Physical therapy program for cervical dystonia: a study of 20 cases

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Summary

Botulinum toxin (BTX) is the best therapeutic option in patients with cervical dystonia (CD), but physical therapy (PT) can be added to the treatment to achieve better results. Forty of our 70 patients with CD were enrolled in a controlled open study. Subjects were divided into two groups: G1 (intervention group comprising patients receiving BTX and PT) and G2 (control group comprising patients receiving BTX only). Both groups were assessed using the Toronto Western Spasmodic Torticollis Rating Scale (TWSTRS) and the 36-Item Short-Form Health Survey (SF-36). On the TWSTRS, significant improvements in disease severity were seen in G1 and G2 but significant improvements on the pain and disability subscales were seen only in G1 patients. There was a significant difference only on the pain subscale between G2 and G1 following treatment. An analysis of the physical aspects of SF-36 showed significant improvement in G1 on three subscales. An intergroup difference was also seen on two subscales. Regarding emotional aspects, G1 showed a significant improvement on three subscales. A significant difference on two subscales was also seen between G2 and G1 following treatment. BTX plus PT treatment achieved symptom relief in patients with CD and improved their quality of life.

KEY WORDS: botulinum toxin type A, cervical dystonia, physical therapy, quality of life.

Introduction

Cervical dystonia (CD), characterized by involuntary contractions of cervical muscles leading to awkward postures of the head and neck (1) and impaired motor control with concurrent activation of both agonist and antagonist muscles, is the most common form of focal dystonia. The dystonic movements may vary according to different tasks, postures or activities, sometimes leading to fixed dystonic postures (2).

Although motor manifestations are most evident, somatosensory perception deficits are also seen in dystonia (3). Other debilitating symptoms include pain, abnormal head posture, and tremor (2). The mental stress from this condition may also contribute to high levels of dysfunction and affect major areas of daily living such as professional and social activities (4).

Botulinum toxin (BTX) is today the treatment of choice for focal dystonia. However, some authors recommend a multidisciplinary approach to CD including physical therapy (PT) for better results (4-6). There are a few studies on the effects of PT in patients with CD. The following techniques were reported in these studies: manual therapy and kinesiotherapy (6), postural reeducation exercises (5,6), strengthening of dystonic antagonist muscles (4,7), vibration of dystonic muscles with sensory stimulation (8), and electroneuromyographic biofeedback (5,6).

Given the scarcity of studies on CD treatment investigating the association between BTX and PT, we developed a new rehabilitation protocol, which consisted of three approaches: kinesiotherapy, motor learning exercises, and functional electrical stimulation (FES). FES is an affordable auxiliary method with simple and reproducible parameters that can be consistently used in all patients.

The present study aimed to assess the effect of BTX treatment associated with an intermediate-term PT protocol by measuring disease severity, disability, pain, and quality of life (QoL) in patients with CD before and after the intervention.

Materials and methods

Forty out of 70 patients with CD treated at the Movement Disorders Clinic of the Department of Neurology, University of São Paulo School of Medicine, participated in a controlled open study.

The inclusion criteria were: a diagnosis of CD dating back more than one year; previous treatment with BTX injections with good response to at least two treatment sessions; and a signed informed consent form. The exclusion criteria included: any contraindications to treatment with BTX.

The protocol was approved by the local institutional review committee and all subjects signed a consent form before entering this study.

Evaluation

Patients were evaluated on the day of BTX injection, before its administration. The evaluators did not know which treatment group the patients were to be assigned to. A previous study conducted at the Chemodenervation Unit in our clinic showed that the clinical benefits of

BTX last on average 13 weeks (9). Since our protocol makes provision for the administration of BTX treatment at 20-week intervals, it was assumed that the effects of any previous BTX treatment had fully worn off.

The patients were divided into two groups: G1 (treated with BTX and PT) and G2 (treated with BTX only). They were re-evaluated 45 days after the BTX treatment session, which coincided with the end of the PT intervention. The Toronto Western Spasmodic Torticollis Rating Scale (TWSTRS) and the 36-Item Short-Form Health Survey (SF-36) were used to assess the patients.

The SF-36 questionnaire assesses patients' QoL and yields an eight-scale profile of scores. These are hypothesized to form two distinct higher-ordered clusters (10). The four subscales of physical health are: physical functioning, role-physical, bodily pain, and general health. The subscales of mental health are: vitality, social functioning, role-emotional, and mental health. The Brazilian version of the SF-36 was translated and validated by Ciconelli et al. (11).

The TWSTRS was developed by Consky et al. (12) and is an assessment scale used to measure the impact of CD on patients. It comprises three different components: severity, disability and pain. This scale was translated and adapted to Brazilian Portuguese by Sekeff-Sallem et al. (13) and is under validation for Brazilian Portuguese by these same authors.

The 40 patients received BTX treatment after medical evaluation. The toxin injected was Dysport® (abobotulinumtoxin A, Ipsen, Wrexham, UK) and the dosage was adjusted to individual requirements, but no patient received more than 1,000 U per treatment session.

The sample size was calculated to detect an improvement of 60% on the TWSTRS scale in G1 and 20% in G2. The percentage of improvement expected in G2 was based on previously published studies (14,15). We estimated an alpha level of 5% for type I errors and a statistical power of 80%. The sample size estimated to be necessary in this study was at least 19 subjects in each group.

The patients were invited to participate in the PT protocol right after the BTX treatment session. They were assigned to either G1 or G2 according to their availability to attend the PT program. The final number of patients in each group was 20; G1 was the study group, while the control group (G2) consisted of the 20 consecutive patients who could not attend PT sessions.

Physical therapy protocol

We proposed a new PT protocol for patients with CD that comprised the following main techniques: motor learning exercises, kinesiotherapy and FES on antagonist muscles.

The motor learning program was designed to help patients recover a positive body image. It consisted of repeated movements in the opposite direction to the dystonic pattern. Patients were instructed how to perform the movements by themselves or with the aid of a physical therapist. Once they were able to correctly perform an exercise without any assistance, at the next PT session they would, compatibly with their compliance and learning ability, begin to learn a new, more difficult exercise. Each exercise session lasted 20 minutes.

Kinesiotherapy exercise techniques involved cervical stretching, passive and active cervical mobilization and pumping. Each session lasted 25 minutes. FES was applied with the use of an electrical stimulator (Neurodyn III, Inbramed, Amparo, SP). Four surface electrodes (2 channels each with 2 electrodes) were placed over non-dystonic cervical muscles that have antagonist actions.

FES was applied as follows: the ipsilateral sternocleidomastoid, contralateral splenius, and trapezius (cervical portion) muscles were stimulated in torticollis; the contralateral sternocleidomastoid, trapezius (cervical portion), and splenius muscles were stimulated in laterocollis. Trapezius and splenius muscles were stimulated in anterocollis and bilateral sternocleidomastoid muscles were stimulated in retrocollis. Electrical stimulations were synchronized (FES-Sync), with two channels operated simultaneously using the on and off, rise and decay ramps.

The following FES parameters were set: frequency 50 Hz; on-time 10 s, off-time 30 s (1:3 on-off ratio); rise and decay times 2 s and 1 s, respectively; pulse 200 µs. Each FES treatment session lasted 30 minutes. All exercises and techniques were similar but adjusted according to the patient's dystonic pattern.

The G1 (PT intervention) patients received treatment for four weeks, five days a week, one hour and 15 minutes per session. Since four to seven days has been found to be the latency for achievement of maximal BTX effect (16), PT was initiated 15 days after BTX injection. By initiating treatment two weeks after BTX injection we could be sure that its full effect had been reached.

The primary and secondary objectives of this study were to assess changes in TWSTRS and SF-36 scores.

Statistical analysis

The Shapiro-Wilk test was used to assess normal distribution of numerical variables. Means ($\bar{\chi}$), and standard deviations (SD) were used for continuous data; medians (Md), quartiles (25-75), and absolute and relative frequency were used for categorical measurements. The Mann-Whitney test was used to compare numerical variables between SF-36 subgroups, while the Wilcoxon test was used to assess SF-36 scores within a group. Student's t-test was used to assess independent variables between TWSTRS groups and dependent variables to assess TWSTRS scores within a group. Cohen's $\bar{d}$ was used to measure the effect size for both groups and for statistical power analysis purposes. The effect size was defined as high ($\bar{d} \geq 0.8$), moderate ($0.2 \bar{d} \leq 0.5$), or low ($\bar{d} \leq 0.2$). For statistical significance a p-value of 5% ($p<0.05$) was set. The analysis was performed using the SPSS (Statistical Package for Social Science, v 15.0) software package.

Results

The demographic characteristics of the subjects are shown in table I. All the patients included in the treatment group fully complied with the proposed protocol.

TWSTRS

Assessed using the TWSTRS, the G1 patients showed significant improvements after treatment on two sub-

scales (severity and disability), whereas those in G2 improved only on the severity subscale. Improvements on the pain subscale after treatment were found only in G1. There also emerged a statistically significant difference on the pain subscale between G1 and G2 after treatment (Table II).

SF-36

As regards the physical health aspects of QoL, assessed using the SF-36, the G1 patients showed significant improvements after treatment on three subscales (physical functioning, role-physical, and bodily pain), but the same was not seen in G2. Comparison, after treatment, of groups G1 and G2 revealed differences on two subscales (role-physical and bodily pain) (Table III).
As for mental health, significant improvements were found on three subscales (vitality, social functioning and mental health) after treatment in G1. There also emerged between-group differences (G1 vs G2) after treatment on two subscales (vitality and mental health). No improvement in the mental health subscales was found in G2 (Table IV).

Table I - Demographic data of the two groups.

	G1 (BTX + PT)	G2 (BTX)
Age, years ($\bar{\chi}$; SD)	52.6 (14.5)	50 (12.6)
Gender, n (%)		
Males	9 (45%)	11 (55%)
Females	11 (55%)	9 (45%)
Formal education, years ($\bar{\chi}$; SD)	10 (3.7)	10 (4.4)
Disease duration, years (Md; 25-75)	9 (2.7-16)	16 (6.5-17.5)
Treatment duration, years (Md; 25-75)	1.7 (1-5.2)	11 (4-14.5)*
Delta (disease duration - treatment), years (Md; 25-75)	3 (1-12)	2 (1-5.5)

Abbreviations and symbols: BTX=botulinum toxin; PT=physical therapy. *p=0.001.
The results are shown as median (Md) and quartiles (25-75) or mean ($\bar{\chi}$), and standard deviation (SD).

Table II - TWSTRS results before and after treatment.

	G1 (BTX + PT) $\bar{\chi}$ (SD)	G2 (BTX) $\bar{\chi}$ (SD)
Severity subscale (I)		
Before	16 (3.5)	14.5 (4.6)
After	8.3 (3.8) *	11.2 (3.9) †
Disability subscale (II)		
Before	11.6 (5.7)	10.5 (5.9)
After	5.7 (5.2) ‡	6.6 (4.9)
Pain subscale (III)		
Before	8.11 (3.7)	9.6 (5)
After	3.13 (3.2) §	7.7 (4.7)

Abbreviations and symbols: BTX=botulinum toxin; PT=physical therapy. *=statistically significant within-group difference (before vs after), p<0.001; †=statistically significant within-group difference (before vs after), p<0.002; ‡=statistically significant within-group difference (before vs after), p<0.001; §=statistically significant within-group difference (before vs after), p<0.001 and between-groups difference (1 vs 2) after treatment, p=0.003, Cohen's $\bar{d}$=1.14.
The results are shown as mean ($\bar{\chi}$) and standard deviation (SD).

Table III - SF-36 results (physical health) before and after PT treatment.

	G1 (BTX + PT) Md (25-75)	G2 (BTX) Md (25-75)
Physical functioning		
Before	50 (26.2-77.5)	65 (41.2-83.7)
After	80 (65-97.5) ll	57.5 (45-88)
Role-physical		
Before	25 (0-87.5)	27.5 (10-75)
After	100 (100-100)¶	62.5 (25-100)
Body pain		
Before	51 (40-91.2)	51 (30-71.5)
After	82 (61.2-100) **	41 (41-53.2)
General health		
Before	62 (45.5-74.2)	57 (33.2-71.5)
After	67 (57-79.2)	62 (38.2-70.7)

Abbreviations and symbols: BTX=botulinum toxin; ll=statistically significant within-group difference (before vs after), p<0.01; ¶=statistically significant within-group difference (before vs after), p<0.01 and between-groups difference (1 vs 2) after treatment, p=0.006; Cohen's $\bar{d}$ =1; **=statistically significant within-group difference (before vs after), p=0.001 and between-groups difference (1 vs 2) after treatment, p=0.002. Cohen's $\bar{d}$ =1.26.
The results are shown as median (Md) and quartiles (25-75).

Table IV - SF-36 results (Mental Health) before and after intervention.

	G1 (BTX + PT) Md (25-75)	G2 (BTX) Md (25-75)
Vitality		
Before	57.5 (45-68.7)	62.5 (37.5-75)
After	77.5 (51.2-90) ††	50 (25-72.5)
Social functioning		
Before	50 (25-75)	62.5 (40.6-87.5)
After	100 (62.5-100) ‡‡	56.2 (37.5-87.5)
Role-emotional		
Before	100 (0-100)	66.6 (33-100)
After	100 (100-100)	49.9 (33-100)
Mental health		
Before	64 (45-84)	68 (43-75)
After	82 (61-96) §§	60 (34-74)

Abbreviations and symbols: BTX=botulinum toxin; PT=physical therapy; ††=statistically significant within-group difference (before vs after), p<0.001 and between-groups difference (1 vs 2) after treatment, p<0.003; Cohen's $\bar{d}$=0.63; ‡‡=statistically significant within-group difference (before vs after), p<0.001; §§=statistically significant within-group difference (before vs after), p=0.001 and between-groups difference (1 vs 2) after treatment, p=0.003; Cohen's $\bar{d}$=0.91.
The results are shown as median (Md) and quartiles (25-75).

Discussion

This study of patients affected by CD assessed, through TWSTRS and SF-36 scores, the impact of a new rehabilitation program provided together with BTX injections. Patients with CD have many disabilities but in this study the PT program focused specifically on muscle weakness, limited range of motion, pain, and central motor and control deficits. The patients who completed the PT program reported improvements in pain, disease severity, and QoL.

A major aspect of CD is deficient muscle relaxation leading to a fixed dystonic posture and limited range of motion (2). Impaired muscle relaxation may be caused by increased activity of agonist and antagonist muscles (co-contraction) and reduced voluntary and sequential movements (17). Therefore, our proposed PT protocol including kinesiotherapy and tissue release techniques may help improve these patients' QoL. It should be pointed out that this protocol can be easily reproduced by other therapists.

Tassorelli et al. (6) reported significant differences between groups treated with BTX plus PT and BTX only in daily life abilities and subjective pain. Subjects receiving PT, consisting of kinesiotherapy, postural control exercises and biofeedback, showed improvements in both areas. These patients required a smaller dose of BTX at the next injection and also reported a longer-lasting toxin effect (days). These findings are partially consistent with our results since these authors did not find any improvements in TWSTRS scores for the pain subscale, whereas we did in G1 (BTX plus PT). One possible explanation for the improvement seen in our G1, as measured by the TWSTRS, is that our PT protocol duration was twice as long as that of Tassorelli et al. (6).

Smania et al. (5) investigated four patients and divided them into two groups to receive two different protocols. The first protocol consisted of biofeedback and the second one of muscle stretching and postural reeducation. Both groups showed improvements with similar results suggesting that the PT program showed therapeutic effects comparable to those of biofeedback.

In these two studies (5,6), biofeedback was used because it acts on central mechanisms of motor learning. The basal ganglia play an important role in motor control, and patients with CD have dysfunctional motor planning, programming and execution, resulting in dystonic movements and a distorted body image (3).

Although biofeedback is used worldwide, access to this treatment modality in Brazil is quite limited and for this reason we developed a program of repetitive motor learning exercises. All the exercises were performed under similar conditions and in a repetitive manner in order to stimulate conditioning mechanisms and create a more solid internal model, which would ensure better adaptation and task generation. Hauptmann and Karni (18) reported that measurement of motor learning performance can be based on behavioral concepts. This was corroborated in our study as we found improved scores, especially on the TWSTRS, in G1 patients. But we were unable to find other similar studies for comparison of our results.

Another important aspect to underline is that patients with CD have weakened muscle strength compared with normal individuals. When pain is present in CD, it is also associated with impaired muscle strength (19).

This study proposed the application of FES for the treatment of patients with CD. Muscle dystonia and abnormal postures impair effective and functional contraction of antagonist muscles, which may lead to muscle hypotonia due to disuse. In addition to muscle contraction of target non-dystonic cervical muscles, the external electrical current used in FES also causes, through reciprocal innervation, relaxation of dystonic muscles that have already been treated with BTX.

FES electrodes were placed on the surface of muscles contralaterally to dystonic muscles so that muscle contraction would move the head to its normal position and induce functional movement. The aim was to provide an adequate input for head positioning. We did not find other articles in English on FES used in patients with CD or other dystonic conditions, although this treatment approach has been applied in other neurological disorders characterized by muscle weakness or failed motor programming resulting in abnormal muscle contraction, such as stroke or other conditions causing spasticity (20).

Ramdharry (4) reported a protocol applied to one patient with CD which resulted in improvement of dystonic posture, according to the TWSTRS scale, after manual strengthening of dystonic antagonist muscle groups. Zetterberg et al. (7) also included manual muscle strengthening in a treatment protocol and improved QoL was seen in five out of six patients with CD. Three patients reported improved pain and better TWSTRS scores. Our study corroborates these findings.

Another way to evaluate patient response to treatment is by assessing self-perceived QoL. The assessment of QoL is recognized as an important component of the evaluation and management of patients with dystonia. In the provision of adequate healthcare to patients with dystonia, it is necessary to focus not only on reducing disease severity but also on managing key factors for improving QoL (21).

General perceptual measures of QoL are useful tools in the treatment of patients with CD because functional quantitative scales are not able to detect significant changes achieved by BTX, neurological rehabilitation, and other therapies. The effect of a multidisciplinary approach to CD may be assessed by means of scales that combine motor function measures with an assessment of the impact of the disease on the patient's daily life activities, and emotional and social functioning. Therefore, the SF-36 is a good tool and has been used in many studies to assess QoL in patients with CD (22-24).

Most studies published on CD and PT did not include a QoL assessment in their analyses (4-6). Although Zetterberg et al. (7) reported improved QoL in five out of six patients, this improvement was exclusively attributed to the PT program, since no patients received BTX injections for at least three months before their enrollment in the study and there was no effect of BTX from previous injections.

Consistent with the results of Zetterberg et al. (7), we found improvements on six of the eight SF-36 subscales in the patients treated with PT, while those who received BTX only did not show any improvement on any QoL-related subscales.

Although some studies have shown consistent improve-

ments in QoL indicators after BTX treatment (22,23), other investigators, like us, found mild or no improvement in QoL perception in controls treated with BTX only (15,25). These conflicting findings may be due to the fact that the effect of BTX treatment varies over time, reaching a plateau right after injection and decreasing after that. Not all injections achieve the same effect; furthermore this is a long-term treatment and it needs to be repeated often because dystonic symptoms recur after a few months. These factors may reduce patient compliance with the treatment and have a negative impact on their QoL.

One limitation of this study is its non-random design. Since CD is not a very common condition, the number of patients with CD managed at our institution was small (n=70), which precluded the use of a randomized design. All the patients were interviewed and invited to participate in the study and our final sample size consisted of 20 subjects in the treatment group and 20 in the control group. The use of a non-random sample may have introduced bias. However, as there are few studies on CD and PT, this study may help physical therapists to make decisions about the management of CD and may encourage further randomized controlled studies on this approach.

Another aspect to be emphasized is treatment duration. In this a non-random sample of patients, the two groups, G1 and G2, were very similar in all respects, except treatment duration. This may have introduced some bias because the longer the treatment is, the less inclined the patient will be to participate in new treatment modalities such as PT, and the less prone to perceive any improvement following treatment. Patients enrolled in G2 also had longer disease duration than those in G1 (16 versus 9 years, respectively). This difference was not statistically significant, but it may have also introduced some bias, because the patients in G2 were more chronically ill and may have felt more despondent about their condition. Regardless of disease or treatment duration, it is worth mentioning that PT was a "new" treatment for all the patients enrolled in this study.

This study suggests that the combination of BTX injections and a PT program including kinesiotherapy, motor learning exercises, and muscle strengthening techniques, may improve disease severity, disability, pain, and QoL in patients with CD. This finding is in agreement with other studies on rehabilitation, although a direct comparison was not possible as each protocol had a different methodology and different techniques. Other studies are needed to further explore these findings and support neurological rehabilitation as an effective approach in the management of patients with CD.

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