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Comparative Effects of Gaze Stabilization Exercises and Cawthorne-Cooksey Exercises on Craniovertebral Angle and Vestibulo-Ocular Reflex in IT Students

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Gaze Stabilization Exercises, Cawthorne-Cooksey Exercises, Craniovertebral Angle, Vestibulo-Ocular Reflex, Forward Head Posture, Vestibular Rehabilitation

Disclaimers

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ABSTRACT

Background: Vestibular dysfunction affects balance and spatial orientation, leading to symptoms like dizziness and impaired gaze stability. Forward head posture (FHP) is common among IT students due to prolonged screen time, exacerbating vestibular and postural issues.

Objective: To compare the effects of Gaze Stabilization Exercises (GSE) and Cawthorne-Cooksey Exercises (CCE) on craniovertebral angle (CVA) and vestibulo-ocular reflex (VOR) among IT students.

Methods: A single-blinded randomized clinical trial was conducted on 50 IT students aged 19-25 years with FHP. Participants were randomly assigned to GSE (n=25) or CCE (n=25) groups. Interventions were performed thrice weekly for 3 weeks. CVA and VOR were assessed pre- and post-intervention using a goniometer and clinical scale, respectively. Data were analyzed using SPSS version 27 with Wilcoxon signed-rank and Mann-Whitney U tests.

Results: Post-intervention, Group B (CCE) showed a significant increase in CVA (mean rank 26.80, U = 280.000, p = 0.527). Group A (GSE) demonstrated a significant reduction in VOR (mean rank 30.80, U = 180.00, p = 0.003).

Conclusion: GSE effectively improved VOR, while CCE significantly enhanced CVA, indicating the potential for targeted rehabilitation in addressing vestibular and postural dysfunctions.

INTRODUCTION

The vestibular system, a complex network integrating the brainstem, cerebellum, cortex, ocular system, postural muscles, and peripheral vestibular apparatus, plays a pivotal role in maintaining balance and spatial orientation. This system is comprised of the vestibular apparatus located in the inner ear, which detects head movements and body position relative to gravity. The brain processes this input to maintain equilibrium, orient the body in space, and synchronize visual images during movement. Specifically, the vestibulo-ocular reflex (VOR) enables eye movements that stabilize retinal images during head motion by engaging a reflex arc from the semicircular ducts to the vestibular nuclei and onward to the extraocular muscles (1). Additionally, the vestibular system regulates head and eye movements and activates postural muscles to maintain stability, primarily through the vestibular nuclear complex, which processes input from the vestibular apparatus and adjusts responses as necessary via the cerebellum (2).

Vestibular dysfunction, which affects balance and spatial orientation, has become a significant focus in clinical research due to its impact on quality of life. Symptoms such as dizziness, blurred vision, and imbalance disrupt gaze and postural stability, highlighting the importance of effective treatment strategies like vestibular rehabilitation (3). Vestibular rehabilitation employs techniques that target eye-head coordination, balance tasks, and body movements, demonstrating effectiveness in treating symptoms associated with vestibular disorders (4). Among these rehabilitation approaches, gaze stabilization exercises (GSE) and Cawthorne-Cooksey exercises (CCE) are particularly notable. GSE involves head movements aimed at enhancing the coordination of eye and head movements, thereby improving visual tracking and stability (5). CCE, on the other hand, consists of a series of head and body movements designed to reduce dizziness and improve balance by habituating the vestibular system to provocative stimuli (6).

The prevalence of forward head posture (FHP) has increased, especially among university students who engage in prolonged smartphone use. FHP is characterized by a forward displacement of the head in the sagittal plane, resulting in altered cervical spine curvature, increased strain on cervical extensors, and a cascade of musculoskeletal symptoms, including neck pain, shoulder

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discomfort, and impaired postural stability (7). The craniovertebral angle (CVA), which decreases as FHP severity increases, serves as a clinical measure to assess the extent of forward head positioning. Poor posture, such as FHP, can significantly impair dynamic postural stability, although static stability may remain unaffected, as young adults tend to adapt to these postural deficits (8). Thus, interventions that can correct FHP are essential for improving postural control and reducing associated symptoms.

This study aims to explore the comparative effects of GSE and CCE on CVA and VOR in IT students, a population particularly vulnerable to FHP due to extended screen time. GSE specifically targets the enhancement of gaze stability, thereby aiming to correct the VOR deficits associated with vestibular dysfunction. Conversely, CCE provides a broader vestibular rehabilitation approach, incorporating head movements that may also influence posture by promoting adaptation and habituation of the vestibular system (9). By comparing these two exercise regimens, this study seeks to determine their relative effectiveness in improving CVA and VOR among students, with implications for broader clinical applications in managing FHP and vestibular dysfunctions (10). Understanding the specific impacts of these exercises on both CVA and VOR could inform the development of targeted rehabilitation protocols for individuals experiencing vestibular-related postural and visual disturbances.

MATERIAL AND METHODS

The study was conducted as a single-blinded randomized clinical trial among IT students at The University of Faisalabad. Participants were enrolled from February 2024 to March 2024, following approval from the relevant ethics committee, and the trial was registered with the Iranian Registry of Clinical Trials under ID number IRCT20240307061205N1. In accordance with the principles outlined in the Declaration of Helsinki, written informed consent was obtained from all participants prior to their inclusion in the study. The inclusion criteria for participants were IT students aged 19 to 25 years of both genders, with a screen time of 6 to 8 hours per day, a positive vestibulo-ocular reflex (VOR), and a craniovertebral angle (CVA) of less than 48 degrees. Exclusion criteria included uncooperative individuals, those with a history of neurological disorders, ear infections, migraine, vertigo, head injury, or attention deficit hyperactivity disorder (ADHD) (11-13).

A total of 58 students were initially screened based on the eligibility criteria, of which 50 participants were selected, comprising 28 males and 22 females. Participants were randomly allocated to one of two groups using the chit and draw method, with 25 participants in each group. Group A performed gaze stabilization exercises (GSE) while Group B performed Cawthorne-Cooksey exercises (CCE). The intervention was delivered thrice a week on alternate days for three weeks, with each session lasting approximately 30 minutes. Both exercise regimens were tailored to the participants' stamina, beginning with 5 to 10 repetitions per exercise and gradually increasing as tolerated. Adequate rest periods were provided between exercises to prevent fatigue and ensure optimal performance.

Data collection involved the assessment of CVA and VOR both pre- and post-intervention. CVA was measured using a goniometer, with participants seated in a standardized posture to ensure consistent and accurate measurements. The VOR was evaluated using a clinical scale to assess the synchronization of eye movements with head motion. All measurements were conducted by the same researcher to maintain consistency in data collection and reduce variability. The primary outcome measures were the changes in CVA and VOR from baseline to post-intervention within and between the two groups.

Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 27. Descriptive statistics, including mean, standard deviation, frequency, and percentages, were used to summarize the demographic characteristics of the participants. Normality of the data was assessed using the Shapiro-Wilk test, which indicated that the data were not normally distributed ($p < 0.05$). Therefore, non-parametric tests were utilized for further analysis. The Wilcoxon signed-rank test was employed for within-group comparisons of pre- and post-intervention measures, while the Mann-Whitney U test was used for between-group comparisons. For parametric data, independent T-tests and paired T-tests were applied within and between the groups, respectively, to compare the differences in CVA and VOR measurements before and after the interventions. All statistical tests were two-tailed, and a p-value of less than 0.05 was considered statistically significant.

The study adhered strictly to ethical guidelines, ensuring confidentiality and anonymity of participant data throughout the research process. The results of this study aimed to provide insights into the effectiveness of GSE and CCE in improving postural and vestibular outcomes in IT students with FHP, offering potential clinical applications in the broader management of vestibular dysfunctions and postural abnormalities. The findings were intended to guide future research and inform clinical practice regarding the optimal exercise protocols for enhancing gaze stability and postural control in populations prone to vestibular impairments (14, 15).

RESULTS

The data collected were analyzed using SPSS version 27, and descriptive as well as inferential statistics were used to summarize the findings. The Shapiro-Wilk test confirmed that the data did not follow a normal distribution ($p < 0.05$), and therefore, non-parametric tests were employed for analysis. A total of 50 participants were included in the study, with a mean age of 21.2 years (SD = 1.6), ranging from 19 to 25 years. The gender distribution consisted of 56% males and 44% females.

The results of the Mann-Whitney U test indicated no significant difference in the baseline CVA measurements between Group A (GSE) and Group B (CCE), with mean ranks of 24.62 and 26.38, respectively ($U = 290.500$, $p = 0.666$). Post-intervention, CVA measurements did not show a significant difference between the groups ($U = 280.000$, p =

0.527). However, within-group analysis using the Wilcoxon signed-rank test showed a statistically significant improvement in CVA measurements for Group B (CCE), with a mean rank reduction from baseline to post-intervention (Z = -3.920, p < 0.001), while Group A (GSE) did not show significant improvement (Z = -1.540, p = 0.124).

The baseline VOR measurements also did not differ significantly between the two groups, with mean ranks of 26.14 for Group A and 24.86 for Group B (U = 296.500, p = 0.735). However, post-intervention VOR measurements revealed a significant difference between the groups, with Group A (GSE) showing a greater reduction in VOR scores compared to Group B (CCE) (U = 180.00, p = 0.003). This significant reduction in VOR for Group A indicates that gaze stabilization exercises were more effective in improving VOR outcomes than Cawthorne-Cooksey exercises.

Table 1: Baseline and Post-Intervention Measurements of Craniovertebral Angle and Vestibulo-ocular Reflex

Parameter	Group	Baseline Mean Rank	Post-Intervention Mean Rank	U-Statistic	p-Value
Craniovertebral Angle (CVA)	GSE	24.62	24.20	290.500	0.666
	CCE	26.38	26.80	280.000	0.527
Vestibulo-ocular Reflex (VOR)	GSE	26.14	30.80	296.500	0.735
	CCE	24.86	20.20	180.00	0.003

The age and gender distributions were summarized using descriptive statistics. The gender distribution included a slightly higher proportion of males (56%) compared to females (44%).

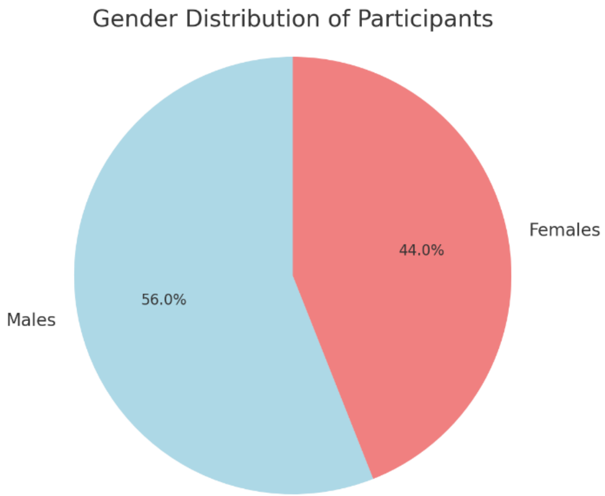

Figure 1: Gender Distribution

The mean age of participants was 21.2 years, with a standard deviation of 1.6 years, indicating a relatively homogenous sample of young adults within the specified age range.

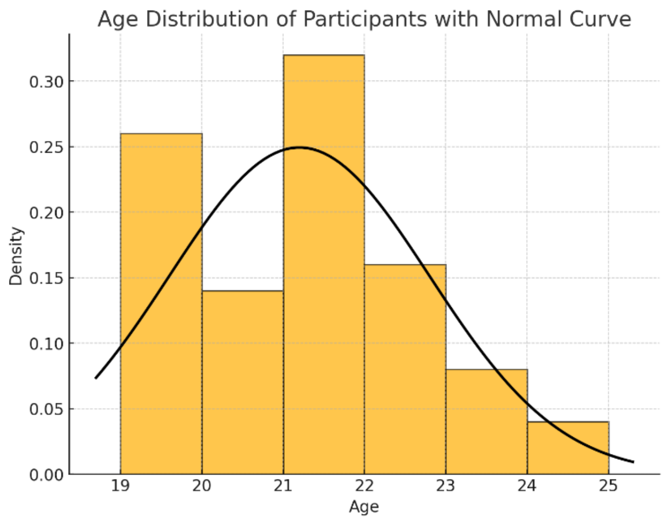

Figure 1: Gender Distribution

The inferential analysis focused on within-group and between-group comparisons of the primary outcome measures. For within-group analysis, the Wilcoxon signed-rank test was applied to evaluate the changes in CVA and VOR from baseline to post-intervention. Group A (GSE) showed a statistically significant improvement in VOR with a Z-score of -4.020 and a p-value of <0.001, suggesting that GSE effectively enhances VOR outcomes. In contrast, Group B (CCE) demonstrated significant improvement in CVA with a Z-score of -3.920 and a p-value of <0.001, indicating that CCE was more effective in increasing craniovertebral angle measurements.

Overall, the results suggest that both GSE and CCE interventions were effective in their respective domains, with GSE showing superior outcomes in VOR and CCE in CVA improvement. These findings highlight the differential impacts of gaze stabilization and Cawthorne-Cooksey exercises on postural and vestibular parameters, underscoring the importance of tailored rehabilitation approaches for individuals with vestibular and postural dysfunctions.

DISCUSSION

This study compared the effects of gaze stabilization exercises (GSE) and Cawthorne-Cooksey exercises (CCE) on craniovertebral angle (CVA) and vestibulo-ocular reflex (VOR) among IT students, a population prone to forward head posture (FHP) due to prolonged screen time. The findings demonstrated that CCE significantly improved CVA, while GSE showed a significant reduction in VOR measurements, suggesting that each exercise type effectively targeted different aspects of vestibular and postural dysfunction. The differential effects observed underscore the need for specific rehabilitation strategies based on the individual characteristics and presenting symptoms of the patient.

The results align with previous research indicating that vestibular rehabilitation exercises, including GSE and CCE, can effectively improve balance and postural stability in individuals with vestibular disorders (3, 18). Specifically, GSE was found to enhance VOR by stabilizing gaze during head movements, which is crucial for maintaining clear vision and spatial orientation (10). This improvement in VOR observed in the present study concurs with findings by Thakkar and Kanase (2022), who reported similar enhancements in VOR outcomes following gaze stabilization interventions. The effectiveness of CCE in improving CVA is consistent with prior studies that highlighted the role of such exercises in correcting postural misalignments and enhancing balance through habituation and sensory re-weighting (7).

Despite the positive outcomes, the study had several limitations. The sample was restricted to IT students with specific postural challenges related to prolonged computer use, which limits the generalizability of the findings to broader populations with varying postural or vestibular conditions. Additionally, the short intervention duration of three weeks may not fully capture the long-term effects of the exercises on CVA and VOR. Previous studies have suggested that longer intervention periods, such as those extending to three months, could yield more substantial improvements in balance and postural stability (19). The study also did not account for potential confounding variables such as individual differences in physical activity levels, baseline postural control, or underlying vestibular conditions that could have influenced the outcomes. Furthermore, the use of a single-blinded design, where only participants were blinded, might have introduced observer bias during data collection.

The strengths of this study include the randomized allocation of participants, which minimized selection bias, and the use of standardized measurement tools such as goniometers for CVA and clinical scales for VOR, ensuring reliable and valid data collection. The study also employed appropriate statistical analyses, including both parametric and non-parametric tests, to account for the non-normal distribution of the data, thereby enhancing the robustness of the findings.

To build on the current findings, future research should consider longer follow-up periods to assess the sustainability of the improvements observed in CVA and VOR. Studies should also explore the effects of combined GSE and CCE interventions to determine whether an integrated approach might offer additive benefits for individuals with complex vestibular and postural dysfunctions. Additionally, expanding the study population to include individuals with a wider range of ages, occupations, and baseline physical conditions could provide more comprehensive insights into the generalizability of the interventions. Finally, incorporating objective measures such as motion capture technology or vestibular function tests could enhance the precision of the outcome assessments and further validate the efficacy of these rehabilitation exercises.

Overall, the study contributes to the growing body of evidence supporting the use of targeted vestibular rehabilitation exercises for managing vestibular and postural disorders. By highlighting the distinct effects of GSE and CCE on VOR and CVA, respectively, this research underscores the importance of individualized exercise prescriptions in clinical practice. Tailoring rehabilitation programs to address specific deficits in gaze stability or postural alignment could optimize outcomes for patients with vestibular dysfunctions and improve their overall quality of life (Joshua and Pai, 2022; Dieterich and Brandt, 2018). These findings advocate for continued exploration into personalized rehabilitation strategies that cater to the unique needs of patients, ultimately advancing the field of vestibular therapy.

CONCLUSION

The study concluded that gaze stabilization exercises (GSE) significantly improved vestibulo-ocular reflex (VOR), while Cawthorne-Cooksey exercises (CCE) notably increased craniovertebral angle (CVA) among IT students with forward head posture. These findings suggest that GSE and CCE are effective, targeted interventions for enhancing specific aspects of vestibular and postural function. In terms of healthcare implications, these exercises offer non-invasive, easily implementable rehabilitation options that can be tailored to individual needs, potentially improving quality of life and reducing the risk of long-term complications associated with vestibular and postural dysfunctions in various populations. These results highlight the importance of personalized rehabilitation strategies in human healthcare, emphasizing the need for continued research to refine and expand the applications of vestibular rehabilitation in diverse clinical settings.

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