DOI:10.3969/j.issn.1005-202X.2017.12.015

医学信号处理与医学仪器

表面肌电图评估脑瘫儿童口部运动训练康复的治疗效果

张靖，韦新艳，韦娟，罗明，黄美貌
柳州市妇幼保健院儿童康复科，广西 柳州 545001

【摘 要】**目的：**探讨表面肌电监测在评估脑瘫儿童口部运动训练康复治疗效果中的应用价值。**方法：**选择2016年1月~2016年12月我院收治的60例脑瘫口部运动障碍儿童作为研究对象，按照随机数字表法分为对照组与观察组，各30例。对照组患儿进行常规口部运动训练，观察组在表面肌电图监测指导下进行口部运动训练，两组均训练12周，采用语言发育评定表(S-S)、口部运动功能评估量表对治疗前后患儿口部肌肉运动功能等进行评估，采用表面肌电图测定治疗前后舌骨下肌群、颏下肌群、咬肌表面肌电均方根值(RMS)。**结果：**① 训练前，两组口部运动功能评估量表比较差异无统计学意义(P>0.05)，训练12周，两组评分均上升(P<0.05)，观察组评分上升幅度高于对照组(P<0.05)。② 训练前，两组放松及主动活动状态下咬肌、颏下肌群、舌骨下肌群RMS比较差异无统计学意义(P>0.05)，训练12周，两组各肌群RMS均上升，观察组患儿不同肌群不同状态下RMS上升幅度均高于对照组，比较差异有统计学意义(P<0.05)。**结论：**在脑瘫口部运动功能障碍患儿的康复训练中应用表面肌电监测，可提高康复训练效果，改善患儿口部运动功能。

【关键词】脑瘫；口部运动障碍；康复训练；表面肌电图
【中图分类号】R493 【文献标志码】A 【文章编号】1005-202X(2017)12-1267-06

Application of surface electromyography-guided oral motor rehabilitation training for children with cerebral palsy

ZHANG Jing, WEI Xinyan, WEI Juan, LUO Ming, HUANG Meimao
Department of Children's Rehabilitation, Liuzhou Maternal and Child Health Care Hospital, Liuzhou 545001, China

Abstract: Objective To investigate the application value of oral motor rehabilitation training guided by surface electromyography (EMG) monitoring for children with cerebral palsy. **Methods** Sixty children with cerebral palsy and oral dyskinesia treated in Liuzhou Maternal and Child Health Care Hospital from January 2016 to December 2016 were selected and randomly divided into control group and observation group, with 30 cases in each group. The children in control group were given routine oral motor training, while those in observation group were treated with oral motor training guided by surface EMG monitoring. Both groups were trained for 12 weeks. Before and after training, the oral muscle movement functions were evaluated with the language development assessment scale (S-S) and oral motor function assessment scale before and after training; The Root mean square (RMS) of infrahyoid muscles, submental muscles and masseter muscles were determined by surface EMG. **Results** Before training, no significant differences were found between the two groups in scores of S-S and oral motor function assessment scale (P>0.05). After 12 weeks of training, scores in the two groups were increased (P<0.05), and observation group showed more significant increases than control group (P<0.05). Before training, the RMS of masseter muscles, submental muscles, infrahyoid muscles in relaxation and active states didn't showed any statistical differences between the two groups (P>0.05). After 12 weeks of training, RMS of all muscles were increased, and the increases of all muscles in different states were more remarkable in observation group than control group, with statistical differences (P<0.05). **Conclusion** Applying surface EMG monitoring in the rehabilitation training of children with cerebral palsy and oral dyskinesia can enhance the effect of rehabilitation training and improve the oral motor functions of children.

Keywords: cerebral palsy; oral dyskinesia; rehabilitation training; surface electromyography

前 言

脑性瘫痪(脑瘫)是一组持续存在的中枢性运动和姿势发育障碍、活动受限症候群，这种症候群是由

【收稿日期】2017-09-19
【基金项目】广西壮族自治区卫计委课题(Z2016790)
【作者简介】张靖，副主任医师，E-mail: 3197144582@qq.com

于发育中的胎儿或婴幼儿脑部非进行性损伤所致，是导致婴幼儿致残的重要原因，患儿多伴视力、听觉障碍及智力低下等表现[1]。统计报道显示，脑瘫患儿口咽部运动障碍发生率约为25%~100%[2]，可引起摄食系统及构音障碍，导致进食困难，严重影响患儿成长发育及日常交流。徐开寿等[3]发现，有80%左右的脑瘫患儿均伴不同程度语言功能障碍。目前常采用口部运动训练法干预脑瘫口部运动障碍患儿，包括口腔按摩、口腔感觉刺激、味觉训练等，但其训练效果与治疗师水平存在密切关联，有其主观性，通常无法确切量化训练参数为康复训练提供指导，无个体化及针对性优势[4]。相对而言，在脑瘫患儿口部运动康复训练中应用表面肌电图有助于客观评定患儿神经肌肉状态，明确其瘫痪程度，同时可分析患儿康复训练过程中肌肉疲劳程度，指导康复训练方案的调整，有助于校正异常运动模式，在表面肌电图指导下能充分调动家属及患儿参与治疗的积极性。目前已有大量报道对表面肌电图在脑瘫患儿辅助诊断及治疗评价中的作用进行研究，但鲜少有文献对其在脑瘫患儿口部运动康复训练中的作用进行分析。基于此，为探讨表面肌电图在评估脑瘫儿童口部运动训练康复治疗效果中的应用价值，现对收治的60例患儿展开了对照研究。

1 资料与方法

1.1 一般资料

选择2016年1月~2016年12月柳州市妇幼保健院收治的60例脑瘫口部运动障碍儿童作为研究对象。纳入标准：均符合脑瘫口部运动障碍诊断标准[5]；年龄1.5~6.0岁；家属均自愿签署研究同意书。排除标准：合并遗传代谢性疾病者；合并染色体疾病者；合并癫痫者；合并严重心肝肾肺功能障碍者；无法配合训练者。按随机数字表法将所有患儿分为对照组与观察组各30例。对照组中男22例，女8例；年龄1.5~6.0岁，平均(3.5±1.1)岁；脑瘫分型：不随意运动型13例，混合型1例，痉挛型偏瘫6例，痉挛型双瘫10例。观察组中男21例，女9例；年龄1.6~6.0岁，平均(3.6±1.2)岁；脑瘫分型：不随意运动型12例，混合型1例，痉挛型偏瘫7例，痉挛型双瘫10例。两组患儿基本资料比较差异无统计学意义(P>0.05)，具有可比性。

1.2 方法

对照组采用常规口部运动训练。治疗前均进行口部运动功能量表评估，根据患儿口部运动障碍情况制定运动训练方案，由康复师一对一指导，在安静治疗室内进行，包括口面部感知刺激、口部运动训练等，常规训练12周。观察组则在表面肌电图监测指导下进行口部运动训练。采用加拿大伟思公司生产的SA7550型表面肌电仪，采用Ag/Agcl表面电极，采集肌电信号，肌电图前置放大，设定阻抗＞100 MΩ，采样频宽为10~500 Hz，灵敏度0.1 μV，采集频率2 048位/s，增益1 000，采集肌电信号，根据表面肌电图结果制定口部运动训练策略，建立正确口部运动模式，作下颌抬高、下降、前伸、后缩及左右运动，以咀嚼、张开口、打哈欠为形式提升下颌运动灵活度，并进行唇闭合、鼓腮、展唇、圆唇运动及夸张咀嚼动作，锻炼下颌、颊部、面部肌肉；对口腔周围口腔内部进行振动刺激及冷热刺激，建立口腔感觉；作抗阻力吹气动作，包括吹哨子、吹气球等，锻炼肺活量与唇部肌肉，牵拉舌肌与唇肌，增加口腔本体感觉。同时按摩下颌部、唇面部，降低口部肌张力；并调整食物性状，辅用冰棒刺激其双侧舌根部、软腭、咽喉壁，并扩大范围涂抹刺激部位，左右交替处理，每个部位各涂抹10~15次。上述训练1次/d，5次/周，并根据表面肌电图监测结果调整训练频率，康复训练共持续12周。

1.3 观察指标

口部运动功能评价。训练前、训练12周均采用语言发育评定表(S-S)[6]、口部运动功能评估量表[7]对治疗前后患儿口部肌肉运动功能、语言运用能力等进行评估。S-S表提示患儿语言、理解能力或表达水平低于实际年龄则表示存在语言发育迟缓，量表为正向计分，评分越高，表示语言能力越好。口部运动功能评估量表包括下颌、唇、舌等运动作为评估标准，评分越高，表示口腔运动功能改善越明显。训练前、训练12周均采用表面肌电图测定患儿舌骨下肌群、颏下肌群、咬肌表面肌电均方根值(Root Mean Square, RMS)，均重复测定3次，取均值。

1.4 统计学方法

所有数据均录入SPSS 20.0统计学软件，计数资料采用 χ^2 检验，计量资料采用 t 检验，重复测量数据采用方差分析，组内行LSD-t检验，P<0.05为差异有统计学意义。

2 结 果

2.1 两组患儿训练前后口部运动功能改善比较

训练前，两组S-S表、口部运动功能评估量表比较差异无统计学意义(P>0.05)，训练12周，两组评分均上升(P<0.05)，观察组评分上升幅度高于对照组，对比差异具有统计学意义(P<0.05)，见表1。

表1 两组患儿训练前后口部运动功能改善比较(分, $\bar{x}\pm s$)

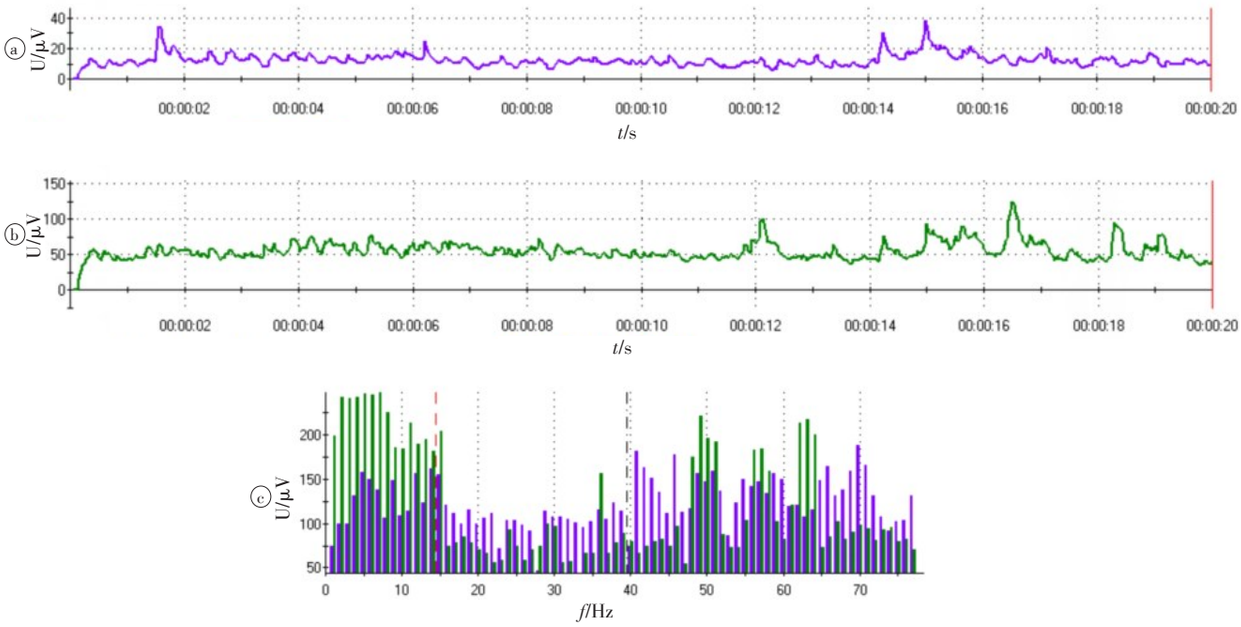
Tab.1 Comparison of oral motor function improvement between two groups before and after training (scores, *Mean±SD*)

Group	Evaluation time	Table S-S	Oral motor function assessment scale
Observation	Before training	24.61±5.26	33.41±4.46
	12 weeks of training	56.81±6.31*#	63.71±5.44*#
Control	Before training	24.71±5.45	33.47±5.12
	12 weeks of training	46.77±7.23*	52.46±6.24

S-S: Language development assessment scale (S-S); Compared with before training, *P<0.05; Compared with control group, #P<0.05.

2.2 两组训练前后表面肌电图测得结果比较

训练前,两组放松及主动活动状态下咬肌、颏下肌群、舌骨下肌群RMS比较差异无统计学意义(P>0.05),训练12周,两组各肌群RMS均上升,观察组患儿不同肌群不同状态下RMS(图1~3)上升幅度均高于对照组,比较差异有统计学意义(P<0.05),见表2。



RMS: Root mean square; MF: Median frequency; Fig.1a was the surface EMG of the left masseter muscles in active contraction for 20 seconds, with a RMS of 9.00; Fig.1b was surface EMG of the right masseter muscles in active contraction for 20 seconds, with a RMS of 36.28; Fig.1c was the surface EMG of masseter muscles in active contraction. The MF of the left (the purple) and the right (the green) masseter muscles were 155.0 and 205.0, respectively. The maximum MF and minimum MF of the left masseter muscles were 185.0 and 72.0, while those of the right were 256.0 and 122.0.

图1 训练后观察组咬肌表面肌电波形图

Fig.1 Surface EMG of masseter muscles in observation group after training

3 讨 论

脑瘫属非进行性脑损伤综合症,表现为中枢神经系统运动障碍及姿势异常,大部分患儿常伴理解、感觉及行为交流等障碍[8]。口部运动功能障碍是脑瘫儿童常见合并症,轻者可能出现构音及语言功能障碍,重者可能出现唇部、呼吸功能、吞咽功能、吸吮功能障碍,伴进食困难,影响其正常发育。人体口咽部运动功能主要建立于婴幼儿时期,新生儿期口咽部在原始反射下支配活动,婴儿时期呈整体运动,幼儿期分解为精确口咽运动模式,其对儿童言语构音、

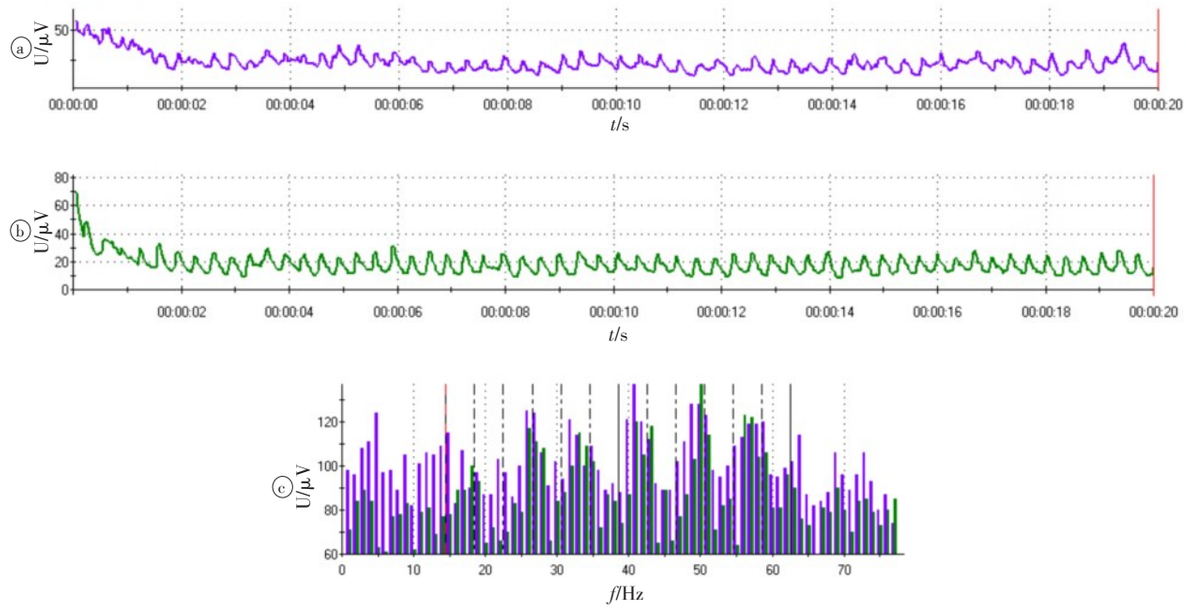


Fig.2a was was the surface EMG of the left submental muscles in active contraction for 20 seconds, with a RMS of 22.65; Fig.2b was surface EMG of the right submental muscles in active contraction for 20 seconds, with a RMS of 16.07; Fig.1c was the surface EMG of submental muscles in active contraction. The MF of the left (the purple) and the right (the green) masseter muscles were 115.0 and 78.0, respectively. The maximum MF and minimum MF of the left masseter muscles were 126.0 and 82.0, while those of the right were 101.0 and 56.0

图2 训练后观察组颏下肌表面肌电波形图

Fig.2 Surface EMG of submental muscles in observation group after training

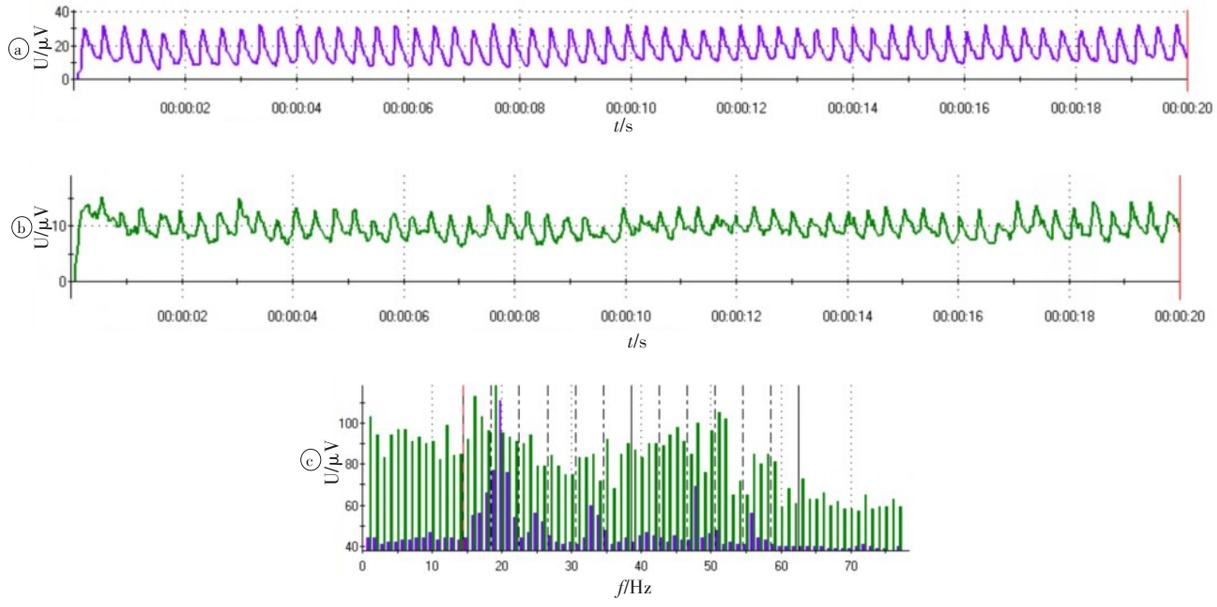


Fig.3a was the surface EMG of the left infrahyoid muscles in active contraction for 20 seconds, with a RMS of 11.83; Fig.3b was surface EMG of the right infrahyoid muscles in active contraction for 20 seconds, with a RMS of 8.71; Fig.3c was the surface EMG of infrahyoid muscles in active contraction. The MF of the left (the purple) and the right (the green) masseter muscles were 44.0 and 92.0, respectively. The maximum MF and minimum MF of the left masseter muscles were 49.00 and 40.00, while those of the right were 113.0 and 79.0.

图3 训练后观察组舌骨下肌表面肌电波形图

Fig.3 Surface EMG of infrahyoid muscles in observation group after training

表2 两组训练前后表面肌电图测得结果比较（μV，$\bar{x}\pm s$）

Tab.2 Comparison of surface EMG measurements in two groups before and after training (μV, *Mean±SD*)

Group	Evaluation time	State	RMS of masseter muscles		RMS of submental muscles		RMS of infrahyoid muscles	
			Left	Right	Left	Right	Left	Right
Observation	Before training	Relaxation	2.32±1.26	2.16±1.11	3.41±1.25	3.42±1.21	3.51±1.03	3.26±1.05
		Active	5.71±1.45	5.46±1.34	7.12±1.44	7.09±1.23	7.22±1.64	7.11±1.51
	12 weeks of training	Relaxation	3.45±0.66*#	3.33±0.41*#	5.01±0.36*#	4.68±0.41*#	4.81±0.33*#	4.72±0.35*#
		Active	8.23±0.41*#	8.14±0.39*#	9.97±0.46*#	9.21±0.65*#	9.52±0.47*#	9.31±0.38*#
Control	Before training	Relaxation	2.35±1.25	2.15±1.13	3.42±1.26	3.40±1.22	3.52±1.04	3.25±1.06
		Active	5.72±1.46	5.47±1.35	7.13±1.45	7.11±1.19	7.23±1.66	7.10±1.49
	12 weeks of training	Relaxation	3.01±0.12*	2.91±0.23*	4.21±0.25*	4.01±0.16*	4.21±0.14*	4.11±0.13*
		Active	7.23±0.41*	7.13±0.41*	8.21±0.45*	8.14±0.33*	8.23±0.36*	8.09±0.45*

EMG: Electromyograph; RMS:Root mean square; Compared with before training, *P<0.05; Compared with control group, #P<0.05

正常进食均有重要的影响，而发育神经中枢受损，则可能引起口咽部运动障碍，导致摄食困难、语言能力障碍，影响其语言能力的建立及营养摄入、体格发育[9]。张家芳[10]表示，约有30%的口咽部运动功能障碍脑瘫患儿无法独立进食，且其中25%的患儿体格发育较正常健康儿童存在较大差异。而完善的进食系统、口腔感觉则为促成口咽部运动功能发育的前提条件。一般脑瘫患儿口部运动功能障碍主要表现为进食运动技能异常、言语构音异常及体格发育异常，其拒绝接受口腔内食物，缺乏咀嚼力与耐力，口腔原始反射消失或口腔刺激减少，引起口腔敏感性降低，影响其食欲，表现为吞咽不充分、口面肌不平衡、咬合不良、构音异常、舌外推食物、咀嚼困难等，进而影响其营养摄入[11-12]。

口部运动训练是目前用于脑瘫患儿口部运动障碍治疗的主要方式，其主要通过口腔感觉及运动刺激来改善患儿口腔吞咽功能及运动能力，但当前尚缺乏具体参数评估口部运动训练的康复效果，难以制定个性化康复训练方案，获取最优策略，针对性差，有其局限性[13-17]。相对而言，根据患儿口部实际运动情况制定个体化训练策略，则可提高资源利用率，优化训练处方，提高康复训练效率，优化训练效果。表面肌电图是目前用于指导脑瘫康复治疗效果的重要仪器，其准确反映人体肌肉状态、肌群协调性及中枢神经系统控制变化规律，同时重视对异常表现的个体化训练，强调对肌肉及骨骼系统的管理，对康复训练策略的制定有重要的指导价值[18-19]。在口部运动康复训练中应用表面肌电图可客观评定患儿神经肌肉状态，明确肌肉瘫痪程度，同时可根据肌电图信号变化情况了解训练过程中患儿肌肉疲劳情况，有助于调整训练强度，提高患儿康复训练耐力。同时在连续监测下进行康复治疗，可为运动模式校正提供依据，且有助于巩固正常运动程序。此外，持续进行表面肌电图监测有助于训练师了解患儿训练及进步情况，不仅有助于康复训练策略的调整，同时可调动患儿训练的积极性。另外，该系统无刺激性影响，且安全性高，无痛，患儿可接受度高[20]。

本研究中，对照组患儿采用常规口部运动训练模式，观察组加用表面肌电图监测，结果发现，观察组患儿口腔运动功能恢复情况均优于对照组，同时观察组患儿其口腔各肌群肌力得到显著改善，与Geister等[15]研究结论一致，提示加用表面肌电图持续监测不仅可优化训练策略，同时可提高康复训练效果，改善患儿口部运动功能。

【参考文献】

[1] 许晶莉, 范艳萍, 代早荣, 等. 表面肌电图在脑瘫患儿疗效评估中的应用研究[J]. 中国康复, 2013, 28(1): 29-32.
XU J L, FAN Y P, DAI Z R, et al. Application of surface electromyography in evaluating the curative effect of cerebral palsy children[J]. Chinese Rehabilitation, 2013, 28(1): 29-32.

[2] 许晶莉, 黄少昂, 代早荣, 等. 不同病情程度脑瘫患儿的表面肌电图特征初探[J]. 中国康复, 2013, 28(5): 354-356.
XU J L, HUANG S A, DAI Z R, et al. Characteristics of surface electromyography in children with cerebral palsy of different severity [J]. Chinese Rehabilitation, 2013, 28(5): 354-356.

[3] 徐开寿, 何璐, 麦坚凝, 等. 偏瘫型脑瘫患儿腕屈伸肌群最大等长收缩时的表面肌电特征研究[J]. 中华物理医学与康复杂志, 2014, 36(8): 617-620.
XU K S, HE L, MAI J N, et al. Characteristics of surface electromyography of wrist flexors and extensors in children with hemiplegic cerebral palsy[J]. Chinese Journal of Physical Medicine

and Rehabilitation, 2014, 36(8): 617-620.

[4] 王利江, 刘秋燕, 于晓明, 等. 肌电生物反馈治疗痉挛型脑性瘫痪患儿尖足的效果[J]. 中国康复理论与实践, 2016, 22(10): 1209-1213.
WANG L J, LIU Q Y, YU X M, et al. Effect of electromyographic biofeedback therapy on children with spastic cerebral palsy[J]. Chinese Journal of Rehabilitation Theory and Practice, 2016, 22(10): 1209-1213.

[5] 李晓捷. 脑瘫指南及定义、分型、诊断标准修订[C]//全国小儿脑瘫康复学术会议暨国际学术交流会议, 2014.
LI X J. Guidelines and definitions, classification, diagnostic criteria revision of cerebral palsy[C]//National Conference on rehabilitation of children with cerebral palsy and international academic exchange conference, 2014.

[6] KRATZ A L, SLAVIN M D, MULCAHEY M J, et al. An examination of the PROMIS® pediatric instruments to assess mobility in children with cerebral palsy[J]. Qual Life Res, 2013, 22(10): 2865-2876.

[7] BECMEUR F, SCHNEIDER A, FLAUM V, et al. Which surgery for drooling in patients with cerebral palsy?[J]. J Pediatr Surg, 2013, 48 (10): 2171-2174.

[8] PARK M S, CHUNG C Y, LEE K M, et al. Rasch analysis of the pediatric outcomes data collection instrument in 720 patients with cerebral palsy[J]. J Pediatr Orthop, 2012, 32(4): 423-431.

[9] 朱俞岚, 孙莉敏, 张备, 等. 康复网络下康复训练和个性化辅具适配对脑瘫患儿功能的影响[J]. 中国康复医学杂志, 2015, 30(1): 35-37.
ZHU Y L, SUN L M, ZHANG B, et al. Effect of rehabilitation network rehabilitation training and personalized fit AIDS function in children with cerebral palsy[J]. Chinese Journal of Rehabilitation Medicine, 2015, 30(1): 35-37.

[10] 张家芳. 不同有氧运动方式治疗脑瘫患者的康复疗效[J]. 中国老年学杂志, 2016, 36(16): 4039-4040.
ZHANG J F. Rehabilitation effect of different aerobic exercises on cerebral palsy patients[J]. Chinese Journal of Gerontology, 2016, 36 (16): 4039-4040.

[11] 汤加利, 史惟, 郭金颖, 等. 学龄期脑瘫患儿日常生活活动能力状况及影响因素分析[J]. 中国康复医学杂志, 2014, 29(6): 552-556.
TANG J L, SHI W, GUO J Y, et al. Status and influencing factors of activities of daily living in school-age children with cerebral palsy[J]. Chinese Journal of Rehabilitation Medicine, 2014, 29(6): 552-556.

[12] USWATTE G, TAUB E, GRIFFIN A, et al. Pediatric arm function test: reliability and validity for assessing more-affected arm motor capacity in children with cerebral palsy[J]. Am J Phys Med Rehabil, 2012, 91 (12): 1060-1069.

[13] WALLEN M, ZIVIANI J. Caution regarding the pediatric motor activity log to measure upper limb intervention outcomes for children with unilateral cerebral palsy[J]. Dev Med Child Neurol, 2013, 55(6): 497-498.

[14] 谭亚琼, 胡继红, 盛小奇, 等. 虚拟现实技术在脑瘫儿童康复中的应用[J]. 医学临床研究, 2015, 32(4): 789-792.
TAN Y Q, HU J H, SHENG X Q, et al. Application of virtual reality technology in rehabilitation of children with cerebral palsy[J]. Journal of Clinical Research, 2015, 32(4): 789-792.

[15] GEISTER T L, QUINTANAR-SOLARES M, MARTIN M, et al. Qualitative development of the 'Questionnaire on pain caused by Spasticity (QPS),' a pediatric patient-reported outcome for spasticity-related pain in cerebral palsy[J]. Qual Life Res, 2014, 23(3): 887-896.

[16] 廖金生. 针灸配合语言训练对脑瘫患儿语言发育迟缓的疗效探讨[J]. 现代诊断与治疗, 2016, 27(15): 2775-2776.
LIAO J S. Effect of acupuncture combined with language training on language development retardation in children with cerebral palsy[J]. Modern Diagnosis & Treatment, 2016, 27(15): 2775-2776.

[17] 郑钦, 李润利, 吴燕秋, 等. 小组语言训练对脑瘫患儿交流功能的影响[J]. 中国康复, 2016, 31(6): 411.
ZHENG Q, LI R L, WU Y Q, et al. Effect of group language training on communication function in children with cerebral palsy[J]. Chinese Rehabilitation, 2016, 31(6): 411.

[18] 覃洪金, 黄任秀, 李玉梅, 等. 健康教育联合口腔运动指导对脑瘫高危儿家长喂养行为的影响[J]. 护理学杂志, 2015, 30(1): 65-68.
TAN H J, HUANG R X, LI Y M, et al. Effect of health education combined with oral movement guidance on feeding behavior of parents with high risk infants with cerebral palsy[J]. Journal of Nursing, 2015, 30(1): 65-68.

[19] 陈旺. 口部运动治疗对脑瘫儿童语言康复的作用探讨[J]. 心理医生, 2017, 23(21): 145-146.
CHEN W. Effect of oral movement therapy on language rehabilitation in children with cerebral palsy[J]. Psychologist, 2017, 23(21): 145-146.

[20] 颜华, 张惠佳, 刘志雄, 等. 针刺配合语言及口腔功能训练对脑瘫患儿语言障碍的临床观察[J]. 中医药导报, 2010, 16(11): 69-72.
YAN H, ZHANG H J, LIU Z X, et al. Clinical observation of acupuncture combined with language and oral function training on language disorder in children with cerebral palsy[J]. Guiding Journal of Traditional Chinese Medicine and Pharmacology, 2010, 16(11): 69-72.

（编辑：薛泽玲）