

# Effect of Local Injection of Botulinum Toxin Type A on Spasticity of the Upper Limb Flexor after Stroke

*Xu Jianxing, Ma Chao, Wu Shaoling, Ou Liming, Yan Tiebin*

*(Department of Physical Medicine and Rehabilitation, Second Affiliated Hospital of Sun Yat-sen University, Guangzhou 510120, Guangdong Province, China)*

## Abstract

**Objective:** To explore the effect of local injection of botulinum toxin type A on spasticity of the upper limb flexor after stroke.

**Method:** Twelve patients with hemiplegia after stroke were selected. All patients showed apparent increment in upper limb flexor muscular tone, ranged 2-3 degree in the modified Ashworth scale, and showed limitation in the range of motion at elbow joint (which influenced the daily life of patients). Various dosage of botulinum toxin type A (100-150 units) were injected to the biceps brachii muscle of the patients on 6-8 points according to the patients' condition. The degree of spasticity and range of elbow joint motion were evaluated at the second, fourth and twelve week after injection. The results were then compared with those before injection.

**Result:** The degree of spasticity of biceps brachii muscle at the second, fourth and twelve week after injection ( $1.7 \pm 0.6$ ,  $1.4 \pm 0.4$ ,  $1.6 \pm 0.5$ ) were significantly improved compared with that before injection ( $2.6 \pm 0.8$ ) ( $P < 0.05$ ). The active [ $(124.2 \pm 14.6)^\circ$ ,  $(126.8 \pm 10.5)^\circ$ ,  $(123.8 \pm 7.6)^\circ$ ] and passive [ $(108.6 \pm 12.1)^\circ$ ,  $(107.4 \pm 13.2)^\circ$ ,  $(103.2 \pm 8.6)^\circ$ ] range of elbow joint motion after the second, fourth and twelve week were also significantly increased ( $P < 0.05$ ).

**Conclusion:** Local injection of botulinum toxin type A showed a better curative effect on spasticity of the upper limb flexor after stroke.

## Introduction

After the stroke, most patients would be suffered from spasticity on the upper limb flexor. Its expression including flexion and restricted motion of elbow joint, spasticity and restricted extension on the flexor of finger and metacarpophalangeal joints flexor. These sequelae are seriously affecting the daily life of patients. To improve the function of upper limb, training of active and passive motion of elbow joint and muscular training of antagonistic muscle were applied to counteract with spasmodic muscle in the traditional clinical rehabilitation with the assistant of heat, ice or medicinal treatment<sup>[1-5]</sup>. However, those results were not satisfactory. In this research, varies dosages of botulinum toxin type A were injected locally into the biceps brachii muscle at the hemipelgic side of the stroke patients. In the meanwhile,

triceps, the antagonistic muscle, were strengthened by the muscular training. The result was observed.

### **Subject and Method**

**Design:** Single-blind, before-after control study

#### **Research Site and Object:**

**Research Site:** Department of Physical Medicine and Rehabilitation, Second Affiliated Hospital of Sun Yat-sen University

**Subject:** 12 patients with upper limb spasm after stroke were selected from the in-patients and out-patients from our hospital from July 2002 to August 2003. Among the 12 patients, 8 cases were cerebral infarction and 4 cases were cerebral hemorrhage. There are 7 male patients and 5 female patients; aged from 55 ~ 77 ( $69.6 \pm 6.6$ ). Those patients were in the 7 ~ 21 ( $12.8 \pm 3.9$ ) months after the stroke. 8 patients were the first time experienced stroke and 4 patients were the second times experienced stroke. The part of stroke were as follow: 6 cases of internal capsule, 1 case of parietal lobe, 2 cases of basal nuclei, 2 cases of thalamus, and 1 case of parietooccipitotemporal. There were 7 patients with left side hemiparalysis and 5 patients with right side hemiparalysis. Patients ranged II ~ III degree in the Ashworth Scale and limited in range of elbow joint motion of hemiparalysis side were selected. Patients with mild spasm and ankylosis were eliminated in this research.

**Researcher:** The author of this paper was the intervention. This research was assessed by the experienced superintendent of our department, who did not join in the treatment.

#### **Measure of Intervention:**

**Treatment Method:** Patients were set in dorsal position. The upper limb of the affected side was fixed by the assistant. 100~150 units of botulinum toxin type A (produced by Lanzhou Institute of Biological Products) were used. It was reconstituted by 3.0 ~ 4.0 ml of normal saline. After the reconstitution, the botulinum toxin type A was settled for 5 minutes to ensure the entire dissolve of air bubble. After the sterilization of injection sites, the elbow joint were pull and push quickly for a few times by assistant to increase the muscular tone of the biceps brachii muscle and fullness of the belly of muscle. After that, 6-8 injection sites were selected around the central of muscle belly on both sides of intermuscular septum. 12.5 ~ 16.5 units were injected per injection site. Both deep and shallow injections

were applied alternatively. Before each injection, needle should be pull back to prevent the direct injection of medicine into blood vessel <sup>[6]</sup>. After the injection, patients should be observed for 30 minutes and should be asked if there is any uncomfortable. In case of allergy reaction, 1:1000 adrenaline and oxygen breathing apparatus were prepared before injection. Medicines, which would affect the muscle tone, were stopped two weeks before botulinum toxin type A injection. In the same way, streptomycin, gentamycin and quinolones were prevented.

**Assessment Method:** Modified Ashworth Scale table and range of active and passive motion of elbow joint were used in the evaluation. Assessments of the 12 patients were carried out before and 2 weeks, 4 weeks and 12 weeks after the treatment. Spasticity and changes of degree in the range of active and passive motion (measured by the protractor) of elbow joint before and after the treatment were compared. Assessment standard please refer to table 1.

**Table 1 Modified Ashworth scale**

<b>Grade 0</b>	No increase in muscle tone.
<b>Grade I</b>	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion when the affected part(s) is moved in flexion or extension.
<b>Grade I+</b>	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM.
<b>Grade II</b>	More marked increase in muscle tone through most of the ROM, but affected part(s) easily moved.
<b>Grade III</b>	Considerable increase in muscle tone, passive movement difficult.
<b>Grade IV</b>	Affected part(s) rigid in flexion or extension.

**Observation Standard of the Results:** ① Ashworth Scale. ② Range of elbow joint motion.

**Statistical Analysis:** SPSS 10.0 software was used in this research. The data was analyzed by the first author of this paper. The mean and standard deviation of the two groups of data were represented by  $\bar{x} \pm s$ . *t*-test was used in the comparison of the efficacy before and after the treatment.

## Result

### 1. Comparison of the Ranking of Ashworth Scale Before and After the Botulinum Toxin Type A Treatment

Ashworth ranking of the biceps before the botulinum toxin type A treatment was  $2.6 \pm 0.8$ . There is significant reduction in the spasticity of the patients' biceps after the treatment ( $P < 0.05$ ). The Ashworth ranking of the biceps in the 2 weeks, 4 weeks, and 12 weeks after the treatment were  $1.7 \pm 0.6$  ( $t = 3.11$ ),  $1.4 \pm 0.4$  ( $t = 2.84$ ) and  $1.6 \pm 0.5$  ( $t = 2.97$ ) respectively.

## 2. The Changes in the Range of Elbow Joint Motion Before and After the Botulinum Toxin Type A Treatment

There are significant improvements ( $P < 0.05$ ) in the range of both active and passive motion in the patients' elbow joint after the botulinum toxin type A injection. The improvement is most significant in the 2 weeks and 4 weeks after the injection, see table 2.

**Table 2 The changes of range of elbow joint motion before and after the botulinum toxin type A treatment (°)**

Type of motion	Before injection	2 weeks	4 weeks	12 weeks
Passive Motion	$123.5 \pm 12.8$	$124.2 \pm 14.6^a$	$126.8 \pm 10.5^b$	$123.8 \pm 7.6^c$
Active Motion	$102.6 \pm 11.3$	$108.6 \pm 12.1^d$	$107.4 \pm 13.2^e$	$103.2 \pm 8.6^f$

Compared with that before injection,  $^a t = 3.21$ ,  $^b t = 3.47$ ,  $^c t = 3.34$ ,  $^d t = 2.79$ ,  $^e t = 2.66$ ,  $^f t = 2.49$ ,  $P < 0.05$

## 3. Side Effects

Almost all the patients were tolerant and without any allergy reaction and uncomfotableness after the botulinum toxin type A injection. Only few cases of temporary asthenia of limb were found.

## Discussion

In these few years, botulinum toxin type A was widely applied clinically. It is mainly use for the treatment of dysfunctional diseases, caused by the increment of muscle tone [7-10]. Botulinum toxins are produced from varies types of *Clostridium botulinum* bacteria. It could inhibit the release of acetylcholine at the pre-synaptic membrane and block the transmission between nerve and muscle. Then, this action causes the asthenia of muscle and paralysis as well. This paralysis would last for about 3 to 4 months or longer. Symptoms would resume around 3 to 4 months after the treatment. Nevertheless, there is limitation in botulinum toxin type A application. Histological researches show that botulinum toxin type A could induce reversible denervated atrophy. New connection and new motor end-plate would be formed by the sprouting from unmyelinated nerve nearby the axon terminal. The predominant

to muscle of the nerve would be kept and the spasticity of muscle would be resumed. Thus, repeated injections should apply regularly (3~6 months) for the improvement of muscle spasticity. It may increase the burden of patient.

As botulinum toxin type A has been used widely in clinics, number of its indications is increasing, too. Nowadays, botulinum toxin type A could apply in the treatment of spasmodic strabismus, facial spasm, blepharospasm and trachelism; and it could apply in the cosmetic field as well. It achieved a better curative effect. There are reports about the local injection of botulinum toxin type A into the spasmodic limb of patients with brain damage in these few years. Guo *et al* <sup>[11]</sup> combined local injection of botulinum toxin type A in the spasmodic limb and training of gait in the treatment. There are significant improvement in gait, step length and step speed of the patients with stroke or brain damage ( $P < 0.05$ ). Some foreign reports believed that botulinum toxin type A treatment could improve the function of limb and hand of the patients with stroke <sup>[12-18]</sup>.

In this research, varies dosages of botulinum toxin type A were injected locally to the bicep of the hemiplegic upper limb of the patients with stroke. The antagonistic muscle, tricep, was trained and reinforced simultaneously after the injection. The treatment could reduce muscle tone of bicep, and alleviate the spasm and limitation of joint motion. Moreover, it could improve the range of joint extension and increase the capability of patients in daily life. Compared to that before the treatment, there was significant improvement ( $P < 0.05$ ) of the spasticity among the patients after 2 weeks, 4 weeks and 12 weeks of the botulinum toxin type A injection. There was significant improvement ( $P < 0.05$ ) of the range of active and passive elbow joint motion, too.

Dosage of botulinum toxin type A injection should be based on the size of muscle belly, spasticity and the myodynamic situation of the suffered limb. In this research, varies dosages of botulinum toxin type A were injected locally according to varies patients. Satisfactory results were acquired. After the treatment, there is no severe side effect and allergy reaction reported. Single asthenias of limb were found in some patients only.

### **Conclusion**

Botulinum toxin type A injection show a better curative effect on the treatment of spasticity of the upper limb flexor of stroke patients. It could alleviate the spasticity of the upper limb, and improve the range of active and passive elbow joint motion.

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