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Effect of Sling Exercise Training Combined with Kinetic Cupping Therapy on Upper Limb Motor Dysfunction in Patients after Stroke

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Keywords

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Abstract

Objective: This study investigates the effect of sling exercise training combined with kinetic cupping therapy on upper limb motor dysfunction in patients after stroke. **Methods:** 40 stroke patients, who were admitted to our hospital from September 2022 to April 2023 and treated with sling exercise training combined with kinetic cupping therapy, were allocated into combination group, and another 40 stroke patients, who were treated with kinetic cupping therapy in the same period, were assigned into the control group. After 4 weeks treatment, the clinical efficacy, pain level, upper limb function, and activity of daily living were compared between the two groups. **Results:** The total effective rate of treatment in combination group was higher than that in control group ($p < 0.05$). Compared with before treatment, visual analogue scale (VAS) score in both groups was reduced after treatment ($p < 0.05$), and the score in combination group was lower than that in control group ($p < 0.05$). The scores of Fugl-Meyer motor function assessment (FMA), Brunnstrom stage, and Modified Barthel Index (MBI) after treatment were increased in both groups compared with before treatment ($p < 0.05$), and these in combination group were higher than those in the control group ($p < 0.05$). **Conclusion:** Sling exercise training combined with kinetic cupping therapy has a good clinical efficacy in the treatment of stroke patients through improving the upper limb function, relieving pain, and enhancing the activity of daily living.

1 Introduction

Stroke is an acute cerebrovascular disease in which blood circulation in the brain is impaired due to rupture or blockage of some blood vessels in the skull, resulting in damage to the brain tissue. Motor dysfunction is a common complication of stroke patients [1]. During the rehabilitation process of the patients with stroke hemiplegia, their lower limb dyskinesia can be quickly improved, with a relatively satisfactory functional reconstruction, whereas the recovery of upper limb motor function is slow and the rehabilitation effect is not very satisfactory [2]. Research has revealed that 6 months after the onset of stroke, about 30% to 66% of patients still have hemiplegic upper limb impairment, whose abilities to learn, work and live in daily life were seriously affected [3]. Conventional rehabilitation methods for upper limb motor dysfunction after stroke include physical therapy and occupational therapy, for example, brain-computer interfaces and electroacupuncture [4-6]. But more than 50% of stroke patients still have long-term upper extremity motor dysfunction [7].

Further, at present, kinetic cupping therapy is clinically used to exercise the upper limb function of stroke patients, which produces a negative pressure effect that can vasodilate blood vessels, improve local microcirculation, and promote local capillary and endothelial cell morphology repair, thereby effectively contributing to the recovery of organism function [8]. Meng et al. study have uncovered that kinetic cupping therapy can increase the blood flow to the muscles of patients with low back pain due to deficiency of the liver and kidney, enhance the working ability and endurance of the muscles, prevent muscle atrophy, and effectively improve the upper limb dysfunction of patients. But its clinical efficacy is limited when used alone [9]. Previous study showed that balance acupuncture combined with kinetic cupping therapy can effectively relieve the pain of patients with shoulder periarthritis and improve the movable function of shoulder joint [10].

Sling exercise training is an active treatment modality aimed at improving skeletal muscle disorders, which integrates diagnosis and treatment. Its core content is neuromuscular strengthening and retraining. Currently, this method has achieved excellent results in the rehabilitation treatment of stroke [11]. He et al. study also uncovered that sling exercise training can not only improve the walking ability of hemiplegic patients, but also enhance their balance function and activity of daily living [12]. And suspension exercise training can effectively improve the movement and balance function of children with spastic cerebral palsy [13].

Therefore, to improve the efficacy of upper limb motor dysfunction in stroke patients, this study investigates the effect of sling exercise training combined with kinetic cupping therapy on patients with stroke, with a view to providing reference for the clinical treatment of stroke.

2 Materials and methods

2.1 General data

40 stroke patients, who were admitted to our hospital from September 2022 to April 2023 and treated with sling exercise training combined with kinetic cupping therapy, were allocated into combination group, and another 40 stroke patients, who were treated with kinetic cupping therapy in the same period, were assigned into the control group. There was no significant difference in the general data in the two groups ($p > 0.05$), and these data were comparable, as seen in Table 1.

2.2 Inclusion criteria

(1) Patients met the diagnostic criteria for stroke in Chinese Guidelines for Diagnosis and Treatment of Acute Ischemic Stroke 2018 [14], and they were

diagnosed by cranial CT examination. (2) The disease duration of the patients was less than 5 months. (3) Patients with upper limb motor dysfunction.

Table 1 Comparison of general data.

Groups	Cases	Gender (cases)		Age (years old)	Duration of disease (days)	Type of stroke (cases)	
		Male	Female			Cerebral infarction	Cerebral hemorrhage
Combination group	40	28	12	60.85 ± 12.03	64.33 ± 24.09	39	1
Control group	40	30	10	63.48 ± 11.23	62.48 ± 25.41	37	3
χ^2/t		0.251		0.950	0.348	0.263	
p		0.617		0.345	0.729	0.608	

2.3 Exclusion criteria

(1) Patients with neurological deficits caused by intracerebral tumors, trauma, parasitic diseases, metabolic disorders, etc. (2) Pregnant or breastfeeding women. (3) Patients with lesions of important organs such as heart, liver, kidneys, etc. (4) Patients with disease exacerbation during this study. (5) Patients with primary diseases of hemopoietic system and endocrine system. (6) Patients with mental disorders.

2.4 Methods

Patients in control group were treated with kinetic cupping therapy. In detail, patients were guided to take a seated position, and Yiguan (a kind of can made of silicone or natural rubber by vulcanization) from Guangzhou Peiyuan Biotechnology Co., Ltd. was pressed down in a vertical direction 2 to 3 times each time. After the gas in the cans was discharged, the cans were naturally adsorbed on the acupuncture points of Jianqian, Jianyu, Jiancheng, Jianjing, Binao, Shousanli, Waiguan, and Quchi. Patients were instructed to perform abduction, rotation, flexion, extension and adduction of the shoulder joint with the cans, with the range of movement to the extent that the patients could tolerate. After 8 to 10 min, these cans were removed, and these acupuncture points were wiped with dry cotton balls and covered by band-aids. The treatment was carried out every other day for a total of 2 courses of treatment, with 2 weeks per course.

Based on the treatment in control group, patients in combination group were given sling exercise training below. (1) Open kinetic chain: the suspension strap was attached to the affected elbow with the affected elbow joint straightened. It was appropriate for the patient to feel that the shoulder and elbow joints were in a relaxed state. After fixation of the suspension straps, according to the patients' upper limb motor

function, the training time of each joint was determined, while different levels of difficulty were set to enable the patients to complete the movement of each joint. Patients were guided to do shoulder joint abduction exercises in the supine position. Patients were guided to do active-passive shoulder joint flexion and extension training in lateral position on uninjured side. Patients were instructed to do shoulder joint adduction and abduction exercises in the seated position, and then operating training was conducted using frosted board, roller, and pegs. (2) Closed kinetic chain: patients were in sitting position, and the suspension strap was attached to the affected hand. While pressing the suspension strap downward with the hand, the shoulder joint of the affected side was kept in forward flexion and backward extension at different angles, and moved in a circular motion. Proprioceptive training was performed for a short period. Open kinetic chain lasted for 30 min, and closed kinetic chain for 10 min, with a total of 40 min every day. Sling exercise training was performed for 4 weeks.

2.5 Research indicators

Clinical efficacy: the clinical efficacy in the two groups of patients was assessed after 4 weeks of treatment [15]. Cured: improvement degree of pain $\geqslant$ 90%; significantly effective: 60% $\leqslant$ improvement degree of pain $\leqslant$ 89%; effective: 20% $\leqslant$ improvement degree of pain $\leqslant$ 59%; ineffective: improvement degree of pain $\leqslant$ 19%. Effective rate of treatment = number of (cured + significantly effective + effective) cases / total number of cases × 100%.

Pain level: the pain level of patients in both groups was assessed before and after 4 weeks of treatment. The pain visual analogue scale (VAS) was used to assess the pain level of patients in both groups, with higher score representing more severe pain [16].

Upper limb function: Fugl-Meyer motor function assessment (FMA) and Brunnstrom stage scale were applied for the evaluation of upper limb function of the two groups of patients before and after 4 weeks of treatment. FMA included 5 items of limb movement, balance, sensation, range of motion, and pain, with the higher score indicating the better motor and balance function of the patients [17]. In Brunnstrom stage scale, there are 6 stages. For statistical convenience, stages of 1-6 represented points of 1-6, respectively, with the higher stage implying the better function of upper limb [17].

Activity of daily living: Activity of daily living was assessed using the Modified Barthel Index (MBI) before and after 4 weeks of treatment. MBI consisted of 10 items, including continence, toileting, ability of moving bed and chair, walking on flat surfaces, walking up and down stairs, eating, grooming, bathing, and dressing, with a total of 100 points. The higher point of MBI represented the better activity of daily living [18].

2.6 Statistical methods

SPSS 20.0 was applied for statistical analysis. For count data, percentages (%) were used to represent the data, and the comparison between the two groups was conducted using χ^2 test. Measurement data were expressed as mean ± standard deviation. Comparison between the two groups was performed using the independent samples t-test, and the comparison in the same group at different time points was made using paired samples t-test. Difference was considered to be statistically significant at $p < 0.05$.

3 Results

3.1 Comparison of clinical efficacy between the two groups

The total effective rate of treatment in combination group was higher than that in control group ($p < 0.05$), as seen in Table 2.

Table 2 Comparison of clinical efficacy between the two groups [cases (%)].

Groups	Cases	Cured	Significantly effective	Effective	Ineffective	Total effective rate
Combination group	40	6 (15.00)	12 (30.00)	21 (52.50)	1 (2.50)	39 (97.50)
Control group	40	4 (10.00)	5 (12.50)	23 (57.50)	8 (20.00)	32 (80.00)
χ^2						4.507
p						0.034

3.2 Comparison of VAS score between the two groups before and after treatment

Before treatment, there was no significant difference of VAS score in the two groups of patients ($p > 0.05$). Compared with before treatment, VAS score in both groups was reduced after treatment ($p < 0.05$), and the score in combination group was lower than that in control group ($p < 0.05$), as shown in Table 3.

3.3 Comparison of upper limb function between the two groups before and after treatment

Before treatment, there was no significant difference of FMA score and Brunnstrom stage in the two groups ($p > 0.05$). FMA score and Brunnstrom stage after treatment were increased in both groups compared with before treatment ($p < 0.05$), and these in combination group were higher than those in the control group ($p < 0.05$), as displayed in Table 4.

Table 3 Comparison of VAS score between the two groups before and after treatment ((means ± standard deviation), point).

Groups	Cases	VAS score	
		Before treatment	After treatment
Combination group	40	5.98 ± 1.25	2.30 ± 1.24*
Control group	40	5.70 ± 1.32	3.15 ± 1.75*
t		0.955	2.506
p		0.343	0.014

Note: *$p < 0.05$ vs Before treatment

Table 4 Comparison of upper limb function in the two groups before and after treatment (means ± standard deviation).

Groups	Cases	Fugl-Meyer score (point)		Brunnstrom stage	
		Before treatment	After treatment	Before treatment	After treatment
Combination group	40	16.78 ± 2.44	49.53 ± 2.41*	2.40 ± 0.59	3.93 ± 0.73*
Control group	40	16.03 ± 2.43	37.85 ± 5.30*	2.45 ± 0.55	3.20 ± 0.72*
t		1.375	12.677	0.391	4.463
p		0.173	< 0.001	0.697	< 0.001

Note: *p < 0.05 vs Before treatment

3.4 Comparison of activity of daily living between the two groups before and after treatment

Before treatment, there was no significant difference of MBI score in the two groups of patients (p > 0.05). The MBI score after treatment was increased in both groups compared with before treatment (p < 0.05), and the score in combination group was higher than that in the control group (p < 0.05), as seen in Table 5.

Table 5 Comparison on activity of daily living between the two groups before and after treatment (means ± standard deviation).

Groups	Cases	MBI score	
		Before treatment	After treatment
Combination group	40	39.38 ± 15.74	65.38 ± 12.58*
Control group	40	39.88 ± 15.67	58.50 ± 9.55*
t		0.142	2.753
p		0.887	0.007

Note: *p < 0.05 vs Before treatment

4 Discussion

In this study, patients in the control group were treated with kinetic cupping therapy, and the patients in combination group were treated with sling exercise training based on the treatment in control group. Our results demonstrated the good clinical efficacy of sling exercise training combined with kinetic cupping therapy in treating stroke patients.

Kinetic cupping therapy can effectively relieve spasmodic muscles by pulling the shoulder muscles, thereby relaxing the superficial and deep myofascial layers [19]. At the same time, the negative pressure

generated by Yiguan in the local area can make the misplaced small joints recover automatically so that the incarcerated fascia can be put back into position, thus increasing the mobility of the shoulder, restoring the motor function of the upper limb, and improving patients' activity of daily living [20]. And our result showed that after 4 weeks of treatment with kinetic cupping therapy, the VAS scores, scores and MBI scores of the patients were significantly improved compared with those before treatment. However, previous study showed that high frequency ultrasound-guided extracorporeal shock wave therapy combined with kinetic cupping therapy can increase FMA scores and MB1 scores and decrease VAS, indicating combination therapy reduced the degree of shoulder joint pain after stroke, improved the motor function in patients with shoulder joint pain [21]. Moreover, suspension straps in sling exercise training can reduce the load on the patient's trunk during training, increase active movement, and maintain the coordination between the deep stability muscles and superficial motor muscles of the trunk during the training, which markedly improves the patients ' coordination function and motion control ability, and stimulates the motor function in the body under non-stable conditions, thus improving patients' upper limb function and activity of daily living [22]. Further, previous study showed that active shoulder motion and sling exercise training can effectively reduce shoulder suluxation and improve upper limb function of patients through increasing FMA score and Brunnstrom stage [23]. Therefore, we explored the effect of combination therapy of kinetic cupping therapy and sling exercise training. And the results of this study revealed that sling exercise training combined with kinetic cupping therapy could improve FMA score, Brunnstrom stage and MBI score and decrease VAS score, which had a good clinical efficacy in stroke patients through improving the upper limb function and enhancing the activity of daily living.

Further, Stroke patients often experience musculoskeletal pain which is often caused by hypertonia [24]. The results of this study found that sling exercise training combined with kinetic cupping therapy could effectively reduce the level of pain in the organism. kinetic cupping therapy not only accelerates the body's metabolism, eliminates the accumulation of inflammatory substances in the upper limb extremity meridian nodes, relieves the body's pain, but also effectively relax myofascia under the skin of the patient's affected area, so that excessive peripheral nerve tension can be alleviated. Thus, the therapy has a good pain-relieving effect [19]. Sling exercise training can be performed on important core muscles such as the multifidus, transversus abdominis, and gluteus medius in both open kinetic chain and closed kinetic chain, thus improving spinal stability and reducing the stimulation of pain receptors in the tissues to alleviate pain [25]. Accordingly, sling exercise training combined with kinetic cupping therapy for the treatment of stroke patients can effectively reduce the degree of pain in the body.

However, this study still has limitation. The sample size of the present study is small, and the effect of above treatment options on the long-term motor function and patients' quality of life has not been analyzed. Follow-up studies are needed to analyze the specific mechanism of sling exercise training combined with kinetic cupping therapy on upper limb dysfunction in stroke patients, so as to provide a reference for the treatment of upper limb dysfunction in stroke patients.

In conclusion, sling exercise training combined with kinetic cupping therapy has a good clinical efficacy in stroke patients through improving the upper limb function, relieving pain, and enhancing the activity of daily living.

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Not applicable.

Conflicts-of-Interest

The authors declare no conflicts of interest.

Author Contributions

Conceptualization:Ruijian Cao; Data curation:Yiqing Du; Formal analysis:Ruijian Cao; Methodology:Yiqing Du; Writing – original draft: Ruijian Cao; Writing – review and editing:Yiqing Du; All authors have read and agreed to the published version of manuscript.

Ethics Approval and Consent to Participate

This study was approved by Medical Ethics Committee, and patients were informed and agreed.

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Availability of Data and Materials

The analyzed data sets generated during the study are available from the corresponding author on reasonable request.

Supplementary Materials

Not applicable.

Reference

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