The Effect of Comprehensive Corrective Exercise Program on Strength, Posture and Movement Pattern on Gym Trainees with Upper Cross Syndrome: A Randomised Control Trial

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Abstract:- **Background**: The prevalence of Upper Cross Syndrome (UCS), characterized by muscle imbalances affecting the musculoskeletal system, is on the rise. This study explores the impact of a Comprehensive Corrective Exercise Program (CCEP) on strength, posture, and movement patterns in gym trainees with UCS.

Methods: This is a parallel-group randomized controlled trial involved 60 participants (30 students, 30 gym trainees) at Galgotias University. The intervention group underwent an 8-week CCEP, while the control group received conventional exercises. Assessments included deep neck flexor strength, Manual Muscle Testing (MMT), Cervico Vertebral Angle, Kyphosis Angle, and Scapular Dyskinesis Test. Statistical analysis employed ANOVA, and MS Excel 2016 facilitated graphical representation.

Results: The CCEP group exhibited significant improvements in cervical flexor strength, Rhomboid Major strength, Cervico Vertebral Angle, and Scapular Dyskinesis Test. Statistical differences between groups underscored the program’s efficacy in enhancing muscle properties. The CCEP effectively addressed scapular stabilizer imbalances, emphasizing the role of mind-muscle concentration in neuromuscular training.

Conclusion: Both gym trainees and non-gym trainees experienced significant improvements in strength, posture, and movement patterns through the CCEP. This study highlights the importance of tailored neuromuscular rehabilitation in mitigating UCS effects, offering implications for fitness training and corrective exercise programs.

Keywords: Comprehensive Corrective Exercise Program, Upper Cross Syndrome, Strength, Posture, Movement Patterns, Neuromuscular Rehabilitation, Randomized Controlled Trial.

1. Introduction

In recent times, the prevalence of musculoskeletal disorders, specifically UCS, has become increasingly common in contemporary society. UCS is characterized by the overactivity or tightness of certain muscle groups, such as the pectoralis major, pectoralis minor, levator scapulae, and upper trapezius, coupled with the weakness or inhibition of others, including the deep neck flexors, serratus anterior, lower trapezius, middle trapezius, and rhomboids.[1,2] This imbalance creates a distinct "X" pattern, forming a cross design when hyperactive muscles on one side counteract underactive muscles on the other. This syndrome can lead to various dysfunctions in the body, such as headaches, premature degeneration of the cervical spine, and the reduction of the cervical curve.

Moreover, it can result in an atypical kyphotic thoracic spine and changes in the biomechanics of the glenohumeral joint.[3,4]

The surge in UCS cases can be attributed to prolonged periods of poor posture, commonly observed in individuals engaged in desk jobs, prolonged computer and device usage, and other activities that involve sustained positions. The resulting forward head posture, rounded shoulders, and scapular dyskinesis contribute to an altered musculoskeletal framework, impacting the stability of the cervico-cranial and cervicothoracic junctions.[5]

Though UCS is frequently associated with desk job-related activities but it also affects athletes and gym trainees. In the pursuit of enhanced performance and physique, individuals in sports, bodybuilding, and high-intensity workouts often engage in repetitive and intense exercises, potentially leading to muscle imbalances, scapular dyskinesis, and altered movement patterns.[6] This, in turn, may compromise their agility, power, and overall athletic performance. Comprehensive corrective exercise approach breaks new ground in addressing musculoskeletal disorders. It not only aims to correct existing malalignments like UCS, but also to prevent secondary complications like pain and injury. This makes extensive testing crucial, particularly for quantifying how this approach mitigates these issues in individuals with poor posture, where UCS and its associated complications are highly prevalent.[7]

Recognizing the need for targeted interventions to address UCS, the present study aims to investigate the effectiveness of a CCEP on the alignment, muscle activation, and movement patterns in gym trainees exhibiting symptoms of UCS. Understanding the impact of a CCEP on alignment and muscle activation is crucial not only for the well-being of gym trainees but also for the advancement of knowledge in the field of corrective exercise physiology.

Methodology

This parallel-group randomized controlled trial, conducted at Galgotias University's Physiotherapy Department, involved a 2-month intervention. The intervention group underwent an 8-week CCEP followed by a 4-week detraining period, while the control group received a conventional exercise program. Initial examinations were conducted, followed by a post-intervention evaluation. All participants signed an informed consent form authorized by Galgotias University and its Department of Physiotherapy.

The study included 60 participants (30 students, 30 gym trainees) randomized into two groups: a controlled group (15 students, 15 gym trainees) and a Comprehensive Corrective Exercise Program group (15 students, 15 gym trainees). Participants were allowed to withdraw from the study after providing informed consent.

Controlled Group Exercises:

The controlled group followed conventional exercises by Bang and Deyle, including shoulder flexion, extension, low rowing, horizontal extension, external rotation, and seated press-ups.[8]

Comprehensive Corrective Exercise Approach:

Dr. Seidi's comprehensive corrective exercise approach simultaneously addresses muscle strengths and weaknesses, focusing on overall muscle condition, especially targeting the kyphosis angle.[9]

Intervention Structure:

The 8-week intervention comprised Initial, Intervention, and Detraining phases. The Initial Phase emphasized voluntary control, scapula rhythm, and muscle concentration. Exercises progressed from non-weight bearing to correct muscle imbalances. As control improved, participants addressed external factors, incorporating weight-bearing exercises with attention to respiratory patterns and proper form.

Outcome Measures:

All assessments were conducted and analyzed by the investigator under the guide's supervision over a 2-month improvement phase and a 3-month maintenance phase. Demographic data, including gender, age, BMI, family and social history, medical history, any previous injuries or accidents, vitals, and neuromotor details, were evaluated before the study.

1. Deep Neck Flexors Strength:

Measured using pressure bio-feedback, assessing improvement over the 2-month period.

2. Manual Muscle Testing (MMT) Measurements:

Upper Trapezius

Middle Trapezius

Lower Trapezius

Levator Scapula

Rhomboid Minor

Rhomboid Major

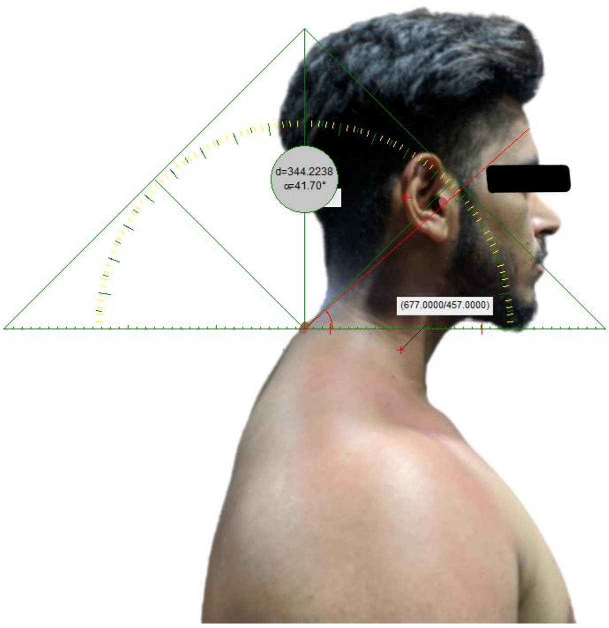
Serratus Anterior

Pectoralis Major

Pectoralis Minor

Cervico Vertebral Angle

The forward head angle, or cervico-vertebral angle, was measured using a photogrammetry method involving marked points at the ear tragus and C-7 vertebra spinous process. A smartphone mounted on a tripod 1.5m away from a white background captured three photos of participants standing 9 inches from the wall, adjusting the tripod height to shoulder level. MB Ruler software calculated the angle between lines connecting the marked points and the vertical line. This method provides a precise and reproducible measure of forward head posture, offering valuable insights into head and neck alignment relative to the vertical axis.[3]



Kyphosis Angle

Thoracic spine alignment was analyzed using the flexicurve ruler method, a reliable approach for measuring thoracic kyphosis. Spinous processes of T-2 and T-12 were marked, and participants stood comfortably for measurements. The flexicurve was molded between the marked points, and the ruler was positioned on graph paper. A straight line (L) connecting T1 and T12 ends was drawn, and the deepest part of the curve was identified. A perpendicular line (H) from this point to the L line was drawn. Using trigonometric equations, the kyphosis angle was calculated. This method provides a standardized and reproducible assessment of thoracic spine alignment.[2]

$$\theta = 4\left[Arctan\left(\frac{2H}{L}\right)\right]$$

Scapular Dyskinesis Test

McClure's method recommends employing a dynamic scapular dyskinesis test, wherein the presence of deviation or dysrhythmia/asymmetry in the position and movement of the scapula is classified as "yes," while the absence of such deviations is classified as "no" bilaterally. This technique, endorsed for its reliability and validity by researchers, has proven clinically satisfactory.

These measures were tracked for improvement over the 2-month improvement phase and assessed for maintenance over the subsequent 3 months.

Stat analysis

Data analysis was done under the Social Science Packaging Software SPSS 21.0 version. ANOVA was utilized to analyse the pre and post readings. The graphical representation is done using MS EXCEL 2016.

Results

From the analysis, our result is evident and shows a significant difference between the conventional group and the comprehensive group. The comprehensive approach has an immense effect on improving muscle strength, posture, and movement patterns in Upper Cross Syndrome.

In the study, gym trainees (G1 and G2) exhibited higher mean ages compared to non-gym trainees in both controlled and CCEP groups. The mean age for controlled non-gym trainees was 22±0.8, while gym trainees in the same group had a mean age of 26±3.0. Similarly, in the CCEP group, non-gym trainees had a mean age of 24±2.0, and gym trainees had a mean age of 26±3.4. The observed age differences suggest potential associations between gym training and participant age in both controlled and CCEP contexts.

BETWEEN-GROUP OUTCOME MEASURES								
Outcome Measures	***CONTROLLED GROUP OUTCOME MEASURES***		***CCEP GROUP OUTCOME MEASURES***		**Pre P Value**	**Post P Value**	**Pre T Value**	**Post T Value**
	CONTROLLED GROUP		**CCEP GROUP**					
	Pre follow-up	**Post Follow-up**	**Pre follow-up**	**Post Follow-Up**				
Biofeedback data								
Cervicle flexors	25.4±2.4	26.63±2.109	26.6±2.2	31.1±2.8	0.053	0	1.97	-6.97
MMT Isometric data								
M Trapezius	4.2±0.5	4.4±0.4	4.2±0.6	4.9±0.3	0.832	0	0.231	-4.687

L Trapezius	4.2±0.6	4.4±0.5	4.3±0.5	4.8±0.3	0.659	0.001	-0.443	-3.474
Rhomboid Minor	3.9±0.8	4.3±0.6	4.23±0.6	4.8±0.3	0.088	0	-1.73	-3.877
Rhomboid Major	3.4±0.4	3.4±0.3	3.8±0.4	4.6±0.4	0.001	0	-3.4	-6.665
Serratus A	3.3±0.4	3.6±0.4	3.4±0.5	4.1±0.3	0.441	0	-0.776	-4.566
Pectoralis Major	85.6±11.1	86.7±11.1	86.2±10.8	100.1±7.9	0.842	0	-0.2	-5.381
Pectoralis Minor	85.6±11.1	86.7±11.14	86.2±10.8	100.1±7.9	0.842	0	-0.2	-5.381
Levator Scapula	3.7±0.4	3.9±0.5	3.9±0.2	4.7±0.4	0.073	0	0	-6.757
U Trapezius	3.7±0.43	3.9±0.5	3.9±0.2	4.7±0.4	0.073	0	0	-6.757
Cervico Vertebral angle								
CvA	46.6±2.3	49.9±2.3	47.2±2.0	55.1±2.4	0.376	0	-0.893	-8.42
Kyphosis data								
K Index	8.9±0.6	8.6±0.6	9.1±0.5	8.2±0.5	0.237	0.12	-1.19	2.596
K Angle	40.6±2.8	39.2±2.9	41.6±2.6	37.4±2.2	0.237	0.12	-1.195	2.592
Scapular Dyskinesis test								
SDT	1.6±0.49	1.7±0.4	1.6±0.4	2.0±0.0	0.759	0.001	0.261	-3.525

Table 1 Between the Group differences in strength, alignment, movement pattern in control and CCEP group.

The CCEP group exhibited significant improvements in cervical flexor strength, particularly in the Rhomboid Major muscle, and demonstrated a substantial enhancement in the Cervico Vertebral Angle (CvA). Notably, the Scapular Dyskinesis Test indicated improved scapular movement and stability. However, no significant changes were observed in the Kyphosis Data (K Index and K Angle) (Table 1). All outcomes were found between the CCEP group and the control group at the pre-test and post-test, demonstrating the relevance of the Comprehensive corrective exercise programme with a p-value of ($P<0.05$).

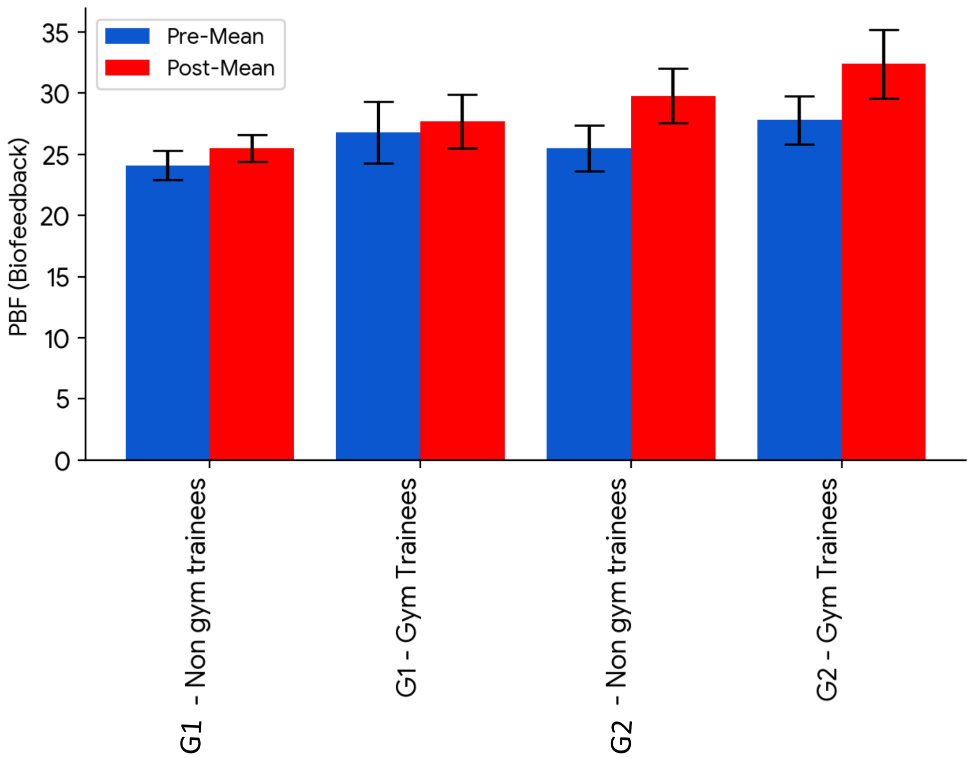


Figure1 Within-group difference in Pressure bio-feedback data.

Significant differences in deep neck flexor muscle strength were observed between the CCEP and controlled groups, with the CCEP group showing a notable improvement (31.1±2.8 vs. 26.6±2.1). Gym trainees demonstrated higher muscle strength (32.4±2.8) compared to non-gym trainees (29.8±2.2), indicating the potential influence of focused mind-muscle concentration in gym training for rapid and effective strength gains (Figure 1). This underscores the significance of the Comprehensive approach in enhancing deep neck flexor strength.

WITHIN GROUP DIFFERENCE IN INHIBITTED MUSCLE STRENGTH(MMT)				
Muscles	Controlled Group		CCEP Group	
	Non Gym Trainees	Gym Trainees	Non Gym Trainees	Gym Trainees
Pre Mid Trapezius	3.8±0.3	4.6±0.4	3.8±0.4	4.6±0.46
Post Mid Trapezius	4.0±0.2	4.7±0.4	4.8±0.4	5±0
Pre low Trapezius	3.8±0.4	4.6±0.4	3.9±0.2	4.6±0.4
Post low Trapezius				

	4.1±0.3	4.7±0.4	4.6±0.4	5±0
Pre Rhomboid Minor	3.2±0.4	4.6±0.5	3.8±0.4	4.6±0.4
Post Rhomboid Minor	3.8±0.5	4.7±0.4	4.6±0.4	5±0
Pre Rhomboid Major	3.2±0.4	3.6±0.5	3.8±0.4	3.8±0.4
Post Rhomboid Major	3.8±0.5	4±0	4.6±0.4	4.6±0.4
Pre Serratus Anterior	3.1±0.3	3.6±0.5	3.2±0.4	3.6±0.4
Post Serratus Anterior	3.4±0.5	3.8±0.3	4±0	4.2±0.4

Table 2. WITHIN GROUP DIFFERENCE IN INHIBITTED MUSCLE STRENGTH (MMT).

Table 2 reveals a progressive enhancement in muscle strength within the CCEP group, showcasing improvements in weak muscle groups. In contrast to the controlled group, the CCEP intervention not only enhances muscle strength but also contributes to restoring muscle balance, elevating the muscle group grade to a mean of 4 in non-gym trainees and 5 in gym trainees (4.6±0.4, 5±0). The observed disparity between gym and non-gym trainees suggests the potential impact of superior mind-muscle concentration in gym training. This strengthening of weak muscles underscores the effectiveness of the comprehensive approach in addressing Upper Crossed Syndrome (UCS).

WITHIN GROUP DIFFERENCE IN HYPERTONIC MUSCLE STRENGTH(MMT&ROM)				
Muscles	Controlled Group		CCEP Group	
	Non Gym Trainees	Gym Trainees	Non Gym Trainees	Gym Trainees
Pre Pec Major ROM	92.8˚±10.9	78.4˚±5.1	92.4˚±11.9	80˚±4.1
Post Pec Major ROM	93.9˚±10.8	79.4˚±5.3	103.8˚±7.0	96.4˚±7.2
Pre Pec Minor ROM	92.8˚±10.9	78.4˚±-5.1	92.4˚±11.9	80˚±4.1
Post Pec Minor ROM	93.9˚±10.8	79.4˚±-5.3	103.8˚±7.0	96.4˚±7.

Pre Levator scapula & Up Trapezius	3.8±0.35	3.6±-0.4	4±0	3.8±0.
Post Levator scapula & Up Trapezius	4.0±0.2	3.8±-0.	4.7±0.4	4.8±0.4

Table 3. Within groups difference in tight/hypertonic muscle strength.

Taking into account the pairwise comparison of the CCEP group's participants (Table 3), there is a significant improvement in muscle tightness, causing in enhancing the range of motion and reducing hypertonicity of levator groups and upper trapezius resulting in restoring muscle balance. While comparing non-gym trainees with gym trainees in the CCEP group, there's a significant increase in muscle strength in non-gym trainees than gym trainees, it could be due to pre-developed muscle strength in gym trainees compared to non-gym trainees.

Groups	Category	CVA Pre Mean ± Std. Dev.	CVA Post Mean ± Std. Dev.	TCA Pre Mean ± Std. Dev.	TCA Post Mean ± Std. Dev.	SDT Pre Mean± Std. Dev.	SDT Post Mean± Std. Dev.
G1	**Non gym trainees**	**46.9±2.8**	**49.8±2.7**	**40.7±2.7**	**39.8±2.8**	**1.5±0.5**	**16.05±0.5**
	Gym Trainees	**46.4±1.7**	**50.0±1.9**	**40.5±2.6**	**38.6±3.0**	**1.7±0.4**	**1.8±0.4**
G2	**Non gym trainees**	**47.3±2.2**	**54.8±2.3**	**41.3±2.4**	**37.7±1.7**	**1.4±0.5**	**2±0**
	Gym Trainees	**47.0±1.8**	**55.4±2.5**	**41.5±2.9**	**37.1±2.6**	**1.7±0.4**	**2±0**

Table 4 WITHIN GROUP DIFFERENCE IN CVA, TCA and SDT

The examination of Cervico Vertebral Angle (CVA), Thoracic Curvature Angle (TCA), and Scapular Dyskinesis Test (SDT) in distinct groups yielded insightful findings. Among non-gym trainees (G1), an increase in CVA from 46.9±2.8 to 49.8±2.7 suggested improved cervical alignment, while TCA decreased from 40.7±2.7 to 39.8±2.8, indicating a reduction in thoracic curvature(table 4). In the same group, SDT increased from 1.5±0.5 to 1.8±0.5, suggesting a potential enhancement in scapular movement. Gym trainees (G1) exhibited similar trends, with positive changes in CVA and TCA, and a stable SDT. Non-gym trainees (G2) and gym trainees (G2) displayed analogous improvements, reinforcing the positive impact of training on cervical alignment and thoracic curvature. The results underscore the potential benefits of physical training, particularly in a gym setting, in promoting musculoskeletal alignment and function, with gym trainees generally demonstrating comparable or slightly more favorable outcomes.

Discussion

The investigation aimed to evaluate the impact of the CCEP in comparison to a conventional exercise program on the strength, posture, alignment, and movement patterns of hypertonic and inhibited scapular stabilizers, particularly in gym trainees and the general population with Upper Cross Syndrome. Throughout the study, the mean MMT grades for various muscle groups and alignment parameters were assessed at different phases. The hypothesis anticipated that the CCEP would significantly correct and enhance strength, alignment, posture, and movement patterns associated with UCS, with a focus on sustaining these improvements during the detraining period.

The results indicated a substantial positive influence of the CCEP on strengthening and balancing scapular stabilizers in gym trainees, despite their pre-existing muscle development. This finding is crucial, considering the scapula's pivotal role in Upper Cross Syndrome complexities, as highlighted in prior research by Janda. CCEP demonstrated efficacy in enhancing cervical flexor strength, addressing scapular dysfunction, and improving postural alignment, as indicated by studies on chronic neck pain, scapular upward rotation, and Cervico Vertebral Angle.[10,11,12] While the program may not directly impact thoracic kyphosis in the short term, its targeted focus on cervical and scapular musculature proves beneficial for musculoskeletal health. The significance of mind-muscle concentration in neuromuscular training, particularly in the initial stages, emerged as a prime factor in enhancing muscle properties of the scapular stabilizers.[13] The study emphasized the importance of improving stability and strength in these muscles to correct motor control and scapular muscle activations. The utilization of Pressure biofeedback and targeted exercises in the CCEP played key roles in achieving immediate and significant impacts on controlled kinematics and motions of the scapulae.[14]

In examining muscle properties, gym trainees exhibited quicker muscle activation, potentially attributed to their long training history and strong mind-muscle concentration. The coordination of arm and scapula, especially the dominance of the Upper Trapezius, was highlighted as a contributing factor to scapular dyskinesis. However, the study's results indicated a notable drop in the excitation/inhibition ratio within the CCEP group by the end of the improvement phase. The findings demonstrated that the CCEP significantly improved muscle strength, posture, movement patterns, and alignment in individuals with Upper Cross Syndrome, particularly in gym trainees.[15,16] The discussion also touched upon the possible reasons and complications for UCS in gym trainees, emphasizing the need for a balanced training approach and the role of mind-muscle concentration. Limitations, such as the absence of EMG biofeedback, were acknowledged, and generalization to other populations was cautioned due to the specific demographic focus of young male adults and gym trainees. Both groups, regardless of training status, exhibited changes in CVA and TCA after the activities, suggesting potential adaptations in cervical and thoracic spine angles. Several studies have investigated the impact of exercise interventions on cervical spine parameters. For example, a study by Henge et al. 2021[17] found that specific neck exercises contributed to improvements in CVA among individuals with neck pain. Similarly,a study by Jung[18] et al. 2022 demonstrated that benefits of thoracic mobilization in improving thoracic hyperkyphosis and forward shoulder posture in individuals with thoracic hyperkyphosis.

Further we have noticed that scapular dyskinesis was more prominent in non-gym trainees in G1, emphasizing the importance of targeted interventions for this group. In the alignment of this a study by Bum[19] et al. 2016 highlighted the prevalence of scapular dyskinesis in overhead athletes and the need for targeted interventions to improve scapular function.Overall, the study highlighted the effectiveness of the CCEP and the importance of tailored neuromuscular rehabilitation in addressing UCS.

Conclusion

Gym trainees and non-gym trainees both exhibited noteworthy enhancements in strength, posture, and movement patterns. The improvements were assessed through various methods, including pressure bio-feedback for deep cervical muscle strength, isometric manual muscle tests and range of motion tests for identifying tight and weak muscle groups, the flexicurve ruler method for assessing kyphosis index and kyphosis angle, photogrammetry for measuring the forward head angle (cervico vertebral angle), and the scapular dyskinesis test for evaluating scapular movement abnormalities.

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