史;② 有吸烟史;③ 合并重症肌无力或膈神经麻痹;④ 合并严重心脏病、肝硬化、肾功能衰竭、严重全身性疾病和恶性疾病;⑤ 体内存在金属植入物;⑥ 上肢-手-下肢的Brunnstrom评分低于Ⅲ-Ⅲ-Ⅲ。

1.2 一般资料

本研究为前瞻性、随机对照临床研究。选取2023年1月1日—6月30日在苏州大学附属第四医院康复科住院的缺血性脑卒中患者70例。患者签署知情同意后,采用随机数字表法以1:1的分配原则将其分为对照组和治疗组,每组35例。在治疗过程中,2组均有5例患者因依从性不强、提前出院而脱落,最终每组纳入30例。2组性别、年龄、疗程及脑梗部位经统计学分析比较,差异均无统计学意义($P>0.05$),具有可比性。见表1。本研究已通过苏州市独墅湖医院医学伦理委员会审批通过(审批号:230068)。

表1 2组一般资料比较

Table 1 Comparison of general data between two groups

组别	例数	性别		年龄/($\bar{x}\pm s$,岁)	疗程/($\bar{x}\pm s$,d)	脑梗部位	
		男	女			左	右
对照组	30	13	17	49.15±10.36	30.58±12.00	16	14
治疗组	30	14	16	52.28±12.23	32.20±9.86	17	13
χ^2/t 值		0.067		1.770	0.252	0.067	
P 值		0.795		0.077	0.801	0.795	

2 方法

2.1 治疗方法

2.1.1 常规基础治疗 2组均采用改善脑循环、保护脑细胞、维持水及电解质稳定性等常规药物治疗及呼吸肌运动训练的常规基础治疗,包括腹式呼吸锻炼、缩唇呼气、阻力呼吸锻炼,每次15 min,每天训练2次,改善膈肌功能、动态肺顺应性和肺通气。

2.1.2 对照组 使用体外膈肌起搏器进行常规肺功能康复治疗。患者首先清洁皮肤,然后将治疗电极片连接胸锁乳突肌下端外缘1/3处(平环状软骨水平处),辅助电极片置于锁骨中线第2肋之间。起搏频率12~18次/min或根据呼吸频率/2调整。刺激频率为40 Hz,根据患者对电刺激的疼痛耐受性,尽可能加大刺激强度,刺激强度为10~15 U或根据患者耐受水平调整。治疗时间分别为4周和8周,每周5次,每次30 min。

2.1.3 治疗组 在对照组的基础上加用四点跪位训练。在该体位下,患者双手掌和前脚掌置于地面,身体与大腿成90°夹角,膝关节成90°夹角,膝关节

自由悬空,腹部收紧,背部伸直。根据患者的耐受性调整中间放松时间,治疗时间分别为4周和8周,每周5次,每天30 min。

所有参与研究的人员都接受了标准化培训,熟悉操作流程,并严格按照标准流程进行相关操作。数据由1名治疗师和1名医生记录,交换数据进行审查,以确保数据输入的准确性和真实性。数据分析由专业人员进行,确保数据分析的客观性和科学性。

2.2 评定方法

2.2.1 膈肌厚度及厚度变化率 采用新型Terason uSmart 3300超声系统评估患者治疗前后健康侧和患侧平静呼气末膈肌厚度(calm end-expiratory diaphragm thickness, CEEDT)、最大吸气末膈肌厚度(maximum end-inspiratory diaphragm thickness, MEIDT)。患者取仰卧位,嘱其平静呼吸,将探头垂直放置于8~9或7~8胸壁辅助间隙,探头标记面朝患者头部。在二维超声模式下,调整M模式,将取样线垂直于膈肌,分别测量CEEDT和MEIDT,重复测

量3次,取平均值作为最终测量结果。

2.2.2 膈肌移动度 患者取相仰卧位,要求平静呼吸。对于右半膈肌,将探头放置在右锁骨中线前肋下的区域。在二维超声模式下,找到下腔静脉及胆囊,当膈肌出现较粗的高回声线时,调整传感器的方向以确保其指向膈肌的内侧、颅侧和背侧。然后将传感器调整到M模式。M线放置在距颅-尾线约30°的位置,在平静呼吸和深呼吸时测量治疗前后健康侧和患侧的平静呼吸膈肌移动度(quiet breathing diaphragm mobility, QBDM)和深呼吸膈肌移动度(deep breathing diaphragm mobility, DBDM)。对于左半膈肌,将探头置于腋窝前中线之间,二维模式下进行横向扫描,确定肺门与脾脏之间的最大距离,然后切换到M模式进行膈肌运动测量,在平静呼吸和深呼吸时测量治疗前后健康侧和患侧QBDM和DBDM。

2.2.3 肺功能评估 使用MasterScreen肺功能仪进行肺功能测试。在坐姿情况下,指导患者快速呼气,测量FVC、第1秒用力呼气容积(forced expiratory volume in 1 second, FEV₁)、FEV₁/FVC、最大呼气流量(peak expiratory flow, PEF)。重复测量3次,取平均值作为最终测量结果。

2.2.4 6分钟步行距离 6分钟步行距离(6 minute

walking distance, 6MWD)是指选择平坦、有明确标识的走廊,让患者尽力步行6 min,记录行走的最长距离,重复测量3次,取平均值作为最终测量结果。

2.2.5 Borg评分 该评分范围为0~10分,评分越高提示患者呼吸越困难。

2.3 统计学方法

所有数据使用SPSS 25.0统计软件进行数据分析。计量资料服从正态分布以($\bar{x} \pm s$)表示,进行t检验;不满足正态分布的计量资料或等级资料采用非参数秩和检验进行比较。以 $P < 0.05$ 表示差异具有统计学意义。

3 结果

3.1 2组治疗前后健侧和患侧CEEDT、MEIDT比较

2组治疗前健侧和患侧的CEEDT比较,差异无统计学意义($P > 0.05$)。与治疗前比较,对照组治疗4周后健侧的CEEDT差异无统计学意义($P > 0.05$),但治疗8周后健侧的CEEDT提高($P < 0.05$);对照组治疗4、8周后患侧的CEEDT均明显高于治疗前($P < 0.05$)。与治疗前比较,治疗组治疗4、8周后健侧和患侧的CEEDT均明显提高($P < 0.05$)。与对照组比较,治疗组治疗第8周后健侧和患侧的CEEDT均提高($P < 0.05$)。见表2。

表2 2组治疗前后健侧和患侧CEEDT比较($\bar{x} \pm s$) cm

Table 2 Comparison of CEEDT on unaffected side and affected side before and after treatment between two groups ($\bar{x} \pm s$) cm

组别	例数	健侧			患侧		
		治疗前	治疗4周	治疗8周	治疗前	治疗4周	治疗8周
对照组	30	0.234±0.015	0.225±0.009	0.243±0.016 ¹⁾	0.207±0.016	0.220±0.015 ¹⁾	0.231±0.011 ¹⁾
治疗组	30	0.232±0.017	0.246±0.016 ¹⁾	0.256±0.015 ¹⁾²⁾	0.198±0.019	0.224±0.013 ¹⁾	0.242±0.011 ¹⁾²⁾

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

Note: Compared with that before treatment, 1) $P < 0.05$; compared with the control group, 2) $P < 0.05$.

2组治疗前健侧和患侧的MEIDT比较,差异无统计学意义($P > 0.05$)。与治疗前比较,2组治疗4、8周后健侧和患侧的MEIDT均升高($P < 0.05$)。

与对照组比较,治疗组治疗4、8周后健侧和患侧的MEIDT均提高($P < 0.05$)。见表3。

表3 2组治疗前后健侧和患侧MEIDT比较($\bar{x} \pm s$) cm

Table 3 Comparison of MEIDT on unaffected side and affected side before and after treatment between two groups ($\bar{x} \pm s$) cm

组别	例数	健侧			患侧		
		治疗前	治疗4周	治疗8周	治疗前	治疗4周	治疗8周
对照组	30	0.338±0.023	0.358±0.026 ¹⁾	0.375±0.027 ¹⁾	0.276±0.024	0.310±0.022 ¹⁾	0.372±0.021 ¹⁾
治疗组	30	0.342±0.027	0.471±0.023 ¹⁾²⁾	0.412±0.030 ¹⁾²⁾	0.271±0.020	0.331±0.021 ¹⁾²⁾	0.371±0.020 ¹⁾²⁾

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

Note: Compared with that before treatment, 1) $P < 0.05$; compared with the control group, 2) $P < 0.05$.

3.2 2组治疗前后健侧和患侧QBDM、DBDM比较

2组治疗前健侧和患侧的QBDM和DBDM比较,差异无统计学意义($P>0.05$);与治疗前比较治疗4、8周后健侧和患侧的QBDM和DBDM均升高

($P<0.05$)。与对照组比较,治疗组治疗4、8周后健侧和患侧的QBDM和DBDM均提高($P<0.05$)。见表4、表5。

表4 2组治疗前后健侧和患侧QBDM比较($\bar{x}\pm s$)

cm

Table 4 Comparison of QBDM on unaffected side and affected side before and after treatment between two groups ($\bar{x}\pm s$)

cm

组别	例数	健侧			患侧		
		治疗前	治疗4周	治疗8周	治疗前	治疗4周	治疗8周
对照组	30	1.388±0.143	1.504±0.141 ¹⁾	1.582±0.139 ¹⁾	1.236±0.114	1.342±0.118 ¹⁾	1.413±0.124 ¹⁾
治疗组	30	1.403±0.139	1.645±0.170 ¹⁾²⁾	1.807±0.201 ¹⁾²⁾	1.267±0.119	1.421±0.168 ¹⁾²⁾	1.524±0.217 ¹⁾²⁾

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

Note: Compared with that before treatment, 1) $P<0.05$; compared with the control group, 2) $P<0.05$.

表5 2组治疗前后健侧和患侧DBDM比较($\bar{x}\pm s$)

cm

Table 5 Comparison of DBDM on unaffected side and affected side before and after treatment between two groups ($\bar{x}\pm s$)

cm

组别	例数	健侧			患侧		
		治疗前	治疗4周	治疗8周	治疗前	治疗4周	治疗8周
对照组	30	4.836±0.663	5.275±0.620 ¹⁾	5.569±0.578 ¹⁾	2.978±0.545	3.539±0.574 ¹⁾	3.912±0.604 ¹⁾
治疗组	30	4.945±0.630	5.612±0.618 ¹⁾²⁾	6.058±0.596 ¹⁾²⁾	2.779±0.421	3.789±0.385 ¹⁾²⁾	4.461±0.349 ¹⁾²⁾

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

Note: Compared with that before treatment, 1) $P<0.05$; compared with the control group, 2) $P<0.05$.

3.3 2组治疗前后FEV₁、FVC、FEV₁/FVC及PEF水平比较

2组治疗前FEV₁、FVC和PEF水平比较,差异无统计学意义($P>0.05$);与治疗前比较,2组治疗4、8周后FEV₁、FVC和PEF水平均升高($P<0.05$)。与对照组比较,治疗组治疗4、8周后FEV₁、FVC和PEF水平均提高($P<0.05$)。2组治疗前FEV₁/FVC水平

比较,差异无统计学意义($P>0.05$);与治疗前比较,对照组治疗4、8周后FEV₁/FVC水平差异均无统计学意义($P>0.05$);治疗组治疗4、8周后FEV₁/FVC水平均明显升高($P<0.05$)。与对照组比较,治疗组治疗4、8周后FEV₁/FVC水平均提高($P<0.05$)。见表6。

表6 2组治疗前后FEV₁、FVC、FEV₁/FVC及PEF比较($\bar{x}\pm s$)

Table 6 Comparison of FEV₁, FVC, FEV₁/FVC and PEF before and after treatment between two groups ($\bar{x}\pm s$)

组别	例数	FEV ₁ /L			FVC/L		
		治疗前	治疗4周	治疗8周	治疗前	治疗4周	治疗8周
对照组	30	1.419±0.494	1.674±0.510 ¹⁾	1.845±0.525 ¹⁾	2.193±0.532	2.530±0.537 ¹⁾	2.755±0.542 ¹⁾
治疗组	30	1.340±0.271	1.992±0.3612 ¹⁾²⁾	2.427±0.452 ¹⁾²⁾	2.148±0.310	2.753±0.374 ¹⁾²⁾	3.156±0.437 ¹⁾²⁾

组别	例数	FEV ₁ /FVC/%			PEF/(L/S)		
		治疗前	治疗4周	治疗8周	治疗前	治疗4周	治疗8周
对照组	30	62.973±7.247	64.844±6.335	65.805±6.053	2.532±0.700	2.903±0.674 ¹⁾	3.150±0.649 ¹⁾
治疗组	30	61.878±3.613	71.918±3.308 ¹⁾²⁾	76.401±3.675 ¹⁾²⁾	2.393±0.709	3.254±0.739 ¹⁾²⁾	3.827±0.769 ¹⁾²⁾

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

Note: Compared with that before treatment, 1) $P<0.05$; compared with the control group, 2) $P<0.05$.

3.4 2组治疗前后6MWD比较

2组治疗前6MWD比较,差异无统计学意义($P>0.05$);与治疗前比较,对照组和治疗组治疗

4、8周后6MWD均提高($P<0.05$);与对照组比较,治疗组治疗8周后6MWD明显提高($P<0.05$)。见表7。

表7 2组治疗前后6MWD比较($\bar{x}\pm s$)

m

Table 7 Comparison of 6-minute walking distance before and after treatment between two groups ($\bar{x}\pm s$)

m

组别	例数	治疗前	治疗4周	治疗8周
对照组	30	471.740±60.690	498.104±61.142 ¹⁾	515.680±61.595 ¹⁾
治疗组	30	479.090±59.531	510.163±61.677 ¹⁾	546.880±63.822 ¹⁾²⁾

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

Note: Compared with that before treatment, 1) $P<0.05$; compared with the control group, 2) $P<0.05$.

3.5 2组治疗前后Borg评分的比较

2组治疗前Borg评分比较,差异无统计学意义($P>0.05$);与治疗前比较,2组治疗4、8周后Borg评

分均降低($P<0.05$)。与对照组比较,治疗组治疗8周后Borg评分明显降低($P<0.05$)。见表8。

表8 2组治疗前后Borg评分比较($\bar{x}\pm s$)

分

Table 8 Comparison of Borg score before and after treatment between two groups ($\bar{x}\pm s$)

Scores

组别	例数	治疗前	治疗4周	治疗8周
对照组	30	4.300±0.781	3.200±0.792 ¹⁾	1.800±0.653 ¹⁾
治疗组	30	4.266±0.680	2.900±0.870 ¹⁾	1.366±0.482 ¹⁾²⁾

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

Note: Compared with that before treatment, 1) $P<0.05$; compared with the control group, 2) $P<0.05$.

4 讨论

肺部功能障碍是缺血性脑卒中患者在恢复期常见的后遗症之一,会出现胸闷、气短、呼吸困难、呼吸道感染,住院时间延长,严重者会对患者的生命安全带来威胁^[1-2]。研究表明,患者肺功能下降与膈肌功能下降、运动能力下降、胸廓扩张度减弱、呼吸肌功能受损、胸肌细胞数量减少、肌肉纤维化等有关^[8]。其中膈肌功能下降、运动能力下降可致肺组织顺应性和氧输送能力下降,诱发肺功能恶化及心肺适应性下降,继而进一步促使并发症发生,严重影响患者功能的恢复^[9]。患者发生缺血性脑卒中后,其患侧膈肌明显比健侧薄^[10-11]。因此,促进膈肌功能和运动能力提升对改善肺功能至关重要。

在本研究中,我们旨在制定一种简单有效的康复训练,通过促进膈肌活动,增强膈肌的厚度和活动性,促进呼吸功能恢复,从而进一步提高患者的整体功能。研究发现,俯卧位能够改变横膈的运动且减轻其他脏器对肺组织的压迫,降低对肺的负担而增大扩张程度来改善肺通气,同时俯卧位也能够改善氧合,说明体位改变能改善肺功能^[12-14]。考虑到俯卧位的病理生理机制,四点跪位可能具有类似的生理作用,包括改善通气不平衡和血液灌注比,促进肺复张,减少患者自身造成的肺损伤^[15]。目前,四点跪位在康复练习中被广泛使用。有研究表明,四点跪位时腹部横肌和内斜肌的激活率高于仰

卧位^[16]。此外,四点跪位能够提高膈肌长度-张力的关系和功能,减少胸锁乳突肌和斜角肌的聚集,促进胸腹运动,减轻呼吸困难^[17]。同时,四点跪式支撑可以改变胸腹形态和运动,影响胸腹顺应性,从而影响潮气量的限制和功能剩余量。因此,四点跪位具有改善肺功能障碍的潜力。体外膈肌起搏是目前临床上广泛使用的肺康复手段,其通过皮肤表面电极刺激膈神经引导膈肌有规律地收缩,增加胸气量和潮气量,改善呼吸肌疲劳和通气功能,从而改善肺功能和临床症状,并促进咳嗽和气道廓清。基于以上研究,我们采用体外膈肌起搏技术结合四点跪位来改善膈肌和肺功能。本研究发现相对于单纯体外膈肌起搏,体外膈肌起搏联合四点跪位训练能够更有效地改善肺功能,治疗第4周后治疗组的CEEDT、MEIDT、QBDM、DBDM、FEV₁、FVC、FEV₁/FVC、PEF、6MWD及Borg评分均出现明显变化,治疗第8周后上述指标变化更明显,说明接受治疗时间越长,改善越明显,这对缺血性脑卒中患者的康复具有重要的临床意义。因此,体外膈肌起搏联合四点跪位训练加速提高缺血性脑卒中患者的肺功能。

但是,本研究有一定的局限性:样本量小;研究周期不足;没有确定外膈起搏技术结合四点跪位是否对所有肺功能障碍患者有效;相关的肺康复机制尚不明确。虽然本研究证实了四点跪位训练对改善缺血性脑卒中患者的肺功能具有较好的效果,需要进行更多相关研究。

综上所述,本研究认为体外膈肌起搏技术结合四点跪位训练可以改善缺血性脑卒中患者的肺功能,值得在临床上推广。

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Effect of Extracorporeal Diaphragmatic Pacing Combined with Four-Point Kneeling Position Training on Pulmonary Function in Patients with Ischemic Stroke

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ABSTRACT Objective To observe the clinical effect of extracorporeal diaphragmatic pacing combined with four-point kneeling position training on pulmonary function in patients with ischemic stroke. **Methods** A total of 60 patients with ischemic stroke admitted to the Rehabilitation Department of the Fourth Affiliated Hospital of Soochow University from January 1, 2023 to June 30, 2023 were enrolled and randomly divided into control group and treatment group, with 30 cases in each group. Both groups received

regular basic training. The control group was treated with extracorporeal diaphragmatic pacing, and the treatment group was treated with extracorporeal diaphragmatic pacing, while combined with four-point kneeling training. After 8 weeks of continuous treatment, the patients were evaluated for changes of clam end-expiratory diaphragmatic thickness (CEEDT), maximum end-inspiratory diaphragm thickness (MEIDT), quiet breathing diaphragm mobility (QBDM), deep breathing diaphragm mobility (DBDM), forced vital capacity (FVC), forced expiratory volume in 1 second (FEV₁), FEV₁/FVC, peak expiratory flow (PEF), 6-minute walking distance (6MWD) and Borg score of patients were detected and evaluated in both groups. **Results** There were no significant differences in the pre-treatment general data and baseline evaluation results at baseline, before treatment between the two groups ($P>0.05$). Compared with the pre-treatment, CEEDT of the unaffected side increased after 8 weeks of treatment in the control group ($P<0.05$), and CEEDT on the affected side significantly increased after 4 and 8 weeks of treatment ($P<0.05$); in the treatment group, CEEDT of both the unaffected and affected sides significantly increased after 4 and 8 weeks of treatment ($P<0.05$). Compared with the control group, the CEEDT of both the unaffected and affected sides increased in the treatment group after 8 weeks of treatment ($P<0.05$). After 4 and 8 weeks of treatment, the MEIDT, QBDM, DBDM on both the unaffected and affected sides, as well as the patients' FEV₁, FVC, PEF, 6MWD were all higher than those before treatment, and Borg score were lower than those before treatment ($P<0.05$). After 4 and 8 weeks of treatment, the MEIDT, QBDM, and DBDM of the unaffected and affected sides, and FEV₁, FVC and PEF in the treatment group were significantly higher than those in the control group ($P<0.05$). Compared with the control group, FEV₁/FVC and 6MWD increased and Borg score decreased in the treatment group after 8 weeks of treatment ($P<0.05$). **Conclusion** Extracorporeal diaphragmatic pacing combined with four-point kneeling position training can improve pulmonary function in patients with ischemic stroke.

KEY WORDS ischemic stroke; pulmonary function; extracorporeal diaphragmatic pacing; four-point kneeling position; respiratory function

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Hyperactive Behavior Screening and Its Influencing Factors in Preschool Children Based on a Computer Cloud Platform

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ABSTRACT Objective To investigate the current situation of hyperactive behavior and related influencing factors in preschool children aged 4-5 years in Longhua District, Shenzhen, based on the intelligent active screening of computer cloud platform, with a view to realizing early screening of hyperactive behavior in preschool children. **Methods** Using the computer platform of Jingyun, a survey was conducted on 59,564 preschool children, aged 4-5 years, from 239 kindergartens in 6 neighborhoods in Longhua District, Shenzhen, who were just enrolled in the fall of 2019. A total of 59,114 valid questionnaires were obtained. The innovation of this experiment was to place the questionnaire collection scale, which has been proved to be effective and feasible by experts in the field, on the computer cloud platform to realize intelligent data collection and intelligent analysis, so as to facilitate early screening and intelligent judgment. The general demographic data of the respondents were collected using the questionnaire prepared and proved by experts. The parent symptom questionnaire (PSQ) was used to assess the hyperactive behavior of the surveyed preschool children. The data collected were used to analyze the current status of the children's hyperactive behavior and related influencing factors. **Results** The detection rate of hyperactive behavior among preschool children aged 4-5 years in 239 kindergartens in 6 neighborhoods of Longhua District, Shenzhen was 4.86%. Children's sex, parents' marital status, length of residence in Shenzhen, neighborhood environment and transferring to another school were all associated with hyperactive behavior in preschool children ($P<0.05$). Logistic regression analysis showed that the length of residence in Shenzhen was a protective factor (95% CI 0.798-0.975), and girls were more visibly protected than boys. The marital status of the children's parents as widowed (95% CI 3.154-19.646) and unmarried (95% CI 1.027-5.268), and the children's kindergartens located in Longhua Street (95% CI 1.138-2.508), in Dalang Street (95% CI 1.384-2.971), and in Guanlan Street (95% CI 1.470-3.509) were risk factors for hyperactive behavior in preschool children. **Conclusion** The active screening through the computer cloud platform can easily and effectively screen preschool children with hyperactive behavior, as well as analyze and obtain the relevant protective or risk factors affecting hyperactive behavior in preschool children, which is recommended for early screening in a large area.

KEY WORDS hyperactive behavior; preschool children; early screening; active health; cloud platform

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