

· 基础研究 ·

电针秩边穴与水道穴对大鼠急性脊髓损伤后运动和排尿功能的影响

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摘 要 **目的:**观察电针秩边穴与水道穴对大鼠急性脊髓损伤后运动和排尿功能的影响。**方法:**将 48 只 SD 大鼠随机分为电针组和对照组, 每组 24 只。采用改良 Allen's 重物打击法将所有大鼠制成急性脊髓损伤模型。造模后 24 h, 电针组大鼠在秩边穴和水道穴进行电针治疗, 对照组大鼠在秩边穴和水道穴旁开 0.5 cm 处进行电针治疗。每天治疗 1 次, 每次 15 min。分别于实验干预 1 d、3 d、7 d 和 14 d 后采用 BBB 评分法评定 2 组大鼠的运动功能, 同时于每次运动功能测试完成后, 测定大鼠的膀胱容量和剩余尿量。**结果:**①运动功能。干预后不同时间 BBB 评分的差异有统计学意义, 即存在时间效应 $[(0.50 \pm 0.53)$ 分, (2.90 ± 1.10) 分, (7.50 ± 1.27) 分, (11.50 ± 0.71) 分; (0.60 ± 0.52) 分, (2.70 ± 0.95) 分, (4.60 ± 0.70) 分, (8.60 ± 0.97) 分; $F = 625.000, P = 0.000]$ 。2 组大鼠 BBB 评分的组间差异总体上有统计学意义, 即存在分组效应 $(F = 29.866, P = 0.000)$; 干预 1 d、3 d 后, 2 组大鼠的 BBB 评分比较, 差异均无统计学意义 $(t = 0.429, P = 0.678; t = 0.435, P = 0.674)$; 干预 7 d、14 d 后, 电针组大鼠的 BBB 评分均大于对照组 $(t = 6.328, P = 0.000; t = 9.222, P = 0.000)$ 。时间因素和分组因素之间存在交互效应 $(F = 24.939, P = 0.000)$ 。②排尿功能。干预后不同时间膀胱容量的差异有统计学意义, 即存在时间效应 $[(1.10 \pm 0.05)$ mL, (1.37 ± 0.05) mL, (1.89 ± 0.09) mL, (2.31 ± 0.19) mL; (1.10 ± 0.06) mL, (1.36 ± 0.05) mL, (1.67 ± 0.08) mL, (1.88 ± 0.08) mL; $F = 193.885, P = 0.000]$ 。2 组大鼠膀胱容量的组间差异总体上有统计学意义, 即存在分组效应 $(F = 65.970, P = 0.000)$; 干预 1 d、3 d 后, 2 组大鼠的膀胱容量比较, 差异均无统计学意义 $(t = 0.177, P = 0.868; t = 0.366, P = 0.733)$; 干预 7 d、14 d 后, 电针组大鼠的膀胱容量均大于对照组 $(t = 4.186, P = 0.014; t = 4.647, P = 0.009)$ 。时间因素和分组因素之间存在交互效应 $(F = 10.283, P = 0.000)$ 。干预后不同时间剩余尿量的差异有统计学意义, 即存在时间效应 $[(2.00 \pm 0.20)$ mL, (1.88 ± 0.15) mL, (1.49 ± 0.07) mL, (0.98 ± 0.11) mL; (1.99 ± 0.19) mL, (1.89 ± 0.17) mL, (1.73 ± 0.12) mL, (1.29 ± 0.07) mL; $F = 131.825, P = 0.000]$ 。2 组大鼠剩余尿量的组间差异总体上有统计学意义, 即存在分组效应 $(F = 3.787, P = 0.038)$; 干预 1 d、3 d 后, 2 组大鼠的剩余尿量比较, 差异均无统计学意义 $(t = 0.016, P = 0.988; t = 0.039, P = 0.971)$; 干预 7 d、14 d 后, 电针组大鼠的剩余尿量均小于对照组 $(t = 3.791, P = 0.019; t = 5.334, P = 0.006)$ 。时间因素和分组因素之间存在交互效应 $(F = 5.646, P = 0.028)$ 。**结论:**电针秩边穴与水道穴能改善大鼠急性脊髓损伤后的运动和排尿功能。

关键词 脊髓损伤 电针 穴, 秩边 穴, 水道 运动功能 膀胱容量 剩余尿量 大鼠 动物实验

Effect of electroacupuncture Zhibian (BL54) and Shuidao (ST28) on motor function and urination function in rats with acute spinal cord injuries Li Changming*, Xie Shangju, Quan Renfu, Yang Zongbao. * Zhejiang Chinese Medical University, Hangzhou 310053, Zhejiang, China

ABSTRACT **Objective:** To observe the effect of electroacupuncture Zhibian (BL54) and Shuidao (ST28) on motor function and urination function in rats with acute spinal cord injuries. **Methods:** Forty-eight SD rats were randomly divided into electroacupuncture group and control group, 24 cases in each group. The acute spinal cord injuries models were built by modified Allen's method in all rats. The rats in the electroacupuncture group were treated with electroacupuncture at Zhibian (BL54) and Shuidao (ST28), while the others in the control group were treated with electroacupuncture at points 0.5 cm apart from Zhibian (BL54) and Shuidao (ST28) at 24 hours after the modeling, once a day for 15 minutes at a time. The motor function were evaluated by using BBB score at 1st, 3rd, 7th and 14th days after experimental intervention. Meanwhile, the bladder capacity and residual urine volume of the rats were measured. **Results:** There was statistical difference in BBB scores between different time points after intervention, in other words, there was time effect $(0.50 \pm 0.53, 2.90 \pm 1.10, 7.50 \pm 1.27, 11.50 \pm 0.71)$ scores; $F = 625.000, P = 0.000$. The difference of BBB scores between two groups was statistically significant, that is, there was group effect $(F = 29.866, P = 0.000)$; after 1 d and 3 d of intervention, the difference of BBB scores between two groups was not statistically significant $(t = 0.429, P = 0.678; t = 0.435, P = 0.674)$; after 7 d and 14 d of intervention, the BBB scores of electroacupuncture group were higher than those of control group $(t = 6.328, P = 0.000; t = 9.222, P = 0.000)$. There was interaction effect between time factor and group factor $(F = 24.939, P = 0.000)$. The difference of bladder capacity between different time points after intervention was statistically significant, that is, there was time effect $(1.10 \pm 0.05, 1.37 \pm 0.05, 1.89 \pm 0.09, 2.31 \pm 0.19)$ mL; $F = 193.885, P = 0.000$. The difference of bladder capacity between two groups was statistically significant, that is, there was group effect $(F = 65.970, P = 0.000)$; after 1 d and 3 d of intervention, the difference of bladder capacity between two groups was not statistically significant $(t = 0.177, P = 0.868; t = 0.366, P = 0.733)$; after 7 d and 14 d of intervention, the bladder capacity of electroacupuncture group was higher than that of control group $(t = 4.186, P = 0.014; t = 4.647, P = 0.009)$. There was interaction effect between time factor and group factor $(F = 10.283, P = 0.000)$. The difference of residual urine volume between different time points after intervention was statistically significant, that is, there was time effect $(2.00 \pm 0.20, 1.88 \pm 0.15, 1.49 \pm 0.07, 0.98 \pm 0.11)$ mL; $F = 131.825, P = 0.000$. The difference of residual urine volume between two groups was statistically significant, that is, there was group effect $(F = 3.787, P = 0.038)$; after 1 d and 3 d of intervention, the difference of residual urine volume between two groups was not statistically significant $(t = 0.016, P = 0.988; t = 0.039, P = 0.971)$; after 7 d and 14 d of intervention, the residual urine volume of electroacupuncture group was lower than that of control group $(t = 3.791, P = 0.019; t = 5.334, P = 0.006)$. There was interaction effect between time factor and group factor $(F = 5.646, P = 0.028)$. **Conclusion:** Electroacupuncture at Zhibian (BL54) and Shuidao (ST28) can improve the motor function and urination function of rats with acute spinal cord injury.

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1.27, 11.50 \pm 0.71 points; 0.60 \pm 0.52, 2.70 \pm 0.95, 4.60 \pm 0.70, 8.60 \pm 0.97 points; $F = 625.000$, $P = 0.000$). In general, there was statistical difference in BBB scores between the 2 groups, in other words, there was grouping effect ($F = 29.866$, $P = 0.000$). There was no statistical difference in BBB scores between the 2 groups at 1 day and 3 days after intervention ($t = 0.429$, $P = 0.678$; $t = 0.435$, $P = 0.674$), and the BBB scores of the electroacupuncture group were greater than those of control group at 7 and 14 days after intervention ($t = 6.328$, $P = 0.000$; $t = 9.222$, $P = 0.000$). There was interaction between time factor and grouping factor ($F = 24.939$, $P = 0.000$). There was statistical difference in bladder capacity between different time points after intervention, in other words, there was time effect (1.10 \pm 0.05, 1.37 \pm 0.05, 1.89 \pm 0.09, 2.31 \pm 0.19 mL; 1.10 \pm 0.06, 1.36 \pm 0.05, 1.67 \pm 0.08, 1.88 \pm 0.08 mL; $F = 193.885$, $P = 0.000$). In general, there was statistical difference in bladder capacity between the 2 groups, in other words, there was grouping effect ($F = 65.970$, $P = 0.000$). There was no statistical difference in bladder capacity between the 2 groups at 1 day and 3 days after intervention ($t = 0.177$, $P = 0.868$; $t = 0.366$, $P = 0.733$), and the bladder capacity of the electroacupuncture group was larger than that of control group at 7 and 14 days after intervention ($t = 4.186$, $P = 0.014$; $t = 4.647$, $P = 0.009$). There was interaction between time factor and grouping factor ($F = 10.283$, $P = 0.000$). There was statistical difference in residual urine volume between different time points after intervention, in other words, there was time effect (2.00 \pm 0.20, 1.88 \pm 0.15, 1.49 \pm 0.07, 0.98 \pm 0.11 mL; 1.99 \pm 0.19, 1.89 \pm 0.17, 1.73 \pm 0.12, 1.29 \pm 0.07 mL; $F = 131.825$, $P = 0.000$). In general, there was statistical difference in residual urine volume between the 2 groups, in other words, there was grouping effect ($F = 3.787$, $P = 0.038$). There was no statistical difference in residual urine volume between the 2 groups at 1 day and 3 days after intervention ($t = 0.016$, $P = 0.988$; $t = 0.039$, $P = 0.971$), and the residual urine volume of the electroacupuncture group was smaller than that of control group at 7 and 14 days after intervention ($t = 3.791$, $P = 0.019$; $t = 5.334$, $P = 0.006$). There was interaction between time factor and grouping factor ($F = 5.646$, $P = 0.028$). **Conclusion:** The motor function and urination function of rats with acute spinal cord injuries can be improved by electroacupuncture Zhibian (BL54) and Shuidao (ST28).

Key words Spinal cord injuries; Electroacupuncture; POINT BL54 (ZHIBIAN); POINT ST28 (SHUIDAO); Motor function; Bladder capacity; Residual urine volume; Rats; Animal experimentation

脊髓损伤 (spinal cord injury, SCI) 可引起截瘫和四肢瘫痪, 甚至死亡。电针可促进急性 SCI 造成的截瘫患者的功能恢复^[1], 但对于具体的选穴, 各家说法不一^[2]。本研究选择秩边穴与水道穴作为治疗用穴, 观察电针干预后急性 SCI 模型大鼠运动和排尿功能的改变, 以期探讨电针秩边穴与水道穴对急性 SCI 的治疗效果及机理, 为临床治疗提供一定的参考。

1 材料与仪器

1.1 实验动物 健康成年雄性 SD 大鼠 48 只, 体重 (250 \pm 30) g, 由厦门大学动物实验中心提供, 实验动物合格证号: SYXK (闽) 2013 - 0006。

1.2 实验试剂 青霉素 (中诺药业有限公司); 碘伏消毒液 (山东利尔康医疗科技股份有限公司)。

1.3 实验仪器 SDZ-II 型电脉冲刺激仪、一次性针灸针 (苏州医疗用品厂); ZH-ZYQ 自由落体脑损伤模型打击器 (安徽正华生物仪器设备有限公司); TP-620C 电子天平 (长沙湘仪天平仪器厂)。

2 方法

2.1 动物分组 适应性饲养 1 周后采用随机数字表将大鼠随机分为电针组和对照组, 每组 24 只。饲养

温度 20 ~ 23 $^{\circ}\text{C}$, 湿度 50% ~ 60%, 自由摄食并保证充足饮水。

2.2 模型制备 采用改良 Allen's 重物打击法制备大鼠 SCI 模型^[3]。实验前禁食 8 h, 以 10% 水合氯醛进行腹腔注射麻醉, 将大鼠俯卧位固定, 以 T₉₋₁₀ 椎间隙为中心作长约 2.5 cm 的纵行切口, 暴露 T₉ 和 T₁₀, 咬除棘突及全部椎板, 暴露 0.5 cm 宽的硬脊膜。用质量为 10 g 的克氏针沿带有刻度的导管从 60 mm 处垂直自由下落, 打击在覆盖于大鼠暴露的硬脊膜上的薄塑半圆片上 (4 mm \times 2 mm), 然后迅速移开打击物, 逐层缝合。术后每天 8 万单位青霉素腹腔注射预防感染, 连续 3 d。

2.3 实验干预 根据《实验针灸学》图谱及其原则确定实验大鼠秩边穴和水道穴。电针组大鼠造模后 24 h 开始进行干预, 以 28 号华佗牌 0.5 寸不锈钢毫针在大鼠同侧秩边穴与水道穴双向对刺, 直刺 0.4 mm, 捻转 1 min 后将同侧秩边穴和水道穴组成一回路连接于 SDZ-II 型电脉冲刺激仪上, 设置频率 0.02 Hz, 电流 1 mA, 刺激 15 min, 左右交替, 每天 1 次。对照组在秩边穴和水道穴旁开 0.5 cm 处进针,

其余处理同电针组。

2.4 实验指标观察

2.4.1 运动功能 分别于实验干预 1 d、3 d、7 d 和 14 d 后采用 BBB 评分法^[4]评定 2 组 SCI 大鼠的运动功能。包括大鼠后肢各关节运动及活动度、步态及前后肢协调功能、中足、趾及尾巴的精细动作等。

2.4.2 排尿功能 分别于每次运动功能测试完成后将大鼠称重,以 10% 的水合氯醛腹腔注射麻醉后,将大鼠仰卧位固定于自制的鼠板上,碘伏消毒大鼠尿道外口及肛门,经尿道插入用石蜡油润滑并灭菌处理的 2 根 3 号输尿管。用 10 mL 注射器抽出大鼠膀胱中的剩余尿液,然后改用 1 mL 注射器以 0.2 mL · min⁻¹ 的速度通过 1 根导管向大鼠膀胱内推注生理盐水,密切观察另一根平放于鼠板的溢出管,待有液体溢出时

停止推注,用小烧杯收集溢出的液体。所推注的生理盐水的总体积即为膀胱容量;溢出液体的总量即为排尿量;剩余尿量 = 膀胱容量 - 排尿量。

2.5 数据统计分析 SPSS13.0 软件进行数据统计分析,2 组 SCI 大鼠 BBB 评分、膀胱容量和剩余尿量的比较采用重复测量资料的方差分析,检验水准 $\alpha = 0.05$ 。

3 结 果

3.1 运动功能 干预后不同时间 BBB 评分的差异有统计学意义,即存在时间效应。2 组大鼠 BBB 评分的组间差异总体上有统计学意义,即存在分组效应;干预 1 d、3 d 后,2 组大鼠的 BBB 评分比较,差异均无统计学意义;干预 7 d、14 d 后,电针组大鼠的 BBB 评分均大于对照组。时间因素和分组因素之间存在交互效应。见表 1。

表 1 电针干预后 2 组 SCI 大鼠 BBB 评分比较 分

组别	干预 1 d 后	干预 3 d 后	干预 7 d 后	干预 14 d 后	合计	F 值	P 值
电针组	0.50 ± 0.53	2.90 ± 1.10	7.50 ± 1.27	11.50 ± 0.71	5.60 ± 4.38	265.630	0.000
对照组	0.60 ± 0.52	2.70 ± 0.95	4.60 ± 0.70	8.60 ± 0.97	4.12 ± 3.08	178.751	0.000
合计	0.55 ± 0.51	2.80 ± 1.00	6.05 ± 1.79	10.05 ± 1.70	4.86 ± 3.84	625.000*	0.000*
t 值	0.429	0.435	6.328	9.222	29.866*	(F = 24.939, P = 0.000)*	
P 值	0.678	0.674	0.000	0.000	0.000*		

* 主效应的 F 值和 P 值;#交互效应的 F 值和 P 值

3.2 排尿功能 干预后不同时间膀胱容量的差异有统计学意义,即存在时间效应。2 组大鼠膀胱容量的组间差异总体上有统计学意义,即存在分组效应;干预 1 d、3 d 后,2 组大鼠的膀胱容量比较,差异均无统计学意义;干预 7 d、14 d 后,电针组大鼠的膀胱容量均大于对照组。时间因素和分组因素之间存在交互效应。干预

后不同时间剩余尿量的差异有统计学意义,即存在时间效应。2 组大鼠剩余尿量的组间差异总体上有统计学意义,即存在分组效应;干预 1 d、3 d 后,2 组大鼠的剩余尿量比较,差异均无统计学意义;干预 7 d、14 d 后,电针组大鼠的剩余尿量均小于对照组。时间因素和分组因素之间存在交互效应。见表 2、表 3。

表 2 电针干预后 2 组 SCI 大鼠膀胱容量比较 mL

组别	干预 1 d 后	干预 3 d 后	干预 7 d 后	干预 14 d 后	合计	F 值	P 值
电针组	1.10 ± 0.05	1.37 ± 0.05	1.89 ± 0.09	2.31 ± 0.19	1.67 ± 0.49	117.983	0.000
对照组	1.10 ± 0.06	1.36 ± 0.05	1.67 ± 0.08	1.88 ± 0.08	1.50 ± 0.31	122.020	0.000
合计	1.10 ± 0.05	1.37 ± 0.05	1.78 ± 0.14	2.09 ± 0.27	1.57 ± 0.41	193.885*	0.000*
t 值	0.177	0.366	4.186	4.647	65.970*	(F = 10.283, P = 0.000)*	
P 值	0.868	0.733	0.014	0.009	0.000*		

* 主效应的 F 值和 P 值;#交互效应的 F 值和 P 值

表 3 电针干预后 2 组 SCI 大鼠剩余尿量比较 mL

组别	干预 1 d 后	干预 3 d 后	干预 7 d 后	干预 14 d 后	合计	F 值	P 值
电针组	2.00 ± 0.20	1.88 ± 0.15	1.49 ± 0.07	0.98 ± 0.11	1.59 ± 0.43	52.082	0.000
对照组	1.99 ± 0.19	1.89 ± 0.17	1.73 ± 0.12	1.29 ± 0.07	1.72 ± 0.31	23.008	0.000
合计	2.00 ± 0.18	1.88 ± 0.15	1.61 ± 0.15	1.13 ± 0.18	1.66 ± 0.38	131.825*	0.000*
t 值	0.016	0.039	3.791	5.334	3.787*	(F = 5.646, P = 0.028)*	
P 值	0.988	0.971	0.019	0.006	0.038*		

* 主效应的 F 值和 P 值;#交互效应的 F 值和 P 值

4 讨 论

针刺作为传统的康复治疗手段,对于 SCI 及其并发症具有较好的治疗作用^[5-6]。同时针刺还能舒经活络、调气和血、增加血供,从而起到促进 SCI 患者功能恢复的作用。中医学对于 SCI 的记载最早见于《灵枢·寒热论》中:“身有所伤……若有所堕坠,四肢懈惰不收,名为体惰。”督脉受损是其主要病机,督脉总督一身之阳气,受损后可导致手足三阳经改变。

本研究的结果提示,电针秩边穴与水道穴可改善急性 SCI 大鼠运动功能,增加膀胱容量,降低剩余尿量。其原因可能有以下几个方面:①秩边穴属足太阳膀胱经,已有研究证实针刺秩边穴对前列腺炎、前列腺增生、遗尿、早泄、脱肛、胃下垂等均有良好疗效^[7-8]。而且足太阳膀胱经与足少阴肾经相表里,“肾主骨,骨生髓”。《针灸甲乙经》有“大小便不通,水道主之”的记载。同时水道穴属足阳明胃经,SCI 发生后的运动功能减退或丧失属中医学“痿证”范畴,而内经中又有“治痿独取阳明”的论述。因此电针秩边穴与水道穴不仅能使受损的排尿功能得以恢复,而且也可使骨髓充实、骨骼坚强,肌肉受到脾胃所化生气血的滋养,偏枯萎废得以修复。②经过秩边穴和水道穴的神经和血管颇为丰富^[9],加上电流的作用,可刺激交感神经及盆丛神经,通过神经反馈到脊髓中枢或大脑皮质,促进损伤区域脊髓神经的重连,改善脊髓局部微环境,激活线粒体酶活性,恢复神经内外电势梯度,诱导神经轴突生长,刺激神经营养因子上调,促进脊髓修复^[10-12]。

总之,笔者认为电针秩边穴与水道穴能改善大鼠急性 SCI 后的运动和排尿功能。对于电针秩边穴与水道穴改善 SCI 大鼠运动和排尿功能的具体机制还需进一步研究。

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