Clinical Study of Botulinum Toxin Type A in the Treatment of Cerebral Palsy with Selective Myodynamic Training

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Abstract

Objective: Clinical study of botulinum toxin type A cooperated with selective myodynamic training treatment of dual lower extremity spasmodic cerebral palsy, improving the lower extremity function.

Method: 46 cases of children with dual lower extremity spasmodic cerebral palsy were selected, injection-used botulinum toxin type A (LANTOX), produced by Lanzhou Institute of Biological Products was used as medicine. Under anesthetic condition, dual lower extremity local injection was applied under electromyography guidance. According to the patients' economic status, patients were separated into two groups, LANTOX treatment group (Group A) and LANTOX injection with selective myodynamic training group (Group B); they were informed for at least 6 months. Compare the observation of spasm status, joint angle and functional ability (direct knee, half-knee, knee forward and walk, standing, and walking ability).

Result: 46 cases of affected children with dual lower extremity spasmodic cerebral palsy, 30 cases were male, 16 cases were female; 39 cases were aged around 19 months to 6 years old, 7 cases were aged around 6 to 10 years old, averaged age was 5 years old; Group A were 20 cases, Group B were 26 cases, 3 months after injection, the different of the Ashworth spasm grading between two groups was not obvious ($P > 0.05$), the different of the joint angles (adductor angle, popliteal fossa angle and ankle flexed angle) between two groups were not obvious ($P > 0.05$), after 6 months, the different of functional ability between two groups were obvious ($P < 0.01$).

Conclusion: Both treatment groups, LANTOX injection treatment (Group A) and LANTOX injection with selective myodynamic training treatment (Group B) enabled to relief spasm obviously. However, through the selective myodynamic training, the improvement of direct knee, half-knee, knee forward and walk, standing and walking ability of affected children's dual lower extremity was better.

Among the children with cerebral palsy, most of them were spasmodic cerebral palsy; among them, affected children with hemi-paralysis and one-sided lower extremity paralysis were able to reconstitute the walking ability easily through the rehabilitation treatment with botulinum toxin type A injection. However, the affected children with dual lower extremity paralysis were classified as serious spasm cases, the selective

control ability of lower extremity were weak. They were more difficult to resume the walking ability, high in crippling rate, and hard to receive rehabilitation training. In recent years, there were many literature reports reported the obvious effect treatment by using botulinum toxin type A injection cooperated with rehabilitation training or ankle corrector to improve the walking ability of affected children, but it was rare of report about using botulinum toxin type A injection cooperation with selective myodynamic training. We used botulinum toxin type A with selective myodynamic training to treat 46 cases of dual lower extremity spasmodic cerebral palsy children, in order to improve the function of lower extremity, and the result was reported as follows.

Material and Method

1. General Information

The 46 cases of affected children with dual lower extremity spasmodic cerebral palsy were collected from our pediatrics clinic and in-patient cases since January of 2002 to January of 2004, they were unable to stand, or heel unable to tough ground when walking. Among them, 30 cases were male, 16 cases were female; 39 cases were aged around 19 months to 6 years old, 7 cases were aged around 6 to 10 years old, averaged age was 5 years old; According to the patients' economic status, patients were separated into two groups, 20 cases were LANTOX treatment group (Group A) and 26 cases were LANTOX injection cooperated with selective myodynamic training group (Group B). Due to the different training methods were applied to hemi-paralysis and one-sided lower extremity paralysis after botulinum toxin type A injection, both of they were excluded in this study. Besides, for the patient who had taken the selective posterior ramus removal of spinal nerve and tendon lengthening treatment, they were also excluded in this study.

2. Method

2.1 Anesthesia: using of Valium or ketamine for anesthesia under experienced pediatrics or anesthetic doctor guidance. First-aid kit and adrenaline were prepared.

2.2 Dosage and Injection Method: injection-used botulinum toxin type A (LANTOX) performed as lyophilized agent and product by Lanzhou Institute of Biological Products; it was reconstituted by sterile normal saline into 5U/0.1ml concentration before injection. According to the size of muscle, the degree of spasm, and weight of patient, each patient was injected with total injection dosage not more than or equal to 300U to 400U.

2.3 Fixing of Muscle: bilateral adductors of hip, hamstring muscle, gastrocnemius of leg, musculus soleus, muscle at the back tibia, flexor hallucis longus, and flexor toe. By observation and tough of the above spasmodic and massive muscle, applied fixed point injection under electromyography guidance.

2.4 Postinjection Training: all of the affected children were wear orthopedic shoes or plaster support one week after injection. Traction was applied to dual lower extremity adductors tendon, hamstring muscle tendon and heel tendon. Group A did not applied selective myodynamic training, while Group B were applied selective myodynamic training after injection, including myodynamic training of greatest gluteal muscle, middle gluteal muscle, quadriceps muscle of thigh and flexor of ankle back, and the functional training of lower extremity, including direct knee, half-knee, knee forward and walk, standing and walking ability. Affected children were trained for more than 1 – 3 hours everyday by therapist cooperated with parents; parents were taught for the training method, and then applied the training to their affected children at home after leaving hospital.

2.5 Effectiveness Evaluation: they were informed for the effectiveness evaluation at clinic 1 month, 3 months and 6 months after injection.

i. Myodynamic: According to Ashworth Table to evaluate the degree of muscular spasm.
ii. Determination of joint angles: The changes of adductor angle, popliteal fossa angle and ankle flexed angle were determined.
iii. Testing of the functional ability of dual lower extremity: According to the Gross Motor Function Measure (GMFM) of cerebral palsy, the functional ability direct knee, half-knee, knee forward and walk, standing and walking ability were evaluated. 0 = unable to do; 1 = able to achieve small part of it, <10%; 2 = partially complete, 10%-100%; 3 = completely achieved.

Result

1. Totally 46 cases were classified as dual lower extremity spasmodic cerebral palsy and fulfilled the selection criteria. The Ashworth grading result of both groups before and after LANTOX injection see Table 1. The different of the changes before and after injection treatment of both groups were very obviously $P < 0.001$.

Table 1 Ashworth grading of both groups before and 1 month after injection

	No. of cases	Before treatment	1 month after treatment	X^2	*P*
Group A	20 cases	2.69±0.60	1.05±0.76	28.33	< 0.001
Group B	26 cases	2.40±0.76	1.02±0.69	20.24	< 0.001
		$P > 0.05$	$P > 0.05$		

2. The changes of joint angles of both groups before and after treatment see Table 2. The changes of the adductor angle, popliteal fossa angle and ankle flexed angle before and 3 months after treatment were very obviously $P < 0.001$ or $P < 0.01$. The different of the results before or 3 months after treatment between two groups were not obvious.

3. The changes of functional abilities of both groups before and 6 months after treatment see Table 3. The different of the abilities of direct knee, half-knee, and knee forward and walk before and after treatment of Group A were not obvious $P > 0.05$, the different of standing and walking abilities were obvious; The different of the 5 functional abilities before and after treatment of Group B were obvious $P < 0.001$.

Table 2 The changes of joint angle of both groups before and 3 months after treatment

	No. of cases	Adductor angle		Popliteal fossa angle		Ankle flexed angle	
		Before treatment	3 months after treatment	Before treatment	3 months after treatment	Before treatment	3 months after treatment
Group A	20 cases	33.82±12.35	120.88±7.18*	151.26±1.08	176.37±3.31**	111.67±1.21	92.41±1.58**
Group B	26 cases	34.01±10.24	132.57±8.89*	154.48±1.58	177.52±6.63**	113.02±6.02	95.12±3.65**

*$P<0.001$, **$P<0.01$

Table 3 The changes of functional ability of both groups before and 6 months after treatment

	Group A		Group B	
	Before treatment	6 months after treatment	Before treatment	6 months after treatment
Direct knee	0.52±0.10	0.69±0.08Δ	0.51±0.13	2.69±0.25*
Half-knee	0.11±0.09	0.13±0.05Δ	0.12±0.07	2.36±0.29*
Knee forward and walk	0.16±0.12	0.17±0.09Δ	0.14±0.06	2.74±0.18*
Standing	0.85±0.18	2.01±0.31*	0.82±0.29	2.72±0.23*
Walking	0.79±0.58	1.97±0.18**	0.80±0.21	2.61±0.27*

ΔP>0.05, *P<0.001, **P<0.01

Discussion

Cerebral palsy, especially the affected children with dual lower extremity spasmodic paralysis, the paralysis and contracture were serious, they lost the ability of selective control of lower extremity, consequently inhibited the active motion control, induced rigidity motion, unable to walking behind side wall; it was one kind of the hardest training of spasmodic cerebral palsy. The improvement of the lower extremity function after LANTOX injection, especially the walking ability was one of the most important objectives for rehabilitation works. It was because we were not satisfied on using botulinum toxin to relax muscle only, but providing a valuable chance and condition for rehabilitation training after injection. At this moment, applied muscular tendon traction and wearing orthopedic shoes, especially during the selective muscular training, myodynamic training of greatest gluteal muscle, middle gluteal muscle, quadriceps muscle of thigh and flexor of ankle back, and functional motion training for lower extremity, including direct knee, half-knee, and knee forward and walk , standing and walking ability training; direct knee, half-knee, and knee forward and walk were the fundamental training of walking ability training. It improved the standing, walking speed and quality of affected child, provided a better effect with half work done. The result showing that affected child through the special myodynamic training able to stand and walk with a better performance than the affected child without training.

Four to six muscle groups of dual lower extremity spasmodic paralysis were selected for botulinum toxin injection , there were large numbers of injection muscle and injection points, it was easily to induce pain and psychological disorder to the affected

child, therefore we applied ketamine for intravenous general anesthesia during injection, 2mg/kg, provided a painless injection, without interference of the electromyography guidance and injection operation, it reduced the painful of affected child, and provided no fear for next time injection. However, it was a high risk for general anesthesia that would induce vomiting and asphyxia, therefore, it should be operated under professional anesthetist and experienced pediatrics doctor guidance, to make sure the safety and applying first-aid at once in need. For the injection required lesser than two muscle groups, Valium for sedative anesthesia could be used in stead of general anesthesia.

Electromyography determination was valuable in the injection point fixing and injection dosage adjustment, especially for the inner-deep muscle, musculus soleus, muscle at the back tibia, flexor hallucis longus, and flexor toe, fixing of the injection point of those muscles were difficult. According to the differences of the size, length and the injection frequency of the affected children's leg muscle, the muscular injection points were different. Therefore, the injection with electromyography guidance was important.

For the medical dosage, according to the reference dosage, we applied injection to 6 affected children (6 – 12U/kg), when it was separated into six muscle groups, the injection dosage of each injection point was very low, therefore, it was unable to control the spasm completely, all the spasm symptom were reconstituted 3 months after injection. Therefore, 20 – 26U/kg injection dosage were applied, the spasm symptom of each affected child was under controlled. The duration of relief spasm was more than 6 to 12 months. It provided a sufficient training time for selective myodynamic training. Weakening of muscle and anorexia were the major side effects of the affected children with light weight, but they were disappeared after 2 – 4 weeks, and able to apply normal training. One case of affected child with the largest injection dosage of 30U/kg, weakening of muscle was also observed, it was continued for 4 weeks and disappeared finally; besides that no side effect was observed. According to clinical experience, 20 – 26U/kg was a safety injection dosage range, at the same time the total dosage should not more than 300U or 400U.

It was important to apply traction and wear orthopedic shoes after injection. For the affected child who allergic and did not willing to wear orthopedic shoes, it was better to fix by plaster support before using orthopedic shoes. The affected child would adapt more easily.

The youngest of this group was 19 months, the oldest was 10 years old; among them, 39 cases were aged 19 months to 6 years old, 7 cases were aged 6 – 10 years old, averaged age was 5 years old. According to the result, affected child below 5 years old performed better functional reconstitution and more long-lasting of the effect. Affected child with 7 – 10 years old were difficult to train, due to some abnormal mode had been built, it was difficult to correct. However, under the well cooperation of parent, and applied intensive training, an effective result would be observed.

In conclusion, botulinum toxin type A injection induced muscular relaxation of dual lower extremity spasmodic cerebral palsy child, it provided a chance for selective myodynamic training and all-rounded rehabilitation training to affected child, it helped affected child to experience and learn for correct lower extremity motion mode. It improved the standing and walking ability of lower extremity, it was benefit to affected child.