Acupuncture Combined with Electromyographic Biofeedback Improves Limb Disturbance, Depression and Quality of Life of Stroke Patients

Yue Liu
Hui Wu
Yuanzheng Sun
Yuanyuan Li

This study was designed to probe into the effects of acupuncture combined with electromyographic (EMG) biofeedback on limb dysfunction, depression and quality of life of stroke patients.Altogether 104 cerebral infarction patients who admitted to our hospital were selected as the research objects. According to different treatment schemes, 53 patients were divided into observation group (OG) (acupuncture combined with electromyographic biofeedback) and 50 were enrolled into control group (CG) (acupuncture alone). The treatment efficacy, National Institute of Health Stroke Scale (NIHSS), clinical spasm index (CSI), Berg balance scale (BBS), Fugl-Meyer Assessment (FMA), Timed Up and Go test (TUG), treatment compliance, depression and quality of life of the two groups were evaluated, and their adverse reactions during treatment were recorded and compared.The efficacy of the OG was obviously better than that of the CG (P<0.05). After treatment, NIHSS, CSI, BBS, FMA, TUG, treatment compliance, depression and quality of life of the two groups were dramatically improved (P<0.05), but the improvement degree of the OG was markedly better than that of the CG (P<0.05). There was no remarkable difference in adverse reactions between the two groups during treatment (P>0.05).EMG biofeedback combined with acupuncture has good efficacy on stroke, which can effectively improve limb dysfunction, relieve patients' negative emotions and improve their quality of life. It is safe and worthy of clinical promotion.

Keywords: acupuncture, electromyographic biofeedback, stroke, limb dysfunction, quality of life

Tob Regul Sci.™ 2021;7(5-1):3888-3895

DOI: doi.org/10.18001/TRS.7.5.1.161

Stroke, as a cerebrovascular accident, has a high incidence among the elderly [1]. For the elderly, once stroke occurs, it will not only have a long recovery period, but also lead to different degrees of limb dysfunction and high disability rate, which has a serious impact on their quality of life [2,3]. At present, with the emergence of an aging population, the morbidity of stroke is getting higher and higher, which not only poses a serious threat to the life and health of the elderly, but also poses a heavy burden on society [4,5]. Therefore, it is of great clinical significance to take timely and effective treatment measures to improve the sequelae of stroke.

As a relatively new rehabilitation technology, the principle of electromyographic (EMG) biofeedback is to set a threshold value in advance, instruct patients to do corresponding actions, and convert EMG signals generated during human activities into audio-visual signals, which are fed back to the brain, so that the cerebral cortex can regenerate new connections and reshape neural

Yue Liu[#] Heilongjiang University of traditional Chinese Medicine, Harbin 150040, Heilongjiang, China, Hui Wu[#] Tianyou Hospital affiliated to Wuhan University of Science and Technology, Wuhan 430060, Hubei, China, YuanzhengSun The Second Affiliated Hospital of Heilongjiang University of traditional Chinese Medicine, Harbin 150040, Heilongjiang, China, Yuanyuan Li[*] Hospital Affiliated to Tongji Medical College of Huazhong University of science and technology, Wuhan 430077, Hubei, China, [#]These authors contributed equally to this work as co-first author, [*]Corresponding author:Yuanyuan Li, Liyuan Hospital Affiliated to Tongji Medical College of Huazhong University of science and technology, Wuhan 430077, Hubei, China (Email: kemingqing1201@163.com)

pathways, thus enabling the central nervous system to resume the control of multiple paralyzed limbs [6]. In recent years, EMG biofeedback has been widely used in functional recovery after stroke, and achieved good results [7]. However, for stroke patients, the occurrence of disease not only has a serious impact on their lives, but also has a great impact on their psychology. For example, many patients will have depression after getting sick, so how to further improve the efficacy and relieve their negative emotions is also vital [8]. Traditional Chinese medicine (TCM) believes that the basic pathogenesis of stroke is stagnancy of functional activities of qi and dysfunction of the mind, which are mostly manifested as mixed excessiveness and deficiency clinically, while acupuncture treatment can promote blood circulation, remove blood stasis, relieve depression and soothe the nerves [9]. In the past, research[10] found that acupuncture treatment had a good effect on the recovery of stroke patients. However, due to the fear of acupuncture in some patients, the treatment compliance is not high, and the efficacy is not ideal.

In order to find a better treatment plan for stroke patients, we compared the effects of acupuncture alone and acupuncture combined with EMG biofeedback in stroke patients, which are reported as follows.

MATERIALS AND METHODS

Clinical Data

A total of 103 stroke patients admitted to our hospital from January 2017 to February 2019 were collected, including 61 male and 42 female patients, with an average age of (63.44±3.58) years. Based on the treatment plan, the patients were divided into observation group (OG) (53 cases treated with acupuncture combined with EMG biofeedback) and control group (CG) (50 cases treated with acupuncture alone). All of those included met the diagnostic criteria of stroke [11]. Exclusion criteria: conscious disorder; serious trauma; malignancy diseases; limb dysfunction caused by other reasons. All patients agreed to participate in the experiment and signed a written informed consent form. This experiment has been approved by the hospital ethics committee, conforming to Declaration of Helsinki.

Treatment Methods

Patients in both groups were given routine treatment to prevent brain edema and improve brain circulation, and given corresponding drug treatment for basic diseases. CG patients were treated with acupuncture alone. The specific treatment methods were taking Baihui, Shenting, Neiguan, Shenmen and Sishencong as the main points, and Hegu, Taichong and Sanyinjiao as the matching points. Acupuncture at Neiguan adopted reducing method, while Baihui, Shenting, Shenmen, Sishencong, Hegu, Taichong and Sanyinjiao adopted invigoration method. After the needle was inserted, they were connected with electroacupuncture instrument, and it was kept for 30 min. Other acupoints were treated with filiform needle and uniform reinforcing-reducing method, one day/time, five times/week, and four-week was a course of treatment.

On this basis, the patients in the OG were treated with EMG biofeedback therapy. The specific method was to take the sitting position, wipe and clean the skin of paralyzed limbs on the affected side with alcohol cotton ball, and connect the electrodes. In view of patients' tolerance, the stimulation current intensity was set to 30-60 mA, and the biostimulation feedback instrument was connected. They could see the EMG signals generated by muscle movement appearing on the display screen. After hearing the sound signals, the medical workers combined the changes of EMG signals to train the upper and lower limb muscle groups of the patients. Patients were encouraged to do their best to make specified actions. At the end of each intervention, the highest EMG signal displayed was recorded and used as the baseline for the next intervention, so that they could try to make breakthroughs continuously, training for 15 min each time and no less than 5 times a week. All the patients were intervened continuously for 3 months.

Outcome Measures

(1) The therapeutic effects of patients in the

two groups were evaluated, which were divided into cured, markedly effective, effective and ineffective. The total effective rate was (number of cured patients+number of markedly effective patients+number of effective patients)/the total number×100%.

(2) The patients were evaluated before and after treatment, and the neurological deficit was evaluated by the National Institute of Health Stroke Scale (NIHSS). The higher the score was, the more serious the neurological impairment was.

(3) The limb spasm degree was evaluated by the Clinical Spasm Index (CSI). The higher the score was, the more severe the limb spasm was.

(4) The balance was assessed by the Berg Balance Scale (BBS), and the higher the score was, the better the balance was.

(5) The motor function was analyzed by the Fugl-Meyer Assessment (FMA), and the score was improved and the motor function was enhanced.

(6) Timed Up and Go test (TUG): Patients could use daily assistive devices, from sitting to standing, walking forward for 3 min and then returning to the original position. The shorter the time was, the better the recovery was.

(7) The patient compliance was evaluated. The higher the score was, the higher the patient compliance was.

(8) The adverse emotions of the two groups before and after treatment were assessed by the Hamilton Depression Scale (HAMD).

(9) The quality of life before and after treatment was analyzed by the Quality of life scale (SF-36).

(10) Safety analysis: The adverse reactions of patients in both groups were recorded and analyzed.

Statistical Analysis

In this study, the collected data were statistically analyzed by SPSS19.0, the required pictures were drawn by GraphPad 7, and the counting data were expressed by percentage. Chi-square test was used for statistical analysis, independent t-test was used for inter-group comparison, and paired t test was used for comparison before and after treatment. There were statistical differences when $P<0.05$.

RESULTS

General Data Comparison

There was no remarkable difference in gender, age and BMI between the two groups ($P>0.05$), which was comparable. (Table I)

Table I.
General data expression

Factor	Observation group (n=53)	Control group (n=50)	t/X2	P
Gender			0.024	0.876
Male	31(58.49)	30(60.00)		
Female	22(41.51)	20(40.00)		
Age (years)			0.007	0.933
≤ 63	28(52.83)	26(52.00)		
> 63	25(47.17)	24(48.00)		
BMI(kg/m^2)			0.009	0.924
≤ 23	26(49.06)	25(50.00)		
< 23	27(50.94)	25(50.00)		
Course of disease (months)	3.54±0.23	3.61±0.24	1.512	0.134
History of smoking			0.065	0.798
Yes	22(41.51)	22(44.00)		
No	31(58.49)	28(56.00)		
Diabetes			0.012	0.915
Yes	27(50.94)	26(52.00)		
No	26(49.06)	24(48.00)		
Hypertension			0.001	0.978
Yes	33(62.26)	31(62.00)		
No	20(37.74)	19(38.00)		

Family history of stroke			0.002	0.962
Yes	14(26.42)	13(26.00)		
No	39(73.58)	37(75.00)		

Comparison of Therapeutic Effects of Patients between Both Groups

The therapeutic effects of the two groups were compared after the end of treatment. The number of patients in the OG who were cured, markedly effective, effective and ineffective was 20, 22, 9 and 2 respectively, with an effective rate of 80.77%. The number of patients in the CG who were cured, markedly effective, effective and ineffective was 14, 11, 15 and 10 respectively, with an effective rate of 80.00%. The effective rate of the OG was obviously higher than that of the CG (P<0.05) (Table II).

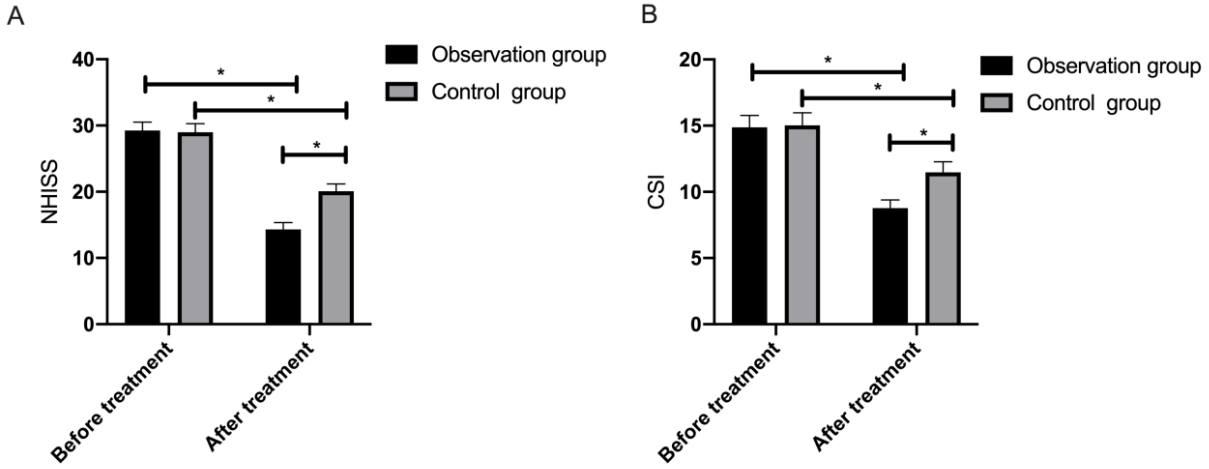
Table II.
Comparison of therapeutic effects of patients between the two groups

Efficacy	Observation group (n=53)	Control group (n=50)	X2	P
Recovery	20(37.74)	14(28.00)	-	-
Markedly effective	22(41.51)	11(22.00)	-	-
Effective	9(16.98)	15(30.00)	-	-
Ineffective	2(9.43)	10(20.00)	-	-
Total effective rate	51(96.23)	40(80.00)	6.581	0.01

Comparison of NIHSS and CSI Scores of Patients between Two Groups before and after Treatment

After intervention, the NIHSS and CSI scores of the two groups were remarkably improved compared with those before treatment, and the difference was statistically marked (P<0.05). Compared with the CG, the scores in the OG improved dramatically after intervention (P<0.05). (Figure 1)

Figure 1.
Comparison of NIHSS and CSI scores of patients between both groups before and after treatment



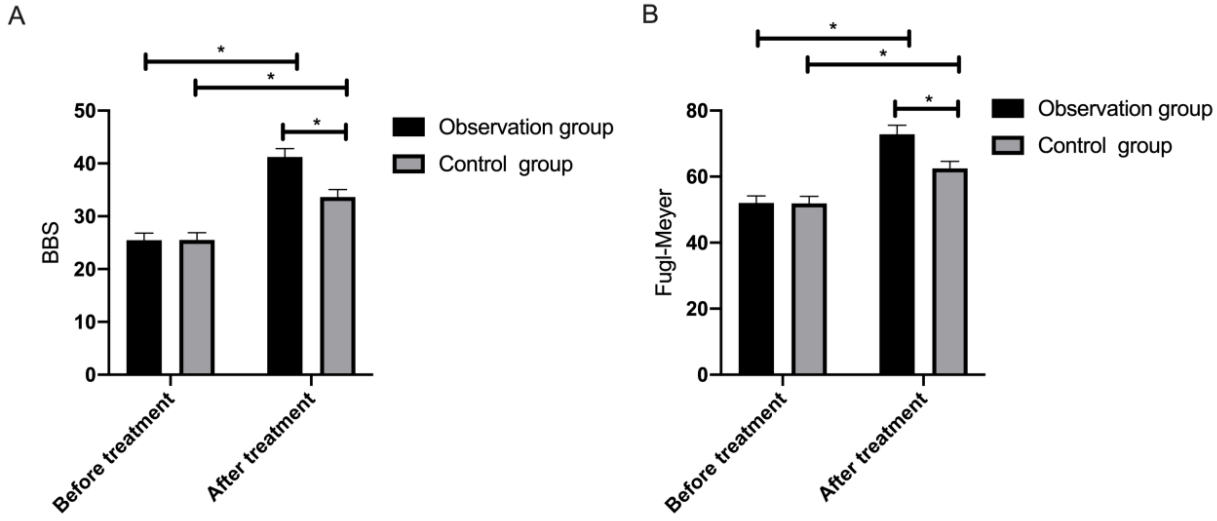
A: NIHSS; B: CSI. * means P<0.05.

Comparison of BBS and Fugl-Meyer scores of patients between both groups before and after treatment

After intervention, the BBS and Fugl-Meyer scores of the two groups were obviously higher

than those before treatment, and the difference was statistically remarkable (P<0.05). And the scores in the OG were markedly higher than those in the CG after intervention (P<0.05). (Figure 2)

Figure 2.
Comparison of BBS and Fugl-Meyer scores of patients between the two groups before and after treatment

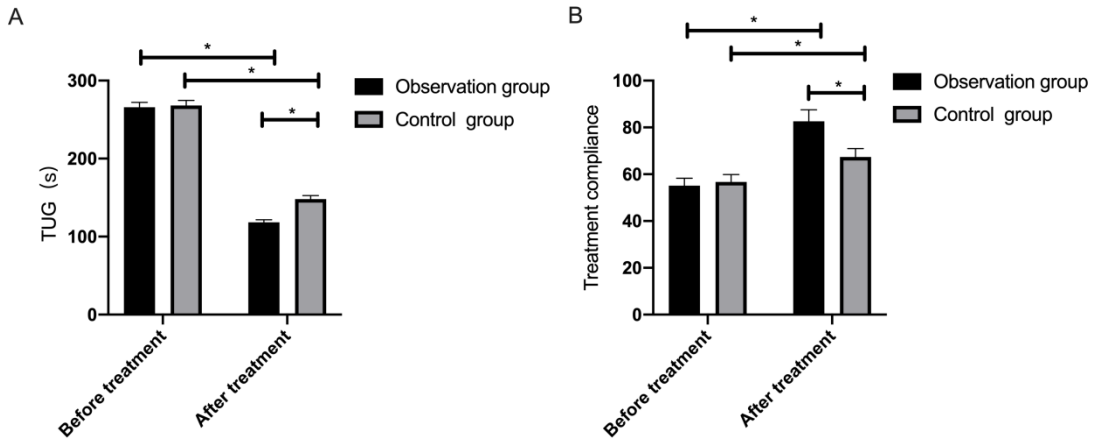


A: BBS; B: BBS. * means P<0.05.

Comparison of TUG and Compliance Scores of Patients between Both Groups before and after Treatment

After intervention, TUG and compliance of patients in both groups were markedly improved compared with those before treatment. The TUG index in the OG was markedly improved compared with that in the CG (P<0.05), and the compliance score in the OG was markedly higher than that in the CG (P<0.05). (Figure 3)

Figure 3.
Comparison of TUG and compliance scores of patients between the two groups before and after treatment



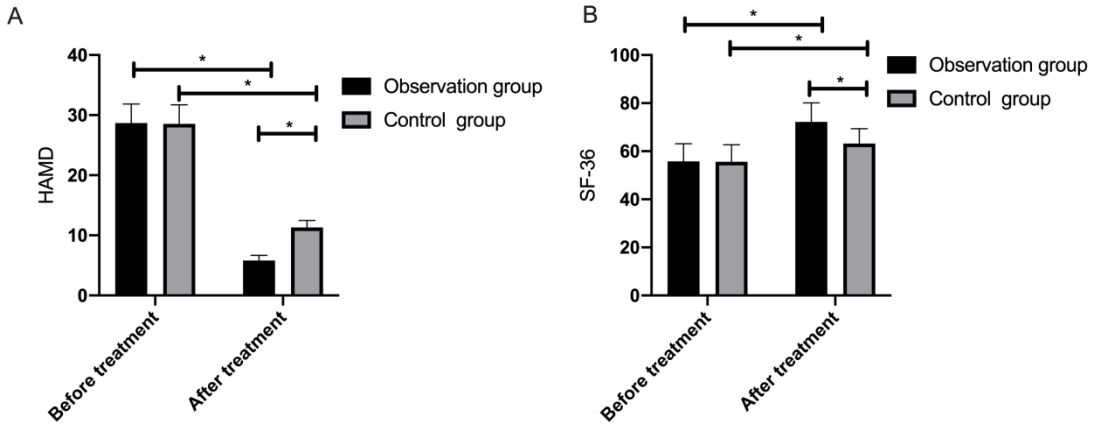
A: TUG; B: compliance. * means P<0.05.

Comparison of HAMD and SF-36 Scores of Patients between Both Groups

We compared the scores of HAMD and SF-36

of patients between the two groups before and after treatment. The results manifested that there was no remarkable difference in the two scores between the two groups before treatment (P>0.05), but after treatment, the scores in the OG were markdly improved (P<0.05). (Figure 4)

Figure. 4.
Comparison of HAMD and SF-36 scores of patients between the two groups before and after treatment



A: HAMD; B: SF-36. * means P<0.05.

Safety Analysis

We recorded and compared the adverse reactions of patients in the two groups during treatment. The results manifested that the number of patients with nausea, vomiting, needle sickness and muscle pain in the OG was 1, 0, 1 and 1 respectively, while the number of those in the CG was 1, 0, 0 and 1 respectively. (Table III)

Table III.
Comparison of adverse reactions of patients between both groups

Factor	Observation group (n=53)	Control group (n=50)	X2	P
Nausea	1(1.89)	1(2.00)	-	-
Vomiting	0	0	-	-
Needle sickness	1(1.89)	2(4.00)	-	-
Muscle pain	1(1.89)	1(2.00)	-	-
Total incidence rate	3(5.66)	4(8.00)	0.223	0.637

DISCUSSION

Recently, with the gradual entry into the aging society, the morbidity of stroke is getting higher and higher. Because of the high disability rate and death rate, it poses a serious threat to the life and health of the elderly [12,13]. With the development of medical technology, the success rate of rescuing stroke is getting higher and higher, but a series of sequelae such as hemiplegia will also have a very serious impact on the quality of life of patients [14]. Therefore, it is of great clinical significance to improve the recovery treatment of stroke patients.

In our research, the therapeutic effect of EMG biofeedback combined with acupuncture on stroke patients was analyzed. Acupuncture treatment, as a TCM, has achieved good results in stroke treatment. However, due to some patients' fear of acupuncture, its efficacy is not good, so it is necessary to find another treatment method [15]. EMG biofeedback therapy is a treatment method combining electrical stimulation and biofeedback technology, which

mainly converts the signals generated by the patient's muscle activity through electromyography biofeedback instrument and feeds them back to him to help adjust self-motion [16]. In our study, we observed that compared with patients treated with acupuncture alone, the efficacy of EMG biofeedback combined with acupuncture was obviously higher. This showed that the combination therapy could effectively improve the efficacy of stroke. Then, we compared the NIHSS and CSI scores of the two groups before and after treatment. The results showed that although the nerve defects and spasms of the two groups were markedly improved, the patients in the OG recovered better. A previous study [17] has shown that EMG biofeedback therapy can stimulate the brain center repeatedly, promote the formation of cerebral cortex excitation focus through conditioned reflex, and make undamaged nerve cells re-establish neural network, thus improving patients' neural function, in line with our observations. Next, we compared BBS, Fugl-Meyer, TUG and treatment compliance of the two groups before and after treatment. The results signified that the combination of EMG biofeedback and acupuncture therapy could not only improve the balance and motor function of patients more effectively, but also promote the recovery of limb dysfunction, and effectively improve the treatment compliance, so that they could cooperate with treatment more effectively, thus achieving better efficacy. An another study [18] pointed out that after EMG biofeedback therapy, it could promote the interaction of sensation and movement, enhance local muscle excitability, reduce muscle tension, improve the coordination of muscle movement and restore the motor function to the maximum extent, which was consistent with our observations.

Finally, we evaluated and compared the depression and quality of life of patients in the two groups. The results manifested that although the depression and quality of life of both groups had improved significantly, the OG was superior to the CG, which suggested that the combination of EMG biofeedback and acupuncture therapy could effectively improve the negative emotions of patients, and its promoting effect on recovery could also improve their life treatment more effectively. In the past, some studies [19,20] indicated that EMG biofeedback therapy was also a psychotherapy technique. Patients could know the influence of active rehabilitation training on muscles in time, see the rehabilitation effect intuitively, effectively mobilize subjective initiative, improve compliance with rehabilitation training, directionally strengthen limb motor function, and adjust limb motion amplitude. Limb spasm is the key to restrict the recovery of patients' motor function. The reorganization or reshaping of nerve function is conducive to promoting the recovery of paralyzed muscles and reducing the degree of limb spasm. And other studies [21] showed that the improvement of limb function and quality of life could effectively alleviate the negative emotions of stroke patients, also consistent with our conclusion.

To sum up, EMG biofeedback combined with acupuncture has a good efficacy on stroke, which can effectively improve patients' limb dysfunction, relieve their negative emotions, and improve their quality of life. It is safe and worthy of clinical promotion.

REFERENCES

1. Amarenco Pierre,Kim Jong S,Labreuche Julien et al. Benefit of Targeting a LDL (Low-Density Lipoprotein) Cholesterol <70 mg/dL During 5 Years After Ischemic Stroke.[J] .Stroke, 2020, 51: 1231-1239.
2. Broersen Leonie H A,Stengl Helena,Nolte Christian H et al. Association Between High-Sensitivity Cardiac Troponin and Risk of Stroke in 96 702 Individuals: A Meta-Analysis.[J] .Stroke, 2020, 51: 1085-1093.
3. Li Linxin,Scott Catherine A,Rothwell Peter M et al. Trends in Stroke Incidence in High-Income Countries in the 21st Century: Population-Based Study and Systematic Review.[J] .Stroke, 2020, 51: 1372-1380.
4. Matsuo Ryu,Ago Tetsuro,Kiyuna Fumi et al. Smoking Status and Functional Outcomes After Acute Ischemic Stroke.[J] .Stroke, 2020, 51: 846-852.
5. Shin Minyoung,Sohn Min Kyun,Lee Jongmin et al. Effect of Cognitive Reserve on Risk of Cognitive Impairment and Recovery After Stroke: The KOSCO Study.[J] .Stroke, 2020, 51: 99-107.
6. Weber Ralph,Krogias Christos,Eyding Jens et al. Age and Sex Differences in Ischemic Stroke Treatment in a Nationwide Analysis of 1.11 Million Hospitalized Cases.[J] .Stroke, 2019, 50: 3494-3502.
7. Casellato Claudia,Ambrosini Emilia,Galbiati Andrea et al. EMG-based vibro-tactile biofeedback training:

effective learning accelerator for children and adolescents with dystonia? A pilot crossover trial.[J] .J Neuroeng Rehabil, 2019, 16: 150.
8. Gill Dipender,James Nicole E,Monori Grace et al. Genetically Determined Risk of Depression and Functional Outcome After Ischemic Stroke.[J] .Stroke, 2019, 50: 2219-2222.
9. Lu Chung-Yen,Huang Hsin-Chia,Chang Hen-Hong et al. Acupuncture Therapy and Incidence of Depression After Stroke.[J] .Stroke, 2017, 48: 1682-1684.
10. [10]Zhang Xin-Yan,Li Yu-Xiang,Liu Dong-Ling et al. The effectiveness of acupuncture therapy in patients with post-stroke depression: An updated meta-analysis of randomized controlled trials.[J] .Medicine (Baltimore), 2019, 98: e15894.
11. Marto João Pedro,Lambrou Dimitris,Eskandari Ashraf et al. Associated Factors and Long-Term Prognosis of 24-Hour Worsening of Arterial Patency After Ischemic Stroke.[J] .Stroke, 2019, 50: 2752-2760.
12. Matsumoto Koutarou,Nohara Yasunobu,Soejima Hidehisa et al. Stroke Prognostic Scores and Data-Driven Prediction of Clinical Outcomes After Acute Ischemic Stroke.[J] .Stroke, 2020, 51: 1477-1483.
13. Marko Martha,Posekany Alexandra,Szabo Simon et al. Trends of r-tPA (Recombinant Tissue-Type Plasminogen Activator) Treatment and Treatment-Influencing Factors in Acute Ischemic Stroke.[J] .Stroke, 2020, 51: 1240-1247.
14. Ni Weiyi,Kunz Wolfgang,Goyal Mayank et al. Lifetime quality of life and cost consequences of delays in endovascular treatment for acute ischaemic stroke: a cost-effectiveness analysis from a Singapore healthcare perspective.[J] .BMJ Open, 2020, 10: e036517.
15. Lu Lin,Zhang Xiao-guang,Zhong Linda L D et al. Acupuncture for neurogenesis in experimental ischemic stroke: a systematic review and meta-analysis.[J] .Sci Rep, 2016, 6: 19521.
16. Kim Ju-Hong,The effects of training using EMG biofeedback on stroke patients upper extremity functions.[J] .J Phys Ther Sci, 2017, 29: 1085-1088.
17. Nelson Lonnie A,The role of biofeedback in stroke rehabilitation: past and future directions.[J] .Top Stroke Rehabil, 2007, 14: 59-66.
18. Park Yong Keun,Kim Je Ho,Effects of kinetic chain exercise using EMG-biofeedback on balance and lower extremity muscle activation in stroke patients.[J] .J Phys Ther Sci, 2017, 29: 1390-1393.
19. Song Rong,Tong Kai Yu,EMG and kinematic analysis of sensorimotor control for patients after stroke using cyclic voluntary movement with visual feedback.[J] .J Neuroeng Rehabil, 2013, 10: 18.
20. Prasomsri Jaruwan,Jalayondeja Chutima,Bovonsunthonchai Sunee et al. Walking and stair climbing abilities in individuals after chronic stroke with and without mental health problem.[J] .J Med Assoc Thai, 2014, null: S10-5.
21. Mitchell Alex J,Sheth Bhavisha,Gill John et al. Prevalence and predictors of post-stroke mood disorders: A meta-analysis and meta-regression of depression, anxiety and adjustment disorder.[J] .Gen Hosp Psychiatry, 2017, 47: 48-60.