

doi: 10.13241/j.cnki.pmb.2021.20.021

脑卒中痉挛性患者经颅磁刺激联合物理治疗后 上肢功能恢复状况的临床观察*

龚晨 沈滢 吴玉霞 李健 陆晓[△]

(南京医科大学第一附属医院(南京医科大学)康复医学科 江苏 南京 210000)

摘要 目的:探讨脑卒中痉挛性患者经颅磁刺激联合物理治疗后上肢功能改善状况的临床观察。**方法:**选取我院 2018 年 1 月到 2020 年 1 月共收治的 80 例脑卒中患者,所有患者均出现不同部位痉挛现象,将患者随机分为观察组与对照组,每组 40 例。给予对照组患者常规治疗与康复训练,观察组患者在常规治疗基础上应用低频重复经颅磁刺激联合肌电生物反馈模式下的康复训练。对比两组患者的治疗效果与上肢功能改善情况。**结果:**观察组治疗总有效率 95.00%,高于对照组 72.50% ($P < 0.05$);治疗前两组患者的 NIHSS 评分应用神经功能缺损量表(Neurological deficit scale,NIHSS)、MMSE 评分应用认知功能量表(Cognitive function scale,MMSE)、ADL 评分应用日常生活能力量表(Activities of daily living scale,ADL)评分对比无显著差异($P > 0.05$),治疗后,观察组的 NIHSS 评分低于对照组,ADL 评分高于对照组($P < 0.05$);治疗前两组患者的肱二头肌和肱三头肌均方根值(Root mean square,RMS)对比无显著差异($P > 0.05$),治疗后,观察组患者的肱二头肌 RMS 低于对照组,肱三头肌 RMS 高于对照组($P < 0.05$);治疗前两组患者的运动功能评估表中的上肢功能部分(Upper limb function in motor function assessment table,FMA-UE)、手部精细化动作及上肢功能测量表(Measurement table of hand fine movement and upper limb function,Carroll)评分对比无显著差异($P > 0.05$),治疗后,观察组患者的 FMA-UE、Carroll 评分高于对照组($P < 0.05$)。**结论:**对脑卒中上肢痉挛患者在常规治疗与康复训练的基础上应用低频重复经颅磁刺激联合肌电生物反馈模式下的康复训练,虽然对患者的认知功能无明显影响,但是能提升患者上肢痉挛的治疗效果,促进患者上肢功能恢复,提高生活能力,值得临床应用推广。

关键词:脑卒中;痉挛性;上肢痉挛;经颅刺激;物理治疗;上肢功能

中图分类号:R743.3;R454 **文献标识码:**A **文章编号:**1673-6273(2021)20-3907-05

Clinical Observation on the Improvement of Upper Limb Function after Transcranial Magnetic Stimulation Combined with Physical Therapy in Patients with Spastic Stroke*

GONG Chen, SHEN Ying, WU Yu-xia, LI Jian, LU Xiao[△]

(Department of Rehabilitation Medicine, The First Affiliated Hospital of Nanjing Medical University (Nanjing Medical University),
Nanjing, Jiangsu, 210000, China)

ABSTRACT Objective: To investigate the effect of transcranial magnetic stimulation (TMS) combined with physical therapy on upper limb function in patients with spastic stroke. **Methods:** 80 cases of stroke patients in our hospital from January 2018 to January 2020 were selected as the research object, all patients had different parts of spasm phenomenon, the patients were randomly divided into observation group and control group, 40 cases in each group. Patients in the control group were given conventional treatment and rehabilitation training, while patients in the observation group were given rehabilitation training under the mode of low frequency repetitive transcranial stimulation combined with electromyographic biofeedback on the basis of conventional treatment. The treatment effect and the improvement of upper limb function of the two groups were compared. **Results:** The total effective rate of the observation group was 95.00%, which was higher than 72.50% of the control group ($P < 0.05$); before treatment, there was no significant difference in NIHSS, MMSE and ADL scores between the two groups ($P > 0.05$); after treatment, the NIHSS score of the observation group was lower than that of the control group, and the ADL score was higher than that of the control group ($P < 0.05$). Before treatment, there was no significant difference in the RMS of the biceps and triceps of the two groups of patients ($P > 0.05$). After treatment, the RMS of the biceps of the observation group was lower than that of the control group, and the RMS of the triceps was higher than that of the control group ($P < 0.05$); there was no significant difference in FMA-UE and Carroll scores of the two groups before treatment ($P > 0.05$). After treatment, the FMA-UE and Carroll scores of the observation group were higher than those of the control group ($P < 0.05$). **Conclusion:** Low frequency repetitive transcranial

* 基金项目:国家自然科学基金面上项目(81772441)

作者简介:龚晨(1986-),男,本科,主管治疗师,研究方向:神经损伤康复,电话:13813082029,E-mail:gongchen_93@163.com

△ 通讯作者:陆晓(1972-),女,博士,主任医师,研究方向:神经损伤及心肺系统疾病康复,电话:13813958023,E-mail:luxiao1972@163.com

(收稿日期:2021-02-06 接受日期:2021-02-28)

stimulation combined with electromyographic biofeedback rehabilitation training on the basis of conventional treatment and rehabilitation training can improve the treatment effect of upper limb spasm, promote the recovery of upper limb function and improve the ability of life, although it has no obvious effect on the cognitive function of patients, it is worthy of clinical application and promotion.

Key words: Stroke; spasticity; Upper limb spasticity; Transcranial stimulation; Physical therapy; Upper limb function

Chinese Library Classification(CLC): R743.3; R454 **Document code:** A

Article ID: 1673-6273(2021)20-3907-05

前言

脑卒中作为危害患者生命健康的常见血管疾病,致残率和后遗症发生率较高。随着脑血管血栓或水肿的加重,脑微循环也会受到一定程度的影响,对脑功能造成不可逆转的损害,其中认知功能和运动功能障碍最为常见,严重者甚至会出现局部偏瘫、肢体、意识、语言障碍的严重并发症,病情凶险,致命率极高,严重影响患者的生存质量^[1,2]。很多脑卒中患者发病后会出现上肢痉挛现象,多数患者为肱二头肌痉挛,为患者的生活及康复治疗带来很大影响,当前用来治疗痉挛的主要方法有外科手术、冲击波治疗、矫正器治疗、针灸、物理治疗、肉毒杆菌毒素注射、口服药物等^[3,4]。临床上,对患者多数采用口服药物、针灸治疗联合康复训练的治疗方式。虽然具有一定治疗效果,但是很多患者在治疗后,上肢功能依然存在恢复不良现象。相关研究表明^[5],对脑卒中上肢痉挛患者在常规治疗基础上联合物理治疗,能够有效的缓解肌肉痉挛。因此本文选取我院 2018 年 1

月到 2020 年 1 月共收治的 80 例脑卒中患者,探讨脑卒中痉挛性患者经颅磁刺激联合物理治疗后上肢功能的改善情况。

1 资料与方法

1.1 一般资料

选取我院 2018 年 1 月到 2020 年 1 月共收治的 80 例脑卒中患者,所有患者均出现不同部位痉挛现象,将患者随机分为观察组与对照组,每组 40 例。纳入标准:符合《中华医学会神经病学分会脑血管病学组》中对脑卒中的判定标准^[6];并经过 MRI 或 CT 检查明确诊断;心、肝、肾等重要器官功能正常,可接受治疗;所有患者通过脑卒中治疗后出现不同程度的上肢痉挛;所有患者或家属知情并签署同意书。排除标准:存在其他精神障碍的患者;合并恶性肿瘤的患者;合并其他严重功能性疾病的患者;存在表达障碍的患者;语言理解障碍和神志不清患者。两组患者一般资料对比无显著差异($P>0.05$),具有可比性,具体如表 1 所示。

表 1 两组一般资料对比
Table 1 Comparison of two general data

Groups	n	Gender (M/F)	Age (years)	BMI(kg/m ²)	Affected	
					Left upper limb	Right upper limb
Observation group	40	22/18	67.01± 2.51	24.23± 1.65	23	17
Control group	40	23/17	66.52± 2.62	24.01± 1.71	20	20

1.2 方法

对照组进行用药物治疗与康复训练,其中康复训练包含神经促进技术、被动运动、主动关节运动等,并对患者以患者个体为导向的作业治疗与普通针刺等常规康复治疗,每项每次 20 min,1 次/日,每周治疗 6 次,共治疗 4 w。药物治疗包括营养神经、改善循环以及控制血压等常规药物^[7]。

观察组患者在上述治疗基础上应用低频重复经颅刺激联合肌电生物反馈模式下的康复训练,具体方法为:(1)低频重复经颅刺激,患者采取坐位,采用 YRD CCY-1 型磁场刺激仪(武汉依瑞德医疗设备新技术有限公司,编号:20142211249),将记录电极(Ag/Ag-Cl)放置在患者健侧的拇短展肌肌腹处,将参考电极放置于记录电极远端 2 cm 处,磁场刺激仪线圈放置在患者健侧 M1 区,记录患者的静息运动阈值,治疗频率设置为 1 Hz,低频刺激强度应用 80% 的静息运动阈值,每一次治疗总脉冲数需要达到 1200 个,持续治疗 20 min,1 次/d,共治疗 4 w;(2)肌电生物反馈模式下的康复训练,应用伟思 S4 型生物反馈治疗仪,设置刺激频率为 2~100 Hz,输出电流为 0~100 mA,脉冲宽度设置为 50~400 μ s,刺激时间为 2~5 s,间歇时间设置为 10~20 s,依照患者的病情采取不同的治疗,将电极放置在患者

患侧的肱三头肌肌腹处,患者采取仰卧位,尽最大力量进行患处主动屈伸,当信号达到最高数值的时候将阈值记录下来。在治疗过程中患者依照语音提示进行患处肢体屈伸运动,并注意肌电信号变化,待肌电信号接近阈值的时候,一起开始对患者肌肉进行刺激辅助患者加强患处肢体的屈伸运动,让肌电信号超过阈值,一次屈伸运动完成。治疗之中根据患者运动情况对阈值水平进行调整。持续治疗 20 min,1 次/d,共治疗 4 w。

1.3 观察指标与疗效判定标准

观察指标:(1)NIHSS 对患者的神经功能进行评价,最高分 42 分,分值越高代表患者的神经功能障碍越严重^[8];MMSE 评估患者的认知状态,包括时间、记忆力、语言、地点等 30 项内容,30 分满分,分数越高证明认知功能越好^[9];ADL 评分评估患者的日常生活能力,满分为 100 分,分布越低患者日常生活能力越低^[10]。(2)应用 FexComp 型表面肌电仪,将电极放置在患者的患侧肱二头肌和肱三头肌的肌腹处,记录主动伸肘和被动伸肘运用肱二和肱三肌纤维 sEMG 信号,进行 3 次测试,取平均值。采样的频率设置为 2048 位/s,信号处理内容应用 RMS,最终数值表现患者的肢体痉挛镜框和主运动功能^[11]。(3)FMA-UE 评估患者的手部功能与上肢功能,其中测项目包含上

肢协调性与速度、手部运动、分离运动、伸肌共同运动、腕稳定性、伸肌协同运动、屈肌共同运动以及上肢反射能力等,满分为66分,分数越高患者的上肢功能恢复越好^[12];Carroll评分应用对患者的手部功能和上肢功能进行评价,满分为99分,分值越高患者的恢复情况越好^[13]。

疗效判定标准:治疗四周后,对两组患者的治疗效果进行评价。治愈:患者肌张力恢复正常状态,患侧肩部、肘部和腕部以及指关节的屈伸抓握恢复自由,与健侧无明显区别;显效:患者的肌张力减值达到2级或者2级以上,但是比健侧数值增高;有效:患者肌张力减值达到1级;无效:患者的肌张力与治疗前相比无明显变化,上肢依然处于痉挛状态。治愈率+显效

率+有效率=总有效率。

1.4 统计学方法

应用SPSS 22.0,计数资料以(n/%)表示,进行 χ^2 检验;计量资料以符合正态分布则用($\bar{x} \pm s$)表示,两组间比较采用t检验; $P < 0.05$ 有统计学意义。

2 结果

2.1 两组疗效对比

观察组治疗总有效率95.00%,高于对照组72.50%,组间比较,差异具有统计学意义($P < 0.05$),如表2所示。

表2 两组患者治疗效果对比分析(例,%)

Table 2 Comparative analysis of the treatment effect of the two groups of patients (n, %)

Groups	n	Cure	Excellence	Valid	Invalid	Total effective rate
Observation group	40	9(22.50)	14(35.00)	15(37.50)	2(5.00)	38(95.00)*
Control group	40	6(15.00)	11(27.50)	12(30.00)	11(27.50)	29(72.50)

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

2.2 两组患者治疗前后NIHSS、MMSE、ADL评分对比

治疗前两组患者的NIHSS、MMSE、ADL评分对比无显著

差异($P > 0.05$),治疗后,观察组的NIHSS评分低于对照组,ADL评分高于对照组($P < 0.05$),如表3所示。

表3 两组患者治疗前后NIHSS、MMSE、ADL评分对比($\bar{x} \pm s$,分)

Table 3 Comparison of NIHSS, MMSE, and ADL scores between the two groups before and after treatment ($\bar{x} \pm s$, scores)

Groups	n	NIHSS score		MMSE score		ADL score	
		Pretherapy	Post-treatment	Pretherapy	Post-treatment	Pretherapy	Post-treatment
Observation group	40	14.97 $\pm$ 3.02	9.09 $\pm$ 1.54**	16.02 $\pm$ 2.50	23.08 $\pm$ 3.12**	68.90 $\pm$ 11.29	85.21 $\pm$ 10.98**
Control group	40	15.13 $\pm$ 2.87	10.59 $\pm$ 2.40 [#]	16.31 $\pm$ 2.48	22.49 $\pm$ 3.09 [#]	69.03 $\pm$ 11.30	78.23 $\pm$ 11.03 [#]

Note: *Compared with the control group, $P < 0.05$; [#]compared with pretherapy, $P < 0.05$.

2.3 两组患者治疗前后RMS对比分析

治疗前两组患者的肱二头肌和肱三头肌RMS对比无显著

差异($P > 0.05$),治疗后,观察组患者的肱二头肌RMS低于对照组,肱三头肌RMS高于对照组($P < 0.05$),如表4所示。

表4 两组患者治疗前后RMS对比分析($\bar{x} \pm s$,mA)

Table 4 Comparative analysis of RMS before and after treatment in the two groups of patients($\bar{x} \pm s$, mA)

Groups	n	Musculus biceps brachii		Musculus triceps brachii	
		Pretherapy	Post-treatment	Pretherapy	Post-treatment
Observation group	40	27.23 $\pm$ 12.40	12.20 $\pm$ 6.87**	6.71 $\pm$ 5.39	13.70 $\pm$ 8.43**
Control group	40	28.40 $\pm$ 11.39	18.45 $\pm$ 11.35 [#]	7.13 $\pm$ 5.40	9.63 $\pm$ 6.81 [#]

Note: *Compared with the control group, $P < 0.05$; [#]compared with pretherapy, $P < 0.05$.

2.4 两组患者治疗前后FMA-UE、Carroll评分对比分析

治疗前两组患者的FMA-UE、Carroll评分对比无显著差异

($P > 0.05$),治疗后,观察组患者的FMA-UE、Carroll评分高于对照组($P < 0.05$),如表5所示。

表5 两组患者治疗前后FMA-UE、Carroll评分对比分析($\bar{x} \pm s$,分)

Table 5 Comparative analysis of FMA-UE and Carroll scores before and after treatment in the two groups of patients ($\bar{x} \pm s$, scores)

Groups	n	FMA-UE		Carroll	
		Pretherapy	Post-treatment	Pretherapy	Post-treatment
Observation group	40	20.19 $\pm$ 11.32	28.03 $\pm$ 16.54**	35.53 $\pm$ 6.21	70.59 $\pm$ 23.52**
Control group	40	20.71 $\pm$ 12.06	21.23 $\pm$ 12.68 [#]	36.58 $\pm$ 7.15	53.62 $\pm$ 14.78 [#]

Note: *Compared with the control group, $P < 0.05$; [#]compared with pretherapy, $P < 0.05$.

3 讨论

上肢功能与手部功能是人们从事正常工作与生活的基础,手部的运动功能比较复杂,依赖手部解剖结构,并且也需要良好的神经控制。由于脑卒中患者在患病之后会出现中枢神经功能受损现象,从而影响患者的手功能和上肢功能^[14,15]。相关研究显示^[16],脑卒中患者的患侧大脑半球,在运动皮质上对于健侧大脑半球运动皮质功能有着消减和抑制作用,并且患者患病之后大脑半球运动区域出现功能障碍,从而导致上肢痉挛。因此相关研究显示^[17],脑卒中患者想要在康复治疗过程中恢复手功能与上肢功能,需要改善受损区域脑功能的兴奋度,并调节双侧大脑半球之间一直作用,从而实现大脑平衡,减少上肢痉挛现象,促进患者手部功能与上肢功能恢复。低频重复经颅电磁刺激属于一项非侵入性刺激治疗技术,可以重新平衡脑卒中患者大脑半球之间皮质的兴奋性,来改善患者的肢体运动功能。而肌电生物反馈主要是利用肌电图信号反馈来增强患者对于肢体运动功能控制,从而改善患者运动功能缺陷的一种物理康复治疗技术^[18,19]。因此本研究对脑卒中患者应用低频重复经颅电磁刺激联合肌电生物反馈的治疗方法对脑卒中痉挛性患者进行治疗。

本研究结果表明,两组患者治疗 4 w 后,观察组患者治疗总有效率 95.00 %,高于对照组患者治疗总有效率 72.50 %,Caliskan E^[20]对 80 例脑卒中肌肉痉挛患者分组进行治疗发现,重复经颅刺激能够明显提升患者的治疗效果,并且其仅对患者进行 2 w 治疗后观察,而且没有增加物理治疗,本研究将时间延长到 12 个月,而且期间增加肌电生物反馈模式下的康复训练,发现患者治疗效果明显提高。相关研究发现^[21],脑卒中患者通过肌电生物反馈治疗之后,上肢运动功能和痉挛状态会明显好转,与本研究结果相符。这是因为肌电生物反馈联合低频重复经颅电磁刺激能够降低患者肢体痉挛,提升患者的运动功能,从而提升患者的治疗效果;治疗前两组患者的 NIHSS、MMSE、ADL 评分对比无显著差异,治疗后,观察组的 NIHSS 评分低于对照组,ADL 评分高于对照组,Lo WLA^[22]对脑卒中后上肢痉挛患者应用 MET 治疗 + 低频 rTMS 治疗 4 周和 8 周之后应用 MBI 评分表示患者的日常生活能力,应用 FMA-UE 表示患者的上肢运动功能,结果显示,联合治疗组患者的患者日常生活能力更好,上肢运动功能提升,与本研究结果相符。由此证明,虽然两者联合治疗不能够提升患者的认知功能,这也与电磁波的脑部治疗位置有关,但是能够明显提升患者的神经功能与日常生活能力。相关研究显示^[23],应用低频重复经颅电磁刺激能够缓解患者的上肢痉挛,提升运动功能。还有研究发现应用低频重复经颅电磁刺激联合任务导向训练治疗,能够促进脑卒中患者的功能康复情况,与本研究具有一定相关性^[24,25];治疗前两组患者的肱二头肌和肱三头肌 RMS 对比无显著差异,治疗后,观察组患者的肱二头肌 RMS 低于对照组,肱三头肌 RMS 高于对照组,这是因为通过低频重复经颅刺激联合肌电生物反馈治疗主要作用在患者患侧的颅脑半球,从而控制肘部运动皮质区,精确患者健侧皮层激发患者上肢运动时作用位置,从而重点关注患者患侧的肱二头肌肌张力变化^[26]。而且本文还通过表面肌电图来观察患者肱二头肌和肱三头肌治疗前

后的痉挛情况,通过观察两者主动运动变化证明了低频重复经颅刺激联合肌电生物反馈对患者的治疗效果。相关研究显示^[27],通过低频重复经颅刺激治疗能够准确针对肱二头肌肌肉痉挛现象,提升患者的上肢功能。还有研究发现^[28],应用电动深层肌肉刺激能够提升肱二头肌的硬度、弹性和肌肉张力。因此本文还需日后增加指标进行深入研究;治疗前两组患者的 FMA-UE、Carroll 评分对比无显著差异,治疗后,观察组患者的 FMA-UE、Carroll 评分高于对照组,由此证明,通过低频重复经颅刺激联合肌电生物反馈治疗能够提升患者的上肢功能,促进患者恢复日常生活能力,相关研究认为^[29,30],应用低频重复经颅刺激能够平衡大脑半球间的活动,从而加快皮质神经重构速度,改善患者的皮质脊髓束运动通路,并应用肌电生物反馈治疗诱导外周神经元去极化后促进肌肉收缩,减小患者痉挛肌肉的张力,加大拮抗肌的肌力,从而让刺激传入到感觉神经纤维,利用上位中枢提升对患者运动功能的控制。因此,两者结合治疗,能够降低上肢痉挛现象,提升患者肢体功能,与本研究结果相符。

综上所述,对脑卒中上肢痉挛患者在常规治疗与康复训练的基础上应用低频重复经颅刺激联合肌电生物反馈模式下的康复训练,虽然对患者的认知功能无明显影响,但是能提升患者上肢痉挛的治疗效果,促进患者上肢功能恢复健康,提高生活能力,值得临床应用推广。

参考文献(References)

- [1] Jan S, Arsh A, Darain H, et al. A randomized control trial comparing the effects of motor relearning programme and mirror therapy for improving upper limb motor functions in stroke patients [J]. J Pak Med Assoc, 2019, 69(9): 1242-1245
- [2] Ravichandran H, Janakiraman B, Sundaram S, et al. Systematic review on effectiveness of shoulder taping in Hemiplegia [J]. J Stroke Cerebrovasc Dis, 2019, 28(6): 1463-1473
- [3] Wang J, Zhang XH, Xu X, et al. Pro-angiogenic activity of Tongnao decoction on HUVECs in vitro and zebrafish in vivo[J]. J Ethnopharmacol, 2020, 254: e112737
- [4] Zou Y, Hu J, Huang W, et al. Non-Mitogenic Fibroblast Growth Factor1 Enhanced Angiogenesis Following Ischemic Stroke by Regulating the Sphingosine-1-Phosphate 1 Pathway [J]. Front Pharmacol, 2020, 11: e59
- [5] Kim HY, Kim TJ, Kang L, et al. Mesenchymal stem cell-derived magnetic extracellular nanovesicles for targeting and treatment of ischemic stroke[J]. Biomaterials, 2020, 243: e119942
- [6] Heydari E, Alishahi M, Ghaedrahmati F, et al. The role of noncoding RNAs in neuroprotection and angiogenesis following ischemic stroke [J]. Metab Brain Dis, 2020, 35(1): 31-43
- [7] Carmeliet P, Jain RK. Molecular mechanisms and clinical applications of angiogenesis[J]. Nature, 2011, 473(7347): 298-307
- [8] Fan W, Kuang X, Hu J, et al. Acupuncture therapy for poststroke spastic hemiplegia: a systematic review and meta-analysis of randomized controlled trials [J]. Complement Ther Clin Pract, 2020, 21 (6): 1124-1127
- [9] Galvevilla M, Rittig-Rasmussen B, Lene MSM, et al. Complex regional pain syndrome[J]. Manual therapy, 2016, (26): 223-230

- [10] Pervane VS, Nakipoglu YGF, Sezgin OD, et al. Effects of mirror therapy in stroke patients with complex regional pain syndrome type 1: a randomized controlled study[J]. Arch Phys Med Rehabil, 2016, 97(4): 575-581
- [11] Pazhenkottil AP, Benz DC, Grani C, et al. Hybrid SPECT perfusion imaging and coronary CT angiography: Longterm prognostic value for cardiovascular outcomes[J]. Radiology, 2018, 288(3): 694-702
- [12] Zhao W, Vernekohl D, Han F, et al. A unified image reconstruction framework for quantitative dual-and triple-energy CT imaging of material compositions[J]. Med Phys, 2018, 45(7): 2964-2977
- [13] Guo P, Gao F, Zhao T, et al. Positive effects of extracorporeal shock wave therapy on spasticity in poststroke patients: a meta-analysis[J]. J Stroke Cerebrovasc Dis, 2017, 26(11): 2470-2476
- [14] Li S, Shin H, Zhou P, et al. Different effects of cold stimulation on reflex and non-reflex components of Poststroke spastic hypertonia[J]. Front Neurol, 2017, 8: e169
- [15] B T L A, B R G, C A N B, et al. Effect of chronic stretching interventions on the mechanical properties of muscles in patients with stroke: A systematic review [J]. Annals of Physical and Rehabilitation Medicine, 2020, 63(3): 222-229
- [16] Wang JS, Lee SB, Moon SH. The immediate effect of PNF pattern on muscle tone and muscle stiffness in chronic stroke patient [J]. J Phys Ther Sci, 2016, 28(3): 967-970
- [17] Agyapong-badu S, Warner M, Samuel D, et al. Measurement of ageing effects on muscle tone and mechanical properties of rectus femoris and biceps brachii in healthy males and females using a novel hand-held myometric device [J]. Arch Gerontol Geriatr, 2016, 62: 59-67
- [18] Yang TH, Huang YC, Lau YC, et al. Efficacy of radial extracorporeal shock wave therapy on lateral epicondylitis, and changes in the common extensor tendon stiffness with pretherapy and posttherapy in real-time sonoelastography: a randomized controlled study [J]. Am J Phys Med Rehabil, 2017, 96(2): 93-100
- [19] Yamaya S, Ozawa H, Kanno H, et al. Low-energy extracorporeal shock wave therapy promotes vascular endothelial growth factor expression and improves locomotor recovery after spinal cord injury[J]. J Neurosurg, 2014, 121(6): 1514-1525
- [20] Caliskan E, Akkoc O, Bayramoglu Z, et al. Effects of static stretching duration on muscle stiffness and blood flow in the rectus femoris in adolescents[J]. Medical ultrasonography, 2019, 21(2): 136-143
- [21] Naro A, Leo A, Russo M, et al. Breakthroughs in the spasticity management: Are non-pharmacological treatments the future [J]. Clin Neurosci, 2017, 39: 16-27
- [22] Lo WLA, Zhao JL, Li L, et al. Relative and Absolute Interrater Reliabilities of a Hand-Held Myotonometer to Quantify Mechanical Muscle Properties in Patients with Acute Stroke in an Inpatient Ward[J]. Biomed Res Int, 2017, 2017: 4294028
- [23] Moon SH, Choi JH, Park SE. The effects of functional electrical stimulation on muscle tone and stiffness of stroke patients[J]. J Phys Ther Sci, 2017, 29(2): 238-241
- [24] Sharif F, Ghulam S, Malik AN, et al. Effectiveness of Functional Electrical Stimulation (FES) versus conventional electrical stimulation in gait rehabilitation of patients with stroke [J]. J Coll Physicians Surg Pak, 2017, 27(11): 703-706
- [25] Bochekezanian V, Newton RU, Trajano GS, et al. Effect of tendon vibration during wide-pulse neuromuscular electrical stimulation (NMES) on muscle force production in people with spinal cord injury (SCI) [J]. BMC Neurol, 2018, 18(1): e17
- [26] Lee YC, Yu WH, Hsueh IP, et al. Test-retest reliability and responsiveness of the Barthel Index-based Supplementary Scales in patients with stroke[J]. Eur J Phys Rehabil Med, 2017, 53(5): 710-718
- [27] Lim SB, Eng JJ. Increased sensorimotor cortex activation with decreased motor performance during functional upper extremity tasks poststroke[J]. J Neurol Phys Ther, 2019, 43(3): e1
- [28] Volz LJ, Vollmer M, Michely J, et al. Time-dependent functional role of the contralesional motor cortex after stroke [J]. Neuroimage Clin, 2017, 16: e833
- [29] Poli D, Massobrio P. High-frequency electrical stimulation promotes reshaping of the functional connections and synaptic plasticity in vitro cortical networks[J]. Phys Biol, 2018, 23(3): 345-58
- [30] Tu-Chan AP, Natraj N, Godlove J, et al. Effects of somatosensory electrical stimulation on motor function and cortical oscillations [J]. J Neuroeng Rehabil, 2017, 14(1): e113

(上接第 3870 页)

- [26] Gao SY, Shi MH, Chen R, et al. Efficacy of Mini Nutritional Assessment Short-Form in Predicting the Risk of Acute Exacerbation in Old Chronic Obstructive Pulmonary Disease Patients [J]. Zhonghua Yi Xue Za Zhi, 2020, 100(14): 1063-1067
- [27] 王静, 徐震, 李立, 等. 评估急性发作期慢性阻塞性肺病患者营养状况、肺功能的临床价值[J]. 中国实验诊断, 2010, 14(2): 239-241
- [28] Matkovic Z, Cvetko D, Rahelic D, et al. Nutritional Status of Patients with Chronic Obstructive Pulmonary Disease in Relation to their Physical Performance[J]. COPD, 2017, 14(6): 626-634
- [29] Holst M, Beck AM, Rasmussen HH, et al. Insufficient intake of energy and protein is related to physical functional capacity among COPD patients referred to municipality based pulmonary rehabilitation[J]. Clin Nutr ESPEN, 2019, 30: 35-41
- [30] Hsieh MJ, Yang TM, Tsai YH. Nutritional supplementation in patients with chronic obstructive pulmonary disease [J]. J Formos Med Assoc, 2016, 115(8): 595-601