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Ultrasound-guided botulinum toxin injections and EMG biofeedback therapy the lower limb muscle spasm after cerebral infarction

H.-X. CHEN[1], W. WANG[2], H.-Q. XIAO[1], H. WANG[1], X.-D. DING[1]

[1]Department of Rehabilitation, Xiangyang Hospital Affiliated to Hubei University of Medicine, Xiangyang, Hubei Province, China
[2]Department of Ultrasound, Xiangyang Hospital Affiliated to Hubei University of Medicine, Xiangyang, Hubei Province, China

Huaxian Chen and *Wei Wang* contributed equally to this work

Abstract. – OBJECTIVE: To evaluate the clinical efficacy under ultrasound-guided injection of botulinum toxin-A (BTX-A) and EMG biofeedback treatment of the lower limb muscle spasm after cerebral infarction.

PATIENTS AND METHODS: Thirty-six cases of lower limb muscle spasm after cerebral infarction hemiplegia were randomly divided into two groups, the treatment group and the control group respectively including 18 cases. Both groups of patients were injected with BTX-A at different sites on spastic muscles. Twenty-four hours later, the treatment group was administered EMG biofeedback. Then, the modified Ashworth scoring was employed to observe the curative effect of the two groups.

RESULTS: After six weeks' injection, the treatment group scored better than the control group ($p < 0.05$).

CONCLUSIONS: Ultrasound-guided injection of botulinum toxin type A at various sites with EMG biofeedback treatment of the lower limb muscle spasms after cerebral infarction is efficient and conducive to the rehabilitation of patients' motor functions.

Key Words:
Botulinum toxin type A, Cerebral infarction, Muscle spasms, EMG biofeedback.

Introduction

Stroke is a common and frequently-occurring disease in old age. About three-quarters of survivors are left with varying degrees of disability, especially the spastic hemiplegia with an incidence of 80%[1-5]. If left untreated, muscle spasms will enter into a vicious circle. The affected muscles do not have enough strength to fight against the contraction caused by spastic dystonia, resulting in abnormal limb posture. Early treatment can avoid secondary maladjustment, functional impairment and the loss of the ability to move and participate in movements. Botulinum toxin type A is an effective drug widely used at home and abroad in the treatment of dystonia since the late 1980s. Currently, adopted means of injection are mostly EMG-guided or based on experience. This article studies the clinical efficacy under ultrasound-guided injection of botulinum toxin-A and EMG biofeedback treatment of lower limb muscle spasm after cerebral infarction.

Patients and Methods

Patients

Thirty-six cases were chosen amongst the patients with cerebral infarction that were admitted to our department from January 2009 to March 2011.They were diagnosed with cerebral infarction by brain MRI in line with the diagnostic criteria for cerebral infarction[6] set by the Fourth National Conference on cerebrovascular disease. These patients were randomly divided into two groups. The treatment group which included 18 patients, 10 males and eight females; aged 48-65 years, average (58.2 ± 8.3) years; illness duration of 60 to 90 d, average (78.1 ± 6.3) d; The control group which included 18 patients, 10 males and eight females; aged 46 to 62 years, average (54.2 ± 7.6) years; illness duration of 62 to 89d, an average of (72.1 ± 7.5) d; There was no statistically significant difference comparing the two groups in the general data.

Corresponding Author: Xu-Dong Ding, MD; e-mail: dingxd1018@163.com

Methods

Both groups adopted a conventional therapy (anti-platelet aggregation, microcirculation and neuroprotective therapy) and exercise therapy. Patients of both groups underwent BTX-A local nerve block. The treatment group was administered EMG biofeedback treatment 24 hours after injection. BTX-A Injection: The injection is called "Hengli" produced by the Chinese Lanzhou Institute of Biological Products, each containing 100 U. It was diluted with sterile distilled water to 25 U per 1ml of BTX-A at the time of injection. The procedure was conducted to the ultrasound room where the patient lay in a supine or prone position. The injection area of skin was disinfected with iodine. The ultrasound probe was applied with an appropriate amount of sterilizing coupling agent. Saline was extracted with a 5 ml syringe and then injected to one finger of the sterile glove to make a water sac. The water sac was placed between the skin and the probe and then the proper dose was injected into the proper sites of the femoral adductor muscle, posterior tibial and gastrocnemius muscle and Achilles tendon under the guidance of the color chart. Three to five sites were selected based on the size of each muscle group and injected 12.5 U BTX-A onto each site. The sites were far away from the blood vessels and nerves.

The injected dose of each muscle and the total dose were determined by the size of the target muscle and spasticity. The dose varied from person to person, but the total dose < 300 U[7,8]. EMG biofeedback therapy. Specific methods are as follows: The MyoTrac biostimulation feedback instrument (Thought, Montréal-Onest, QC/H4X/1N1, Canada) is adopted. The main technical parameters include the number of channels 2, frequency 2-100 Hz, EMG sensitivity 0.1 uV, EMG range 0-2000 uV, output current 0-100 mA, pulse width 50-400 uS, rise and fall time 0-10S, stimulus duration and gap time 1-80S. Lying in a supine position, the patient receives treatment in a quiet environment. PREPARATION: At the beginning of the use of the instrument, the patients was informed that the combined therapy with the application of the biostimulation feedback instrument can bring about ideal effects, so that patients can have a better understanding and cooperate with medical workers. The position of the surface electrodes were as follows: the three electrodes are placed on the side of the lower limb suffering paralysis. The positive pole is placed 7 cm above the lateral malleolus, and the negative pole is placed on the outside of 1/3 the shank. The intermediate electrodes are dry ones while the electrodes on both ends are EMG electrodes. The choice of the range was as follows: adjust to the affordable gear according to the patient's tolerance. Remember to explain to the patients that the signal variation when independent movement reaches the preset value of the instrument and continue to encourage them to experience their change according to the change in the signal value. Treatment: once a day, 20 min at a time, five times a week, six weeks for a course of treatment.

Evaluation Indicators

Muscular tension: assess the spasticity of the lower limb extensor according to MAS[9]. 2. Step length and pace: Let the patient walk 10 m and take the average of the three step lengths in the middle 6 m by the footprints method. Record the time required to walk 10 m, and calculate the pace[5]. Ask a rehabilitation physician who is not involved in the injection and rehabilitation to take the assessment of the two groups before the BTX-A injection and four weeks after the injection.

Statistical Analysis

Data obtained in the statistical process are expressed in the form of the mean ± standard deviation ($\bar{x} \pm s$). Statistical processing was performed with SPSS12.0 software. *t*-test after the analysis of variance between groups was performed. $p < 0.05$ is considered statistically significant.

Results

The two groups of patients have no discomfort or allergic reactions after the injection of BTX-A. Compared with the previous treatment, the leg MAS scores declined six weeks after treatment. The pace and length of step have improved significantly. The improvement in performance of the treatment group is more evident than that of the control group (Table I).

Discussion

Motor dysfunction caused by the cerebral hemiplegia is due to upper motor neuron damage. This leaves the motion system out of the control of the high central so that the original, subcortical central motor reflexes release causes abnormal movement patterns. This leads to the formation

Table I. The comparison of scores before and after the injection of BTX-A ($\bar{x} \pm s$).

Group Mas	Score	Walking speed (m/s)	Step size (m)
Matched group (n = 18)			
Before injection	3.25 ± 0.46	0.21 ± 0.08	0.29 ± 0.07
After injection	2.16 ± 0.37*	0.32 ± 0.07*	0.41 ± 0.06*
Treatment group (n = 18)			
Before injection	3.15 ± 0.52	0.23 ± 0.06	0.28 ± 0.09
After injection	1.76 ± 0.24*	0.41 ± 0.05*	0.52 ± 0.08*

Note: compared with the score of treatment group, $^*p < 0.05$, compared with that of the matched group, $p < 0.05$.

of limb spasm after cerebral infarction. The major clinical manifestations include upper limb, the joint adduction, flexion, internal rotation, leg joints straight, external rotation as well as particular position and gait. The movement disability affects the patient's functional activity. In severe cases, the patient suffers the disuse syndrome[10-12]. Traditional methods that treat muscle spasm are mainly the removal of incentives, physical therapy, medication, acupuncture, or surgery. But the effects are not sure. Botulinum toxin is a bacterium exotoxin produced in the process of growth and reproduction of *Clostridium botulinum*. *Clostridium botulinum* is anaerobic, whose spores are found in soil. It belongs to the same family with tetanus toxin-producing bacteria. According to different toxin antigen, it can be divided into A, B, C, D, E, F, G, 7 antigen types, of which the most virulent is type A. BTX can, by acting on cholinergic nerve endings, inhibit calcium-mediated irritation and the release of spontaneous acetylcholine (Ach), thereby, reducing muscle tension and relieving muscle spasm[13-14]. This study made an assessment of limb spasticity at six weeks after BTX-A injection. The results showed that the two patient groups had a lower MAS score six weeks after the BTX-A injection. Walking speed and step length had significantly improved for both groups. This proves that BTX-A injections can help relieve muscle tension in patients suffering stroke, which facilitates their rehabilitation training and improves their motor function. At present, major international commercial botulinum toxin products include Botox @ (Allergan), Heng Li (Lanzhou Bio), Dysport (Ipsen), Xeomin (Mertz), and Neurobloc/Myobloc (Solstice). Domestic products approved are imported Botox and local Heng Li (Lanzhou)[7]. This study uses Hengli produced by the Lanzhou Institute of Biological Products in China. In this study, ultrasound can facilitate the injection into the target muscle, avoiding the unarmed position of too deep or too shallow caused by inaccurate positioning, and thus gain more significant effects than the bare stretch positioning.

It has been reported that BTX-A has a significant effect on reducing muscle tension but has little effect on the function[15-17]. According to Wallen et al, BTX-A reduces muscle tension while improving the function[18-21]. Functional improvement may be associated with the injection technique and related rehabilitation after injection.

Conclusions

This study suggests that botulinum toxin injection with EMG biofeedback therapy can improve the strength of the anterior tibialis muscle, reduce the contractility synergy of the antagonistic muscle and improve the balance between the active and antagonistic muscles. It can also reduce the electric signal of the abnormal muscle suffering too high tension or spasm so that the abnormal joint movement patterns are corrected and improved. The motor function of the lower extremity can be improved significantly. Also, the EMG biofeedback is easy to operate, noninvasive and easily accepted by patients[22-24]. Such advantages make it worthwhile to be used in the treatment of stroke patients suffering from lower limb spasm.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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