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Research Article

SURGICAL TREATMENT VERSUS BOTULINUM TOXIN TYPE 'A' INJECTION FOR SPASTIC EQUINUS IN CEREBRAL PALSY

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A B S T R A C T

Introduction: Cerebral palsy is the most common cause of childhood physical disability in developed countries. Equinus deformity is one of the most common deformities associated with cerebral palsy. Different methods of treatment of this deformity including repeated passive stretching manipulation and casting, surgical correction either by tendoachilis lengthening or gastrocnemius recession. Other modality of treatment includes Botulinum toxin 'A' injection in the affected muscle. The goal of this study was to compare the results of treatment of spastic equinus deformity in cerebral palsy by Botulinum toxin 'A' injection and surgical treatment. **Materials and Methods**: A prospective, randomized trial was performed to compare the results of surgical treatment of equinus in cerebral palsy versus botulinum toxin type 'A' injection. Fifty-five children with 70 feet suffering from cerebral palsy participated in this study in the period between October 2007 and March 2011. Children were divided randomly into two groups. Group 'A' included 25 children with spastic equnius (40 feet) treated surgically, while group 'B' included 30 children (30 feet) with **Results**: The improvement in group 'B' was better than group 'A'. The difference between them were significant as regard calf muscle tone grading, clonus, active range of ankle motion and highly significant in passive maximal dorsiflexion range. On the other hand, the difference was insignificant as regard ankle reflex grading. **Conclusion**: This study suggests that the usage of Botulinum toxin 'A' injection in treating spastic equinus deformity in cerebral palsy give superior results than the use of surgery. It is simpler, less invasive with better results of improvement.

INTRODUCTION

Cerebral palsy is the most common cause of childhood physical disability in developed countries and affects two children per thousand live births. Equinus deformity is one of the most common deformities associated with cerebral palsy[1,2,3] Different methods of treatment of this deformity including repeated passive stretching manipulation and casting, surgical correction either by tendoachilis lengthening or gastrocnemius recession[4,5]. Other modality of treatment includes Botulinum toxin 'A' injection in the affected muscle. When injected intramuscularly, botulinum toxin A effectively denervates a muscle by inhibiting the release of acetylcholine at the neuromuscular junction[6]. It decreases a spastic muscle's ability to generate forceful contractions, thus decreasing the strength of the spastic response and allowing the muscle to function in a more lengthened position[7]. The clinical effect of botulinum toxin A lasts for three to six months.

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As botulinum toxin "A" works to decrease the force of muscle contraction or spasticity, it is commonly used to treat dynamic abnormalities rather than fixed contractures in children with cerebral palsy[8,9,10].

Patients and Methods

A prospective, randomized trial was performed to compare the results of surgical treatment of equinus in cerebral palsy versus botulinum toxin type 'A' injection.

Fifty-five children with 70 feet suffering from cerebral palsy participated in this study. Children with equino-varus or any other foot deformity were excluded from this study. Children with dynamic equinus contractures, that could be passively or conservatively corrected were also excluded from this study. Children were divided randomly into two groups. Group A included 25 children with spastic equnius (40 feet) treated surgically, while group B included 30 children with spastic equinus (30 feet) treated by botulinum toxin type A injection.
In group A, there were 25 spastic cerebral palsy children, 20 boys and 5 girls. There were 10 unilateral feet affected and

bilateral affection was found in 15 children with a total of 40 feet. The age of this group ranged from 4.9 to 7.1 years with a mean of 5.5 years. All the examined children were classified as groups according to Gross Motor Function Classification System (GMFCS)[8] (IV:Children may achieve self-mobility using a power wheelchair., V; children have no means of independent mobility and are transported) The follow up period ranged from 1 to 4.1 years with a mean of 3.9 years. Vulpius technique9 for gastrocenmius lengthening was done in all feet. Rehabilitation and a strict program of physiotherapy was ensured for all the operated feet to maintain the correction, elasticity of the muscles and the gait pattern of the examined children. A knee immobilizer was used to guard against knee flexion deformity.

In group B, There were 30 children with spastic equinus, 18 boys and 12 girls. Their age ranged from 2 to 7 years old with a mean of 3.02-+0.71 years. All of the children were subjected to local injection of BTX-A into calf muscles (gastrocnemius and soleus) after determination of which muscle is responsible for equines deformity. If gastrocenimus is the cause of spasticity the tone is increased in knee extension and if the tone decreased while knee flexion the cause will be the soleus muscle[11]. The dosage and injection procedure were done according to the recommendations of (2 unit/Kg) Russman *et al*[10]. Every child was subjected to injections 2 times, at the beginning (0 point) and after 6 months. Children began exercise program 48 hours post injection.

All children in both groups were subjected to clinical examination in the form of (grading of calf muscle tone[13], Reflex grading[14], clonus [15], active range of motion of ankle joint[16] and passive range of motion of ankle joint[17]), functional assessment by modified physician rating scale.[17]

RESULT

Both groups did not differ in terms of age, gender, walking ability and type of cerebral palsy. In group A, there was a significant difference between calf muscle tone grading before and after surgery (table1).

Table 1 Calf muscle tone grading before and after surgery (in group A)

	Calf muscle tone grading		
	Mean ± SD	**t. test**	**p.value**
Before surgery	3.60±0.50	9.747	0.001*
After surgery	2.60±0.50		

*=significant

There was a significant difference between calf muscle tone grading before and after surgery.

While the difference was non-significant in maximum passive dorsiflexion before and after surgery (table2). No changes were found in other parameters before and after surgery.

Table 2 Equines maximum passive dorsiflexion before and after surgery

	Mean ± SD	**t. test**	**p.value**
Before surgery	13.50±5.32	0.863	0.325
After surgery	-12.75±1.79		

The difference was non-significant in maximum passive dorsiflexion before and after surgery.

In group B, there was a significant decrease in muscle tone, ankle reflexes and ankle clonus before and after botulinium toxin type A injection (tables 3,4&5).

Table 3 Muscle tone ((gastrocnemius and soleus) changes in group B before treatment ,3-6 months after injection and after 1 year treatment

	Group B									
Tone	**Before injection**		**After 1st injection**		**Before 2 nd injection**		**After 2ndhnjection**		**After 1 y**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
0	0	0.00	6	20.00	0	0.00	10	33.33	0	0.00
+	0	0.00	10	33.33	0	0.00	10	33.33	1	3.33
++	7	23.33	10	33.33	13	43.33	6	20.00	9	30.00
+++	15	50.00	0	0.00	10	33.33	1	3.33	13	43.33
++++	8	26.67	4	13.33	7	23.33	3	10.00	7	23.33
Total	30	100.00	30	100.00	30	100.00	30	100.00	30	100.00
Chi-square			x^2	32.868	x^2	2.867	x^2	34.60	x 2	1.460
			P1	<o.oo1*	P2	>0.05	P3	<o.oo1*	P4	>0.05

There is statistical significant decrease in muscle tone in group B only after 1st and 2nd injection.

P1:before VS after 1st injection. P2: before VS after 1st injection.
P3: before VS after 1st injection. P4: before VS after 1st injection.

Table 4 Ankle reflex in group B before and after injection and after 1 year treatment

	Before injection	**After 1st injection**	**Before 2 nd injection**	**After 2nd hnjection**	**After 1 y**
Mean +	4+0.743	2.60+0.97	3.80_0.81	2.50+0.94	3.63+1.03
T-test	t	11.366	2.693	11.238	3.612
	P-value	P1 <o.oo1*	P2 <o.o5*	P3 <o.oo1*	P4 <o.oo1*

There is significant decrease of ankle reflex in group B in all results after treatment.

Table 5 Ankle clonus in group B before and after injection and after 1year treatment

	Before injection	**After 1st injection**	**Before 2 nd injection**	**After 2nd injection**	**After 1 y**
Mean +SD	1.10+0.759	0.33+0.66	0.93+0.83	0.30+0.65	1.27+0.83
T-test	t	6.707	1.720	6.595	-1.223
	P-value	P1 <o.oo1*	P2 >o.o5	P3 <o.oo1*	P4 >o.o5

There is significant decrease of ankle clonus in group B only after first and second injection

There was significant increase of ankle active range of movement (ROM) as well as passive ankle ROM before and after injection. (tables 6&7). ROM as well as passivankle ROM before and after injection.(tables 6&7). passivankle ROM before and after injection.(tables 6&7).

Table 6 Ankle active range of movement in group B before and after injection and after 1 year treatment

	Before injection	**After 1st injection**	**Before 2nd injection**	**After 2nd Injection**	**After 1 y**
Mean +SD	-30+13.26	-21+10.62	-30.67+9.80	-14.17+12.94	-28.33+8.94
T-test	t	-4.999	0.343	-7.67	-0.823
	P-value	P1 <o.oo1*	P2 >o.o5	P3 <o.oo1*	P4 >o.o5

There is significant increase of ankle active ROM in group B only after first and second injection

Table 7 Ankle passive range of movement in group B before and after BTX-A injection and after 1 year treatment

	Before injection	After 1st injection	Before 2nd injection	After 2nd hnjection	After 1 y
Mean +SD	-29+14.17	-12.50+11.28	-28.17+9.96	-4.83+12.35	-27.83+7.51
T-test	t	-6.279	-0.341	-9.397	-0.538
	P-value	P1 <o.oo1*	P2 >o.o5	P3 <o.oo1'	P4 >o.o5

There is significant increase of ankle passive ROM in group B only after first and second injection

The difference between group A&B was significant as regard calf muscle tone grading, clonus, active range of ankle motion and highly significant in passive maximal dorsiflexion range (tables 8,9,10,11). On the other hand, the difference was insignificant as regard ankle reflex grading.

Table 8 Comparison between calf muscle tone grading after one year surgery and BTX-A injection

	Calf muscle tone grading		
	Mean ± SD	t. test	p.value
After surgery	2.60±0.50	3.562	0.021*
After injection	1.96±0.85		

The difference between group A&B was significant as regard calf muscle tone grading.

Table 9 Comparison between clonus after surgery and BTX-A injection by one year

	Mean ± SD	t. test	p.value
After syrgery	0.70±0.22	5.629	0.003*
After injection	1.27±0.83		

The difference between group A&B was significant as regard clonus.

Table 10 Comparison between active ROM after one year surgery and BTX-A injection

	Mean ± SD	t. test	p.value
After surgery	-18.75±9.18	6.523	0.005*
After injection	-28.33±8.94		

The difference between group A&B was significant as regard active range of ankle motion

Table 11 Comparison between ankle reflex grading after one year surgery and BTX-A injection

	Mean ± SD	t. test	p.value
After surgery	3.60±0.99	0.638	0.421
After injection	3.63±1.06		

The difference between group A&B was significant

DISCUSSION

Vulpius technique for gastrocenmius lengthening is an effective method for treating spastic equinus deformity. However, it reduces the power of flexion by one or two grades on the Medical Research Council scale and in over 70%of patients this was sufficient to produce balanced action of extensors and flexors[18].

On the other hand, the use of BTX-A has gained widespread acceptance in the clinical management of focal muscle spasticity seen in patients with CP. It decreases muscle tone with increased joint mobility of the affected limb[10].

In group A with surgical correction, it is found that gastrocnemius recession reduces the power of flexion by one to two grades on the Medical research Council scale and in over 70 per cent of patients it was sufficient to produce balanced action of extensors and flexors.

In this study, the recurrence of the equinus deformity was recorded in 4 feet (10%) during the follow-up period. This is matches with that described in the literature (Green and McDermott 1942, Phelps 1957, Pollock 1962 with the exception of a report by Bassett and Baker (1966) which mentioned a 4% recurrence rate but does not state the length of time of follow up after the operation[18]. Calcaneus deformity was not found in any of the studied cases and no other foot deformities were found at the final follow-up examination. A small amount of equinus at follow-up was found to be of no great determent, and in hemiplegics was advantageous because it allowed some compensation for inequality of limb length, as noted by Banks and Panagakos (1966) and Staheli, Duncan and Schafer (1968) [18]. Even when some fixed equinus was present on one side in a bilateral case, function was more satisfactory than in those who had weakness of flexion with a tendency to calcaneus gait. This finding confirms the clinical impression that full range of extension should never be the aim in the management of equines deformity in cerebral palsy.

In group B our results are matched with those of Koman *et al*., (1994[10]), Gracies, (2004[19]), Berweck and Heinen (2004[20]) and Kelly *et al*., (2018[21]) in which there were decrease spasticity in children with spastic equines deformity with casting following it. Also, our results in group B agreed with Cosgrove *et al*., (1996[22]) who stated that selective injection of BTX-A may allow sufficient time to regain muscle length before the muscle tone returns and facilitating increase in ROM thus reducing muscle conversion to fixed contractures.

From the same point of view, our results are matched with those of Eames *et al*., (1999[23]), Heinen *et al*., (1997[24]), Wong (1998[25]) and Koman *et al*., (2000[26]) who demonstrated increase gastrocnemius muscle length, significant improvement in the joint mobility adjacent to the injected site and significant improvement in dorsiflexion after BTX-A injection.

In group B, the most common adverse effects reported after BTX-A treatment were localized pain at injection site which relieved by low dose of NSAID, constipation, low grade fever, and extremity weakness in one patient only after the first injection with no similar weakness was noted after the second injection of the same patient.

In comparing the results of both groups A&B, it is found that the usage of BTX-A injection in spastic equinus deformity gives better results superior to surgical correction. There is marked improvement in calf muscle tone grading, clonus, active range of ankle motion and passive maximal dorsiflexion range in usage injection rather than surgery (tables 8,9,10,11). There was no recurrence after injection while 4 feet of recurrence deformity followed surgery

On the other hand, there was no difference as regard ankle reflex grading.

CONCLUSION

This study suggests that the usage of Botulinum toxin 'A' injection in treating spastic equinus deformity in cerebral

palsy give superior results than the use of surgery. It is simpler, less invasive with better results of improvement.

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