Am J Transl Res 2022;14(3):1868-1876
www.ajtr.org /ISSN:1943-8141/AJTR0141083

Original Article

Effects of cross electro-nape-acupuncture (CENA) on recovery of consciousness and tracheotomy tube sealing in serious cerebral hemorrhage

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Received December 12, 2021; Accepted February 12, 2022; Epub March 15, 2022; Published March 30, 2022

Abstract: Objective: This study was designed to explore the effects of cross electro-nape-acupuncture (CENA) treatment on the recovery of consciousness and tracheotomy tube sealing in patients with serious cerebral hemorrhage (SCH). Methods: A total of 60 patients with SCH admitted to the Intensive Care Unit of the South Hospital of the Second Affiliated Hospital of Heilongjiang University of Traditional Chinese Medicine from November 2020 to June 2021 were selected and randomized into two groups: the CENA group and a control group, given no acupuncture. Both groups were given the same basic treatment and patients in the CENA group were additionally given CENA treatment. Glasgow coma scale (GCS) scores, mismatch negative wave (MMN) and the cough reflex grading score (TCRGS) were recorded and compared after treatment for four weeks. The time to tracheostomy tube sealing was also recorded. Results: After treatment, the GCS scores and MMN latency values of the two groups were significantly improved, with significantly better GCS scores and MMN latency values in the CENA group than in the control group. After treatment, the two groups of TCRGS were reduced, with more significant decreases in the CENA group than in the control group. Conclusion: With CENA, it took less time to achieve recovery of consciousness, improve cough reflex score and shortened the time to tracheal tube cutting and sealing in patients with SCH.

Keywords: Cross electro-nape-acupuncture (CENA), serious cerebral hemorrhage, consciousness, tracheotomy

Introduction

With the changes in diet and living habits and the increase of social pressure, people face an increasing incidence of cerebral hemorrhage due to hypertension, diabetes, and heart disease etc. [1]. Intracerebral hemorrhage (ICH) results from spontaneous direct bleeding in the brain [2]. Serious cerebral hemorrhage (SCH) currently lacks a unified medical criterion and is usually defined as a hematoma larger than 30 ml (on the tentorium cerebellum) in clinic [3]. As a common symptom of SCH, DOC is a state of prolonged altered consciousness, which can be categorized into coma, vegetative state, or minimally conscious state based on neurobehavioral function [4, 5]. Damage of the reticular ascending activation system, the cerebral cortex and the consciousness transmission pathway could disturb the consciousness and arousal level [6, 7]. According to the World Health Organization, stroke is the second leading cause of death and the third leading cause of disability-adjusted life years lost, which places a huge burden on the health resources of many countries [8]. Based on the conjecture of neuronal correlates of consciousness [9], special nerve areas are damage after SCH and this may trigger confusion in patients. Due to the complex anatomical structure and clinical manifestations of the nervous system, cerebral hemorrhage has poor prognosis, with a high fatality rate and disability rate, which exerts a heavy burden on patients, families, and society.

Because of paralysis of the limbs and weakened swallowing reflex and cough reflex, spu-

Table 1. Basic information

Group	n	Men/women	Average age (years old)	Average bleeding (ml)	Bleeding site		
					Basal ganglia	Brain lobe	Thalamus
CENA	30	18/12	54.53±8.14	46.27±8.03	12	5	13
Control	30	16/14	55.13±9.96	44.90±7.30	10	7	13
t/χ^2		0.271	-0.26	0.69		0.515	
P-value		0.602	0.799	0.493		0.773	

tum cannot be excreted, which can give rise to lung infections, airway obstruction, and breathing difficulty, and may even cause brain hypoxia. In order to avoid hypoxia in patients, artificial airways need to be established to provide fresh air. Although a tracheotomy can cause a certain degree of trauma, it is time-saving and its combined use with active disease supervision and nursing intervention after the operation can assist the wound healing time [10]. However, it also exacerbates the possibility of aggravation of pulmonary infection, so improving the swallowing reflex and cough reflex of patients and sealing the tube for tracheotomy as soon as possible, is of positive significance for recovery. Therefore, timely and effective treatment and nursing are important to improve the consciousness of patients after intracerebral hemorrhage and shorten the tracheostomy tube sealing time. The CENA therapy, invented by Guofeng Cai, has a good effect on the recovery of cough reflex and swallow reflex after cerebrovascular disease [11]; at the same time, it also has a good protective effect on necrotized nerves in rats with cerebral hemorrhage [12]. In this study, we explored the effects of cross electro-nape-acupuncture (CENA) treatment on the recovery of consciousness and tracheotomy tube sealing in SCH patients.

Materials and methods

General information

The 60 SCH patients were recruited from the Intensive Care Unit of the Second Affiliated Hospital of Heilongjiang University of Traditional Chinese Medicine from November 2020 to June 2021. The patients who met the diagnostic criteria were randomly divided into the CENA group and a control group. There was no statistically significant difference between the two groups of patients in gender, age, average bleeding, postoperative time, bleeding site, etc. (P>0.05), as shown in **Table 1**. The study protocol was approved by the Ethics Committee of the Second Affiliated Hospital of Heilongjiang University of Traditional Chinese Medicine (ethical approval no. (2019-K114)) and registered at www.chictr/showproj.aspx?proj=126302.

Diagnostic criteria

(1) In Western medicine: the diagnostic criteria of SCH was referred to as "China Consensus on the Management of Severe Cerebrovascular Disease 2015" [3]. (2) In Traditional Chinese Medicine (TCM): the diagnosis was referred to as the "Stroke Diagnosis and Efficacy Evaluation Criteria (Trial)" proposed by the State Administration of Traditional Chinese Medicine of the Encephalopathy Emergency Cooperation Group in 1995 [13]. Primary symptoms: Unconsciousness, hemiplegia, paresthesia, slurred or silent speech, and crooked tongue. Secondary symptoms: Headache, dizziness, sluggish pupils, changes in pupils, non-immediate eyesight, choking with drinking water and ataxia. Onset mode: Acute onset, usually with aura symptoms and triggers, and the age of onset was ≥40 years old. The disease can be diagnosed with more than 2 primary symptoms or 1 primary symptom plus 2 secondary symptoms combined with onset mode, predisposing factors and aura symptoms, age, etc. Patients who do not meet the above conditions can be diagnosed additionally with imaging examinations.

Inclusion criteria

(1) Those who met the diagnostic criteria for SCH; (2) Aged 18-75 years old; (3) Received tracheotomy 14-30 days after the onset; (4) Patients with GCS score of 8-15 points; (5) Patients with cough reflex grading scale score ≥2 points; (6) Patients who or whose families agreed to join the study and signed an informed consent.

Exclusion criteria

(1) Patients with cerebral hemorrhage, cerebral embolism, cerebral infarction or brain space-

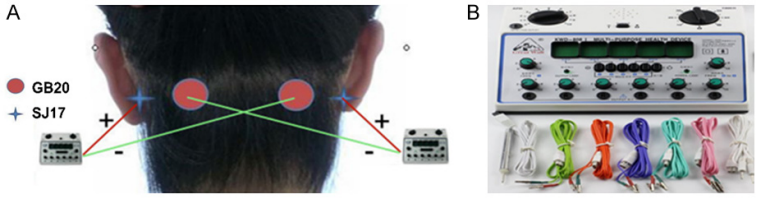

Figure 1. A: The picture on the left shows the connection of CENA. B: The picture on the right shows the KWD-808 pulse acupuncture treatment instrument.

occupying lesions caused by trauma; (2) Patients who have not undergone tracheotomy after the onset of the disease; (3) Patients accompanied with serious heart, liver, kidney or other organ and system diseases; (4) Patients with untreated active bleeding diseases, malignant tumors, pulmonary contusion, tuberculosis cavity and hemoptysis, pulmonary bullae and bronchiectasis, pneumothorax, or mediastinal emphysema; (5) Patients who relied on a ventilator to assist breathing; (6) Patients with hearing impairment or visual impairment caused by the disease.

Rejection criteria

(1) Patients who were transferred to other hospital due to deterioration of disease; (2) Patients who had severe comorbidities during treatment or change of treatment plan; (3) Patients who withdraw spontaneously during treatment.

Methods

Basic treatment and nursing methods

Both groups were given western medicine, including anti-inflammatory treatment (antibiotics were adjusted and used according to the results of sputum culture and drug sensitivity test), phlegm-resolving treatment, gastric mucosa-protecting treatment, Xingnaojing wake-up promoting therapy and basic treatments once a day. In the meantime, both groups were given standard nursing care for patients' respiratory tract, modified Venturi heating and humidification [14], and shallow sputum suction to reduce airway damage. Moreover, attention was paid to the skin condition around the tracheotomy tube to avoid infection, oral hygiene was strengthened, and the patients were turned over to promote the restoration of the original volume of the lungs.

Control group: The Control group received basic treatment and nursing.

CENA group: The CENA group received CENA treatment additionally on the basis of the care given to the control group. Huatuo brand 0.35×40 mm milli needles were disinfected with 75% ethanol and used. The following acupoints were stimulated: Bilateral SJ17 acupoints: straight piercing of about 20-24 mm; bilateral GB20: piercing of about 25 mm, with the needle tip toward the tip of patients' nose; DU20: puncture of 12-20 mm backwards; EXHN1 (one inch before DU20) penetrating GB6 acupoint, flat puncture approximately 25 mm; RN20, straight puncture 20-24 mm; ST18, flat puncture 12-25 mm; DU23, backward flat puncture 12-20 mm; lesion side motor area, ST2, oblique puncture 12-20 mm; ST4, penetrating the ST6 oblique puncture 12-20 mm, LI14, straight puncture 12-25 mm; LI11, straight puncture 12-25 mm; LI10, straight puncture 12-20 mm; SJ15, straight puncture 12-25 mm; LI15, diagonal puncture 30-40 mm; ST32, straight puncture 15-30 mm; SP10, straight puncture 12-25 mm; ST31, straight puncture 15-30 mm; ST36, straight puncture 12-37 mm; GB30, straight puncture 25-37 mm; SP36, straight puncture 12-25 mm; ST, straight puncture 10-15 mm; LR3, straight puncture 12-20 mm. The KWD-808 pulse acupuncture treatment instrument was used, and the nape was cross-connected, namely, the positive electrode of the same electrode line was connected to the left SJ17 point, and the negative electrode was connected to the right GB20 point; the positive electrode of the other electrode line was connected to the right SJ17 point, negative electrode to the left-side GB20 point (**Figure 1**). We used a continuous wave at 1-1.5 Hz frequency, adjusted current strength scale between 6 and 7 (tolerable for patients), and performed acupuncture once on Sunday and twice on the other days (30 minutes each time).

Outcome measures

The Glasgow Coma Scale (GCS) [15, 16] is a tool developed more than 40 years ago by TEASDALE etc. in Glasgow to assess and ca-

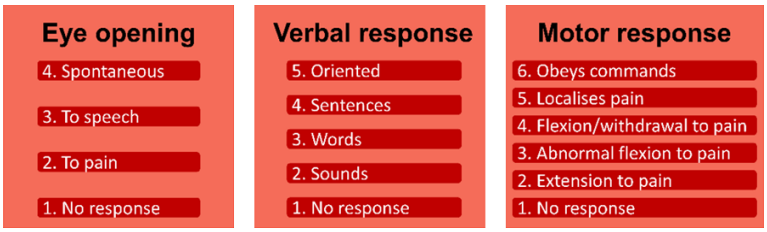

Figure 2. Glasgow coma scale. Score the best level of response seen for each component.

lculate a patient's level of consciousness, which is extensively adopted today [16] (**Figure 2**). Glasgow coma score was measured on the day of admission and at the end of the treatment period. Event-related Potentials (ERP) [17] are one of the most commonly used tools to assess cognitive processing with a high temporal resolution [18-20]. The mismatch negative wave (MMN) was first described in the auditory domain, but can also be observed in other sensory modalities and constitutes an automated slow cortical response to infrequent deviant stimuli [21, 22]. The presence of MMN in coma patients has been verified to be a reasonably good predictor of recovery of consciousness. The P300 wave summarizes a family of frontal and parieto-temporo-occipital positive components that emerge around 300 ms and indexes the detection and discrimination of task-relevant targets and cues. Awakening from coma is well correlated with the presence of a clear P300 or an MMN response, and might provide a signal that the cortical network architecture is still intact [23]. The amplitude and latency changes of mismatch negativity (MMN) were recorded [24]. With the improvement of consciousness level, the amplitude of MMN gradually increased, the latency gradually shortened, and the waveform differentiation gradually became obvious (**Figure 3**). Tracheostomy cough reflex grading score (TCRGS) [25]: TCRGS spans from 1 point to 5 points, with a lower score indicating better prognosis. Patients whose TCRGS met the conditions for tracheal extraction were extubated (**Figure 4**).

Statistical analysis

The data was analyzed statistically using GraphPad 9.0 software. Measurement data were expressed as the mean ± standard deviation ($\bar{x} \pm s$), and those in a normal distribution were compared between the two groups by the t test. The comparison between the same group before and after treatment was performed by the paired sample t test, and the comparison between the two groups was performed by the independent sample t test. When the variance was uneven, the t' test or rank sum test was adopted. Count data were compared using the χ^2 test, and P=0.05 was regarded as a statistically significant difference.

Results

The difference of GCS scores between the two groups before treatment was not statistically significant (P>0.05), indicating group comparability. After treatment, the GCS scores of the two groups significantly increased (P<0.05), with significantly better GCS scores in the CENA group than in the control group, as shown in **Table 2**.

The difference of MMN latency between the two groups before treatment was not statistically significant (P>0.05), indicating group comparability. After treatment, the latency period of MMN in the two groups was significantly shortened (P<0.05), with significantly better latency period of MMN in the CENA group than in the control group, as shown in **Table 3**.

The difference of MMN amplitude between the two groups before treatment was not statistically significant (P>0.05), indicating group comparability. After treatment, the MMN amplitude of the two groups significantly increased, with significantly better MMN amplitude in the CENA group than in the control group, as shown in **Table 4**.

The difference of TCRGS between the two groups before treatment was not statistically significant (P>0.05), indicating the comparability. After treatment, the TCRGS of the two groups significantly decreased (P<0.05), with significantly better TCRGS in the CENA group than in the control group, as shown in **Table 5**.

Discussion

According to the World Health Organization, stroke is the "incoming epidemic of the 21st

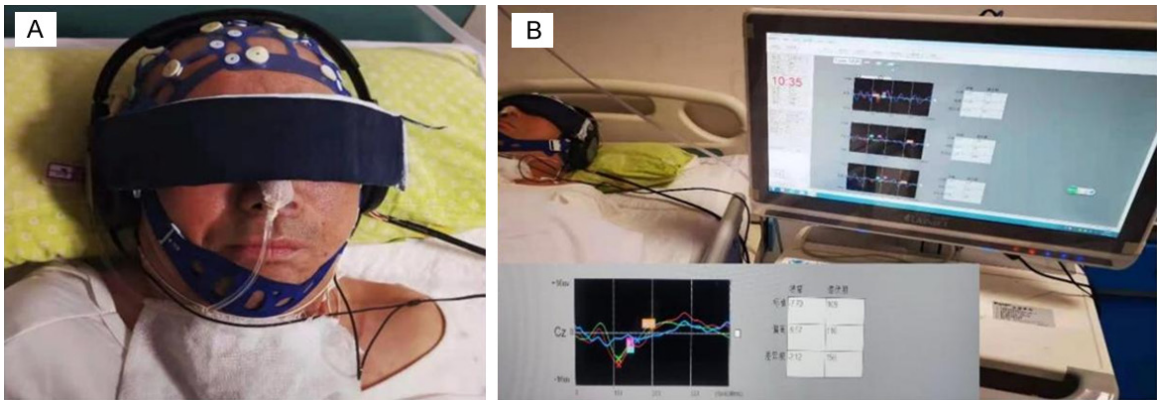

Figure 3. The patient in the picture above is being treated with an event related potentiometer.

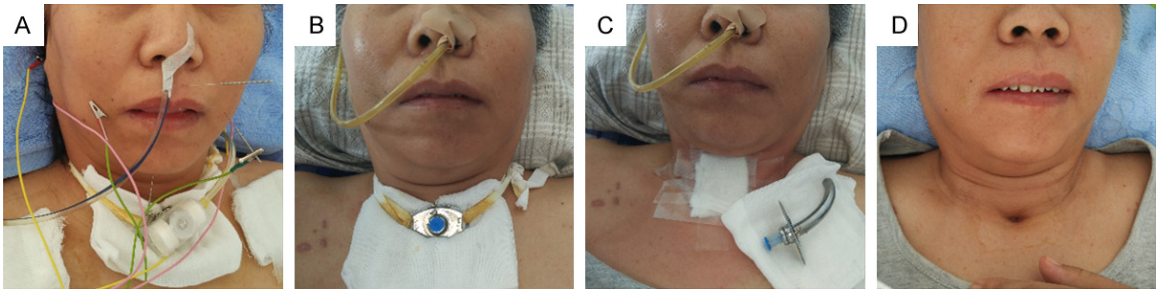

Figure 4. A typical process by CENA. A: Plastic tracheotomy cannula in CENA. B: The plastic cannula was replaced with an iron tube. C: The tracheostomy cannula was pulled out. D: The tracheostomy wound was healed.

Table 2. GCS scores ($\bar{x}$±s, points)

Group	n	Before treatment	After treatment	t	*P*-value
CENA	30	9.20±0.55	13.53±1.04	-35.91	<0.001
Control	30	9.30±0.59	12.03±1.13	-15.27	<0.001
t		-0.67	5.35		
P-value		0.502	<0.001		

Table 3. MMN latency ($\bar{x}$±s, ms)

Group	n	Before treatment	After treatment	t	*P*-value
CENA	30	178.3±15.36	120.33±11.14	23.504	<0.001
Control	30	178.6±16.02	131.13±16.13	19.913	<0.001
t		0.058	-3.018		
P-value		0.947	0.004		

Table 4. MMN amplitude ($\bar{x}$±s, μV)

Group	n	Before treatment	After treatment	t	*P*-value
CENA	30	2.14±0.39	4.97±2.03	-7.42	<0.001
Control	30	2.26±0.29	3.78±1.20	-7.58	<0.001
t		-1.35	2.78		
P-value		0.183	0.008		

century [26], gradually becoming the second major risk factor that threatens human health". An increasing number of patients suffer from cerebral hemorrhage, and the affected population is gradually becoming younger [27, 28]. It triggers limb sensory disorders, motor dysfunction, cranial nerve palsy, disturbance of consciousness, autonomic nerve disorder and even respiratory failure, seriously endangering human health and life. SCH is more harmful, so it particularly entails effective treatment after onset. Consciousness disorder is a common symptom after severe brain injury, and patients who develop consciousness disorders need long-term monitoring and treatment to maintain their survival. The long treatment cycle is expensive, which brings heavy mental shock and huge economic pressure to the

Table 5. TCRGS changes and tracheostomy sealing time ($\bar{x}\pm s$)

Group	n	TCRGS (points)		Sealing time (d)
		Before treatment	After treatment	
CENA	30	4.47±0.57	2.2±0.89	9.26±2.05
Control	30	4.43±0.63	3.17±0.95	12.08±3.14
t		0.22	-4.075	4.119
P-value		0.549	<0.001	<0.001

families of patients and a great burden to the society, and even triggers a series of ethical and legal issues.

After the onset of cerebral hemorrhage, patients are unable to excrete sputum because of paralysis of the limbs and weakened swallowing reflex and cough reflex, which can lead to lung infections, airway obstruction, and breathing difficulty and it may even trigger brain hypoxia. In order to avoid brain hypoxia, artificial airways need to be established to provide oxygen. Establishing artificial airway through laryngeal intubation does not require an incision, but its safety is poor, and it is easy to induce oral ulcers and damage to the inner wall of the airway, inducing infectious complications of the upper and lower respiratory tract. Although a tracheotomy in establishing an airway causes a certain degree of trauma, it is time-saving, and its combined use with active disease supervision and nursing intervention after the operation can improve the wound healing time [10, 29]. Tracheostomy is one of the most commonly performed surgical procedures in patients with acute respiratory failure. However, after tracheotomy, poor airway care will give rise to excessive coughing and increased airway secretions due to external stimuli, which promotes the accumulation of sputum in the lung and the production of bacteria, and thus exacerbates lung infections, compromising the prognosis of patients. Therefore, timely and effective treatment methods to improve the patient's cough reflex function and swallowing function are of great significance for early tracheotomy and sealing of the tube to reduce lung infections. Acupuncture has been practiced in China for more than 3000 years and it was introduced to Europe and America from the 16th to the 19th century. With a history of research initiated in the 18th century and developed rapidly since then [30], acupuncture has made a significant contribution to TCM. With the development of TCM theory and the combination of modern medicine, electroacupuncture has been gradually and fruitfully used in the later rehabilitation of cerebrovascular diseases [31-34].

Based on the application of CENA in clinical research and experimental research, it has been found that CENA has a good effect on the recovery of cough reflex and swallowing reflex after the onset of cerebrovascular disease [11], and also has a protective mechanism for rats with cerebral hemorrhage necrotic nerves [12]. This study adopted the method of CENA. The electrical current was crossed through the neck points to stimulate the brainstem ascending network activation system [35], then to stimulate the connection between the cerebral cortex and the brainstem network to improve the consciousness of patients after SCH [36]. At the same time, this stimulation improves the ability of cranial nerves to restore the swallowing and cough reflex functions of patients to achieve early extubation and improve satisfaction.

The results of this study showed that CENA could not only promote the recovery of consciousness disturbance in patients after SCH, but also improve the cough reflex score, shorten the time to tracheostomy tube sealing and greatly improve the level of consciousness after SCH, which provides a new idea for the treatment of patients with severe cerebrovascular diseases with integrated TCM and Western medicine. This study focused on the recovery of consciousness disturbance and cough reflex function of cerebral hemorrhage. The acupuncture points were selected according to the patients' complex clinical manifestations, and common clinically effective acupoints. SJ17 acupoint is located on the Sanjiao meridian of Hand Shao yang. The GB20 points belong to the acupoints of the Gallbladder Meridian of foot Shaoyang, which are the main points for the treatment of getting rid of wind evil. The disease of apoplexy is mainly caused by wind evil. Puncturing those acupoints can relieve the wind evil and suppress the Yang-qi of body, eliminate phlegm evil and relieve the pharynx, refreshing the brain and resuscitating conscious. Modern medicine shows that these two-point acupunctures can adjust the activity in the cerebral cortex. The two points are close to the brain stem, and acupuncture stimulating the surface of the foramen magnum and the

center of the medulla can improve the reflex function of the brainstem and directly help improve brain function. Current passing through the two acupoints can strengthen the original stimulating effect of acupuncture and promote the recovery of cranial nerve function. DU20 and DU23 are the Du Channel acupoints located on the surface of the frontal cortex of the head brain with the ST8 acupoint. Puncture at this point can achieve the effects of clearing the mind, activating the collaterals and dredging the meridian, and thus play an important role in the regulation of emotional intelligence. EX-HN1 (one inch before DU20) is not only a peculiar acupoint outside the meridian, but also on the circulation of the DU Channel. GB6 acupoint is the gall bladder meridian point, and the Stomach meridians and Sanjiao meridians also go through this area. EX-HN1 is a peculiar point outside the meridian, with magical effects of refreshing and rejuvenating the brain, nourishing blood, and benefiting the brain. Acupuncturing EX-HN1 (one inch before DU20) to GB6 can dredge the meridians and improve blood circulation. Acupuncture at the motor area of the lesion (anterior parietal-temporal oblique line) can promote the recovery of hemiplegic limbs in patients with motor dysfunction after cerebral hemorrhage. Electric current passes through this point to strengthen its ability to refresh the brain and resuscitate. RN20 is located in the pharynx and belongs to the Ren Channel of the "Sea of Yin Channels". It can regulate the Qi of the Yin Channel, relieve the throat and tongue orifices, nourish Yin and invigorate the brain and channel the pulse. The Yangming meridian is the meridian with more Qi and Blood. If the Qi and Blood are strong, the meridians are smooth. Therefore, in the paralyzed phase after cerebral infarction, the Yangming meridian points are used to invigorate Qi and Blood. Otherwise, acupuncture can penetrate the cheek to improve the function of facial paralyzed muscles. Acupuncture points on the Yangming large intestine meridian LI15, LI11, LI10, LI14, etc. can help clear the upper limb meridians and restore limb function. The SJ5 acupoint is used to treat weak upper limbs. SP16 is the junction point of the three-yin meridian of the foot. Acupuncturing this point can help nourish the three yin and the brain, regulate Qi and Blood and thus soothe the mind. It can be used in combination with the SP10 and GB34 to treat the paralysis of lower limbs. GB34 is the tendon point of the Eight-convergent points. Certainly, tonic can relieve muscles and spasm. ST13, ST12, and ST16 are all acupoints on the Stomach meridian of foot Yangming. The deep part of ST12 and SP10 is the quadriceps femoris, and the deep part of ST16 is the tibialis anterior muscle. Stimulating these points can treat the paralyzed lower limbs, induce the muscle tension of the quadriceps, tibial anterior muscle, extensor pollicis longus and extensor digitorum longus, and promote the recovery of weak lower limbs. The above acupoints are used in combination to obtain the power of refreshing the brain, refreshing the meridians, tonifying the orifices of the organs, strengthening the body and replenishing the deficiencies, so it can calm the yin and yang, achieve the balance and coordination of yin and yang and full of energy.

Modern medicine shows that the amount of stimulation of the head-neck electroacupuncture far exceeds that of ordinary acupuncture methods, and the treatment method of CENA has a significant effect on the recovery of consciousness and tracheal extubation after SCH. Although this study shows that the CENA method has a good clinical effect on patients with SCH consciousness disorders and tracheal intubation, it has not clarified its mechanism of action. That is, whether CENA stimulates the acupoints on the neck and head to stimulate the brainstem ascending reticular activation system, thus strengthening the interaction between the cerebral cortex and the reticular structure and storing patient's consciousness? By stimulating the brainstem to restore cranial nerve function and enhance its cough reflex function, the tracheostomy and tube sealing were completed. In the future, we need to use experimental research for verification. In addition, the sample size of this study is small, and the elucidation of its mechanism needs further study.

Acknowledgements

The authors would like to thank Dr. Peng Liang from Changchun Institute of Optics and Mechanics, University of Chinese Academy of Sciences for his suggestions regarding manuscript writing revision. This work was funded by "Chunhui Plan" Cooperative Scientific Research Project of the Ministry of Education (HLJ2019031); Natural Science Foundation of Heilongjiang Province (H2018066); Research Fund of Heilongjiang University of Traditional

Chinese Medicine (2019MS19); Research Fund Project of Heilongjiang University of Traditional Chinese Medicine (201709); Innovative scientific research project fund of Heilongjiang University of Traditional Chinese Medicine.

Disclosure of conflict of interest

None.

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