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What is This?
Active exercise for individuals with cervical dystonia: a pilot randomized controlled trial

Melani J Boyce1,2, Colleen G Canning2, Neil Mahant3,4, John Morris3,4, Jane Latimer5 and Victor SC Fung3,4

Abstract

Objective: To investigate the feasibility and effectiveness of an active exercise program for cervical dystonia.

Design: Pilot randomized controlled, single-blind trial of a 12-week intervention followed by a four-week follow-up period.

Setting: Supervised physiotherapy and outcome measurement sessions were conducted in a hospital outpatient physiotherapy setting. Participants also performed exercises at home.

Subjects: Twenty participants with idiopathic cervical dystonia were randomized into an experimental (n = 9) or control (n = 11) group. Two participants from the experimental group and one from the control group dropped out.

Interventions: The experimental group undertook a semi-supervised active exercise program aimed at correcting the dystonic head position, plus relaxation. The control group performed relaxation only.

Main outcome measures: Feasibility of the intervention was assessed by recording adherence, muscle soreness, and adverse events. The primary outcome measure was blinded analysis of the Toronto Western Spasmodic Torticollis Rating Scale (TWSTRS) score.

Results: The active exercise program was feasible and safe, with participants in the experimental group completing 84% of prescribed training sessions in the 12-week intervention period. There were no adverse events in either group, while mild muscle soreness was reported by 66% of the experimental group. There was no significant difference between groups at post-test or follow-up. The difference between groups of –1.9 (95% confidence interval (CI) –9.0–5.2) on the TWSTRS demonstrates a trend towards greater improvement for the experimental group.

Conclusion: Active exercise for people with cervical dystonia is feasible and can be completed with good adherence and no adverse effects.

Keywords
Cervical dystonia, exercise, physiotherapy, randomized controlled trial

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Introduction

Cervical dystonia is the most common form of focal dystonia\(^1\) and is defined as involuntary posturing of the head away from the normal upright position.\(^2\) Cervical dystonia can present in different forms (torticollis, laterocollis, anterocollis and retrocollis), which can occur in isolation or in combination. The dystonic position may be intermittent or constant and head tremor may also be present.\(^3\) Idiopathic cervical dystonia has no known cause and in 90% of cases will be a lifelong condition. Neck and shoulder pain are reported by up to 70% of sufferers.\(^4\) Idiopathic cervical dystonia has a prevalence of 5–9 per 100,000 population, and the average age of onset is relatively young (i.e. 42 years).\(^1,5\) Therefore, people with cervical dystonia experience the burden of pain and disability over decades, which can lead to social withdrawal and depression.\(^4,6,7\)

There is Class A evidence for the effectiveness of treatment of cervical dystonia with botulinum toxin injected into the dystonic muscles, with symptomatic relief in up to 85% of patients.\(^4,8\) The duration of benefit of botulinum toxin treatment is between three and four months,\(^9\) however, some people develop a resistance to botulinum toxin after repeated injections and there remains a proportion of patients who experience partial or no relief. There is limited evidence of the benefit of various oral medications that have been used to treat cervical dystonia, and their side-effects are often severe enough that many patients choose to cease their use.\(^9,10\) Pallidal deep brain stimulation is emerging as another option for treating the symptoms of cervical dystonia, particularly for patients who have had limited benefit from medication or botulinum toxin therapy.\(^10\) This treatment is expensive and therefore not available to all sufferers of cervical dystonia, and entails a small risk of potentially serious adverse events.\(^11\)

Despite the limitations of medical and surgical interventions, only scant attention has been paid to more conservative self-management approaches that may reduce symptoms, such as physiotherapy including exercise. Tassorelli and colleagues\(^12\) used a randomized controlled cross-over trial design to investigate the effect of a multi-facetted physical rehabilitation program in addition to botulinum toxin. The rehabilitation group had a longer duration of benefit of botulinum toxin, required a lower subsequent dose of botulinum toxin, had less pain and improved ability to perform activities of daily living. However, there was no significant change in dystonia severity scores between groups, rated on the Toronto Western Spasmodic Torticollis Rating Scale. Ramdharry\(^13\) published a case study of exercise plus botulinum toxin, where the exercise was based on the relaxation of dystonic muscle groups and the activation of muscle groups opposing the dystonia, as described by Bleton.\(^14\) Improvement in head control and reductions in disability and pain were reported, as well as a longer period between botulinum toxin injections and a lower subsequent botulinum toxin dose. Zetterberg and colleagues\(^15\) administered a four-week inpatient program of progressive muscle relaxation, strengthening, coordination, balance, body perception, and stretching exercises in six single case studies. Five of the six participants reported improved quality of life following physiotherapy, however, there was no effect reported on the Toronto Western Spasmodic Torticollis Rating Scale.\(^15\)

In summary, there is currently insufficient evidence to determine the role of exercise or rehabilitation in the treatment of cervical dystonia. Further investigation into this area is therefore warranted. Considering that cervical dystonia has a young age of onset and is a lifelong, chronic condition, investigating treatment options that have a self-management focus is important to help these people manage their condition over the long term. The exercise program (described by Bleton\(^14\)) for people with cervical dystonia is designed to be conducted alone or in conjunction with botulinum toxin therapy, and incorporates an individually designed exercise program, delivered in a healthcare setting, with the participant continuing the exercises at home. This approach showed positive results in a case study\(^13\) and is compatible with interventions that have been proven effective in other chronic disorders, such as low back pain.\(^16,17,18\) Therefore, the aim of this study is to assess the feasibility and effect of a 12-week
program of active neck exercises, as described by Bleton,\textsuperscript{14} with follow-up assessment at 16-weeks, on people with idiopathic cervical dystonia in a pilot randomized controlled trial.

**Methods**

A pilot randomized controlled trial with blinded assessment, to determine the feasibility and effect size of a 12-week program of active neck exercises plus relaxation, compared with relaxation alone, for idiopathic cervical dystonia, was conducted. The trial was registered with the Australian and New Zealand Clinical Trial Registry (trial registration number: ACTRN12607000643471).

This study was approved by the relevant Human Ethics committees and all participants gave written informed consent prior to data collection. Participants were recruited from the Westmead Hospital Movement Disorders Clinic (Sydney, Australia), and through referral from neurologists in the local area. Some participants referred themselves to the study after seeing advertisements in the Australian Spasmodic Torticollis Association and Dystonia Australia newsletters.

Participants were accepted into the study if they had a diagnosis of idiopathic cervical dystonia with no other severe cervical pathology, were over 18 years of age, and were considered stable on medication for their cervical dystonia. In an effort to determine the effect of physiotherapy without any confounding effects from botulinum toxin therapy, participants were initially excluded from the study if they were having botulinum toxin therapy as a part of their medical management. After the completion of nine participants through the study, this exclusion criterion was removed, as recruitment of eligible participants was becoming increasingly difficult. Botulinum toxin therapy forms a part of the usual medical management for cervical dystonia and, therefore, including participants having botulinum toxin seemed appropriate. These participants joined the study on the same day as their scheduled botulinum toxin injections, having their initial assessment up to 24 hours prior to injection. This design amendment was approved by the relevant Human Ethics committees and the trial protocol was updated on the clinical trial registry.

Participants in both groups received eight treatment sessions over 12 weeks, weekly for the first four weeks and fortnightly for the following eight weeks. The control intervention consisted of a program of whole body relaxation.\textsuperscript{19} The experimental intervention consisted of an individually designed program of active neck exercises plus whole body relaxation. This exercise program was based on the concept of motor relearning through active exercises.\textsuperscript{20} Participants were prescribed specific exercises to activate and strengthen the muscles of the neck that oppose the dystonic neck position, and correct the position of the head, as described by Bleton.\textsuperscript{14} Exercises were selected for each participant based on the presentation and severity of their dystonia, and were progressed as appropriate when the participant had learnt the previous/easier exercise. Therefore, not all exercises were performed by all participants. A description of the exercise and relaxation programs used in the study is located in Appendix 1 (online). All supervised physiotherapy sessions were conducted individually by one of three physiotherapists at Westmead Hospital, and were approximately 30 minutes in duration.

In line with the self management aspects of the intervention, participants were encouraged to practice the exercises at least four times per week, including supervised physiotherapy sessions. Participants were therefore expected to complete a minimum of 48 exercise sessions during the intervention period, and a further 16 sessions during the follow-up period. No participants were having concurrent physiotherapy treatment specific to their cervical dystonia, and all participants were requested to maintain their usual physical activity for the duration of the trial.

Baseline measures were taken prior to randomization. Randomization into experimental or control groups was conducted off site using permuted block randomization (with block sizes of two and four), and communicated to the treating physiotherapist by telephone. All outcome measurement sessions were conducted by one of six physiotherapists who remained blinded to group allocation throughout the study. The participants attended four measurement...
sessions at the following times: prior to treatment (week 0), mid-treatment (week 6), at the completion of treatment (week 12), and four weeks following the completion of treatment (week 16).

The primary outcome measure was the Toronto Western Spasmodic Torticollis Rating Scale\textsuperscript{3,21} at 12 weeks. Secondary outcome measures were: the severity, disability, and pain subscales of the Toronto Western Spasmodic Torticollis Rating Scale, the Craniocervical Dystonia Questionnaire \textsuperscript{24,22} the Beck Depression Inventory II,\textsuperscript{23} and active cervical range of motion.

The Toronto Western Spasmodic Torticollis Rating Scale is a standardized assessment scale measuring the severity, disability, and pain associated with cervical dystonia.\textsuperscript{3,21} The Toronto Western Spasmodic Torticollis Rating Scale was chosen for this study as it is commonly used in clinical trials to assess any change in the severity of cervical dystonia.\textsuperscript{4} The severity section of the Toronto Western Spasmodic Torticollis Rating Scale assessment was recorded on a mini DVD recorder by the assessing physiotherapist, and then converted to DVD (in a random order) by the researcher (MB). The randomized recorded assessments were then rated at a later date by two neurologists (VF and NM) blinded to treatment allocation, whose scores were averaged to produce the final Toronto Western Spasmodic Torticollis Rating Scale severity score. The pain and disability sections of the Toronto Western Spasmodic Torticollis Rating Scale are self-report questionnaires that were completed independently by the participants.

Since depression is commonly associated with cervical dystonia and exercise is known to be an effective intervention for mild depression, measures of depression and quality of life are included. The Craniocervical Dystonia Questionnaire \textsuperscript{24} is a quality of life questionnaire that consists of 24 questions that relate specifically to people with cervical dystonia.\textsuperscript{22} The Beck Depression Inventory II is a questionnaire that assesses depression in the participant.\textsuperscript{23} Both of these questionnaires were completed independently by the participants, who were asked to rate their responses in relation to how they were feeling during the previous two weeks.

Active cervical range of motion (flexion, extension, lateral flexion, and rotation) was measured using a Cervical Range of Motion instrument (Performance Attainment Associates 350 East County Road D, Saint Paul, MN 55117, USA).\textsuperscript{24,25} Participant attendance at the supervised physiotherapy sessions, muscle soreness, and adverse events were recorded. Participants also completed an exercise diary documenting their home exercise sessions.

Data for adherence, muscle soreness, and adverse events are presented descriptively. To test for between-group effects of the intervention, analysis of covariance was performed using multiple linear regression. Pre-intervention (week 0) scores for the primary outcome variable (Toronto Western Spasmodic Torticollis Rating Scale) were entered into the model as a covariate. Separate analyses were conducted on the mid-intervention (week 6), post-intervention (week 12), and follow up (week 16) scores. Analysis was by ‘intention to treat’, and SPSS version 16.0 statistical software (Chicago, Illinois) was used for all data analysis.

**Results**

Twenty participants were randomized into the experimental or control group. Fourteen of the participants were female and six male, with an average age of 57.8 years (range 48–74 years; SD 7.8 years). All participants had idiopathic cervical dystonia with an average duration of 10.2 years (range 1–36 years; SD 7.9 years). All participants had a mixed type of cervical dystonia, with all types (anterocollis, retrocollis, torticollis, and laterocollis) and forms (tonic and clonic) represented. Seven participants (four experimental, three control) were receiving botulinum toxin injections every three months, while 13 participants were not. Figure 1 shows the study design and flow of participants through the study.

Both groups showed good adherence to the eight supervised physiotherapy sessions, with the experimental group completing an average of 7.0 (SD 2.1) and the control group completing an average of 7.5 (SD 1.5) supervised sessions. The number of sessions
completed by each group in the intervention and follow-up periods, the range of scores, and adherence (i.e. the number of sessions completed expressed as a percentage of required sessions) is shown in Table 1.

There were no adverse events reported by any participants in the study. Two-thirds of participants in the experimental group reported mild muscle soreness in the first few weeks of starting the exercises, but none of them felt it was severe enough to stop the exercises.

There was no significant between-group difference on the Toronto Western Spasmodic Torticollis Rating Scale at mid-treatment (week 6), post-treatment.
Clinical Rehabilitation 0(0)

(week 12), or follow-up (week 16). However, the experimental group did show a greater (non-significant) improvement in Toronto Western Spasmodic Torticollis Rating Scale scores than the control group at weeks 12 and 16. Similarly, there were no significant between-group differences in any of the secondary outcome measures at mid-treatment (week 6), post-treatment (week 12), or follow-up (week 16). However, the experimental group showed a greater (non-significant) improvement in scores on the Beck Depression Inventory II than the control group at week 12. Post-intervention (week 12) and follow-up (week 16) results compared with baseline are shown in Table 2. Mid-treatment results (week 6) are available as online supplementary material.

**Discussion**

This study has shown that active exercise is a feasible and safe treatment option for people with cervical dystonia. While there were no significant changes between the groups, the experimental group showed a greater (non-significant) improvement in the Toronto Western Spasmodic Torticollis Rating Scale and quality of life scores, which indicates a trend towards a beneficial effect of the exercise over the control intervention. The difference between groups on the Toronto Western Spasmodic Torticollis Rating Scale of −1.9 (95% CI −9.0–5.2) compares favourably with the only other randomized controlled trial of a physical intervention. The difference between groups in the study by Tassorelli et al. was −1.1 (SD 6.0) in favour of the physiotherapy group, who all received botulinum toxin therapy and a larger exercise dose. Although these effect sizes are small, it is possible that larger effects may have been attained if the exercise program delivered in the current study had been delivered at a higher dose and consistently in combination with botulinum toxin therapy.

The supervised physiotherapy sessions and the home exercise sessions were well adhered to by both groups, indicating a willingness for people with cervical dystonia to participate in a semi-supervised self-management therapy program. The intervention was safe, as participants reported no significant muscle soreness or adverse effects of the exercise.

While there have been no previous studies investigating the benefit of an individually designed, semi-supervised exercise program for people with cervical dystonia, it has been shown to be a beneficial approach in the treatment of other chronic pain conditions where the cause of the condition remains unclear and management is focused on treating chronic pain as a disease entity. Such a condition is chronic low back pain, where studies have demonstrated the benefits of exercise. Key features of successful programs include individually designed, high intensity, supervised exercise programs. It may be hypothesized therefore, that similar treatments may be useful in other chronic conditions, like cervical dystonia.

### Table 1. Adherence data

<table>
<thead>
<tr>
<th></th>
<th>Sessions completed intervention period</th>
<th>Sessions completed follow up period</th>
<th>Total number of sessions completed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD) (Range)</td>
<td>Mean (SD) (Range)</td>
<td>Mean (SD) (Range)</td>
</tr>
<tr>
<td></td>
<td>Adherence</td>
<td>Adherence</td>
<td>Adherence</td>
</tr>
<tr>
<td><strong>Exercise group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>40.1 (27.9) (2 – 96)</td>
<td>8.0 (10.8) (0 – 28)</td>
<td>51.8 (34.9) (1.5 – 123)</td>
</tr>
<tr>
<td></td>
<td>84%</td>
<td>50%</td>
<td>81%</td>
</tr>
<tr>
<td><strong>Control group</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>54.6 (19.8) (24 – 104)</td>
<td>8.9 (5.3) (0 – 16)</td>
<td>64.1 (19.4) (30 – 105)</td>
</tr>
<tr>
<td></td>
<td>114%</td>
<td>56%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Note: prescribed sessions for the intervention period = 48; prescribed sessions for the follow up period = 16; prescribed sessions for the total trial = 64.
Table 2. Mean (SD) score, mean (SD) difference within groups, and mean (95% CI) difference between groups for outcomes for the experimental group and the control group.

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Score</th>
<th>Difference within groups</th>
<th>Difference between groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Week 0</td>
<td>Week 12</td>
<td>Week 16</td>
</tr>
<tr>
<td>Exp N=9</td>
<td>Con N=11</td>
<td>Exp N=7</td>
<td>Con N=11</td>
</tr>
<tr>
<td>TWSTRS Total score (0-88)</td>
<td>37.7 (10.7)</td>
<td>34.7 (13.4)</td>
<td>32.3 (11.3)</td>
</tr>
<tr>
<td>TWSTRS Severity (0-38)</td>
<td>18.6 (5.2)</td>
<td>16.1 (5.9)</td>
<td>17.9 (6.1)</td>
</tr>
<tr>
<td>TWSTRS Pain (0-20)</td>
<td>8.4 (4.5)</td>
<td>8.6 (3.7)</td>
<td>6.3 (4.9)</td>
</tr>
<tr>
<td>TWSTRS Disability (0-30)</td>
<td>10.7 (5.0)</td>
<td>10.1 (5.6)</td>
<td>8.4 (3.6)</td>
</tr>
<tr>
<td>CDQ-24 (0-96)</td>
<td>36.2 (21.9)</td>
<td>32.9 (12.1)</td>
<td>23.3 (18.3)</td>
</tr>
<tr>
<td>BDI-II (0-63)</td>
<td>12.6 (10.4)</td>
<td>7.6 (6.2)</td>
<td>8.9 (10.5)</td>
</tr>
<tr>
<td>Suboccipital flexion ROM</td>
<td>9.9 (5.7)</td>
<td>11.1 (6.2)</td>
<td>13.7 (7.7)</td>
</tr>
<tr>
<td>Suboccipital extension ROM</td>
<td>24.4 (7.9)</td>
<td>26.2 (9.7)</td>
<td>23.4 (7.4)</td>
</tr>
<tr>
<td>Flexion ROM</td>
<td>31.8 (12.4)</td>
<td>31.0 (11.6)</td>
<td>28.9 (9.4)</td>
</tr>
<tr>
<td>Extension ROM</td>
<td>52.8 (10.9)</td>
<td>45.3 (22.0)</td>
<td>50.0 (16.9)</td>
</tr>
<tr>
<td>Left Lateral Flexion ROM</td>
<td>31.6 (9.7)</td>
<td>25.0 (6.5)</td>
<td>28.7 (6.9)</td>
</tr>
</tbody>
</table>

(continued)
There were a number of limitations to this pilot study. We were unable to recruit sufficient participants at our site, which is a tertiary referral movement disorder centre. Therefore, in order to increase our sample size, we opted to modify our protocol and include volunteers who were receiving botulinum toxin therapy. Even with this modification, we could not recruit the number of participants required based on our a priori sample size calculation. In addition, including a subset of participants receiving botulinum toxin caused a further limitation. Including these participants was reasonable given that, in clinical practice, achieving additional benefits with physiotherapy in patients already receiving botulinum toxin is a valid goal, however, there is a possibility that the gains attributable to botulinum toxin may have diminished the effect size of the physiotherapy.

The Cervical Range of Motion instrument has not been tested for reliability in people with cervical dystonia, and proved difficult to use with some participants who had head tremors or jerks. This may account, in part, for a lack of significant results in the range of motion scores.

Further research into the benefits of exercise in the treatment of cervical dystonia is warranted. To determine the number of participants required for a full-scale trial, we have reviewed studies into the benefits of botulinum toxin for cervical dystonia, which suggest that a between-group difference on the Toronto Western Spasmodic Torticollis Rating Scale of at least 7 points would be reasonably expected from an effective treatment for cervical dystonia. Therefore, a power calculation based on this effect size and the variability found in the current trial suggests that a sample size of 34 (17 per group), would be required for a full scale trial. It is also suggested that a measure of global perceived effect should be incorporated into any future trial to capture the participants’ view of their response to exercise and its effects.

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Clinical messages
- Active neck exercises are a feasible and safe treatment option for cervical dystonia.
- Good adherence to self management of exercise was shown in this population.
- A study of 34 participants is required to show a 7-point treatment effect on the Toronto Western Spasmodic Torticollis Rating Scale.

Contributors

MJB participated in the study design, participant recruitment, delivery of intervention, data collection, data analysis, and drafted the initial manuscript. CGC participated in the study design, data analysis, and manuscript revision. NM participated in the study design, participant recruitment, data collection, and manuscript revision. JM participated in the study design, participant recruitment, data collection, and manuscript revision. JL participated in the study design, data analysis, and manuscript revision. VSCF participated in the study design, participant recruitment, data collection, and manuscript revision.

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Conflict of interest

The authors declare that there is no conflict of interest.

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