Comparative Effectiveness of Different Therapies for Convergence Insufficiency

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ABSTRACT

Purpose: This study aimed to determine the effectiveness of different treatment options such as brock string, dot card, jump convergence and pencil push-up exercises for convergence insufficiency (CI).

Methodology: After ethical approval, this quasi experimental study was conducted at District Head Quarter (DHQ) Bhakkar, Thel University Bhakkar, schools and collages of Bhakkar and district Layyah by selecting 140 patients presenting with symptomatic convergence insufficiency through non-probability convenient sampling. After informed consent, Positive Fusional Vergence (PFV), CI Symptom Survey (CISS) and near point of convergence (NPC) were measured. Then randomly divide into four groups of 35 patients by non-probability purposive sampling. Each group received one of the chosen therapy for 3 consecutive months. All patients were examined and self-structure proforma was filled as baseline data on each follow-up of therapy. Data was analyzed by IBM SPSS version 23.

Results: After completion of three month of treatment, near point of convergence improved from mean 13.343 ±.219 to 8.757±.194; CI 95%: $p<0.001$ respectively in brock string, mean 13.486 ±.197 to 7.729 ±.169; CI 95%: $p<0.001$ in dot card exercise, in jump convergence mean 13.614 ±.214 to 9.057, ±.170; CI 95%: $p<0.001$ improvement of NPC occur and in pencil push-up 13.243 ±.208 to 8.329 ±.143; CI 95%: $p<0.001$.

Conclusion: The dot card is most effective treatment to perform at home for CI, effective for achieving clinically significant improvements in signs and symptoms associated with CI in young adults.

Keywords: Asthenopia, Convergence Insufficiency, Pencil Push Up, Near Point of Convergence.

INTRODUCTION

Convergence Insufficiency (CI) is the inability to sustain binocular fusion and converge both eyes while focusing on a close object. Patients frequently complain of eye fatigue, reading with one eye closed, or impaired vision following the increased time of near work tasks.

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The clinical presentation of the patient and the previously mentioned clinical signs are used to diagnose primary CI.[1] Even though every age group has convergence deficiency, it is more prevalent in young adults because of the daily tough routine and excess of near tasks. The range of prevalence varies between 1.7% to 33%.[2, 3] The average range of CI prevalence in the general population has been estimated to be 5%.[4] This rate varies greatly according to demographic variables such as age and the chosen CI definition. These differences between incidence and prevalence are caused by a variety of symptom, including various exclusion criteria, measuring methods of NPC, PFV, and diagnosis criteria.[5, 6] Review studies in which student samples from schools was used have found that the prevalence of AI ranging from 0.2 to 32.5%. The rate of comorbidity varies between AI and CI ranges from 1.9 to 14.7%.[7] It is proposed that insufficiency of convergence occurs due to an Innervational difference, which results in a reduced capability to converge to close the required target distance. An imbalance in vergence ocular movement, which can be inherited or acquired, is thought to be the root of primary CI.[8] Drugs that affect the parasympathetic nervous system, fatigue, Adie tonic pupil, uveitis and glasses with the effect of a base-out prism, post exanthemata's encephalitis and traumatic damage are examples of acquired etiologies of convergence insufficiency.[9] Certain health issues also increase the risk of convergence insufficiency such as myasthenia gravis, Parkinson's disease, Alzheimer's disease and Graves' disease.[10]

Amplitudes of convergence decreased in CI.[11] AC/A ratio less than 2:1, at near exophoria higher than distance, decrease +ve fusional vergence, and the score of CISS should be less than or equal to 16 are key factors of convergence insufficiency.[12, 13] As of right now, researchers have established the fact that orthoptic/vergence therapies is a scientifically validated cure for convergence insufficiency.[14] But still there has been no single agreement regarding the most beneficial and effective treatment for convergence insufficiency, but this study is designed to understand the effectiveness of different treatment options.

METHODOLOGY

A Quasi-experimental study was conducted in the District head quarter of Bhakkar, Thel University Bhakkar and different schools and colleges of district Bhakkar and Layyah. The duration of the study was from September, 2022 to May, 2023.

Verbal and written consents were taken from each patient. The target population of this study was between the ages of 15 to 25 years. First, patients were investigated through detailed history related to ocular health, systemic issues and family health problem. The visual acuity of patients was measured by using a Log MAR chart. The CISS questionnaire was used to rule out the severity of convergence insufficiency symptoms of the patients. All those people whose score of CISS was more than 16 were selected for the research. Detailed ocular media, and retinal examination were done by using a slit-lamp in DHQ-visited patients while an ophthalmoscope was used during the remote visits of data collection processes in Thel University Bhakkar, and different schools / colleges of districts Bhakkar and Layyah. Any patient with any other ocular abnormality was excluded from further study procedure.

Measurement of the patient's positive fusional vergence was done by using a prism bar at 6 meters as well as 33 cm. Next, the vergence response were noted while looking at patient eye coordination objectively and subjectively asking the patients to respond to the blur, break and recovery points. Positive fusional vergence less than 15-20 PD at distance and less than 25 PD for near were included in this study.

Procedures of therapies were explained and demonstrated to patients properly and in easy language that they can understand easily. Brock string 10 to 15 minutes per day in one setting, pencil push-up, dot card and jump convergence three times a day for 5 minutes each time were prescribed. Each patient was scheduled for three follows up with intervals of one month. Each patient was contacted via phone call once a week to make sure adherence of the time to therapy. Whenever the patient came for follow-up near point of convergence, positive

fusional vergence and CISS were measured and noted, and compared with baseline NPC, positive fusional vergence and CISS as well. Collected data was analyzed by the SPSS version 23 to find out the results. The scoring of the CISS was statistically analyzed by using descriptive ANOVA.

RESULTS

Different convergence insufficiency therapies seem to greatly influence the near point of convergence. On the first, second and third months of follow-up, dot card therapy show better recovery of near point of convergence in convergence insufficiency patients followed by the pencil push-up, brock string and jump convergence respectively as shown in the table1.

Table - 1: NPC Assessment

Parameter		Mean	Std. Deviation
Near point of convergence on very first visit	Brock String	13.3429	1.29349
	Dot Card	13.4857	1.16623
	Jump Convergence	13.6143	1.26657
	Pencil Push Up	13.2429	1.23295
	Total	**13.4214**	**1.23538**
Near point of convergence on 1st month of follow up	Brock String	11.8571	1.12832
	Dot Card	11.5571	1.13611
	Jump Convergence	12.1143	1.05778
	Pencil Push Up	11.5857	1.10137
	Total	**11.7786**	**1.11767**
Near point of convergence on 2nd month of follow up	Brock String	10.4143	1.13426
	Dot Card	9.7000	1.09276
	Jump Convergence	10.7143	1.10004
	Pencil Push Up	10.1571	0.90563
	Total	**10.2464**	**1.11481**
Near point of convergence on 3rd month of follow up	Brock String	8.7571	1.14642
	Dot Card	7.7286	1.00252
	Jump Convergence	9.0571	1.00566
	Pencil Push Up	8.3286	0.84838
	Total	**8.4679**	**1.11435**

P=0.001 (p<0.05) of 2nd follow-up and p=0.00 (p<0.05) of 3rd follow-up of NPC measurement show that there is significant difference between the brock string, dot card, jump convergence and pencil push-up (Table 2).

Table - 2: Comparison of Near Point of Convergence

Parameter		Sum of Squares	Mean Square	P - value
Near point of convergence on very first visit	Between Groups	2.779	.926	0.615
	Within Groups	209.357	1.539	
	Total	**212.136**		
Near point of convergence on 1st month of follow up	Between Groups	7.179	2.393	0.124
	Within Groups	166.457	1.224	
	Total	**173.636**		
Near point of convergence on 2nd month of follow up	Between Groups	19.377	6.459	0.001
	Within Groups	153.371	1.128	
	Total	**172.748**		
Near point of convergence on 3rd month of follow up	Between Groups	34.891	11.630	0.000
	Within Groups	137.714	1.013	
	Total	172.605		

P=0.05 (p<0.05) of 2nd follow-up and p=0.00 (p<0.05) of 3rd follow-up of CISS measurement show that there is significant difference between the brock string, dot card, jump convergence and pencil push-up (Table 3).

Table - 3: CISS Measurement

Parameter		Sum of Squares	Mean Square	P - value
CISS on very first visit	Between Groups	71.571	23.857	0.125
	Within Groups	1667.829	12.263	
	Total	**1739.400**		
CISS on1st month of follow up	Between Groups	42.993	14.331	0.171
	Within Groups	1149.143	8.450	
	Total	1192.136		
CISS on 2nd month of follow up	Between Groups	375.736	125.245	0.055
	Within Groups	6555.200	48.200	
	Total	6930.936		
CISS on 3rd month of follow up	Between Groups	195.450	65.150	0.000
	Within Groups	1051.486	7.732	
	Total	1246.936		

The significance of the recovery point of positive fusional vergence p is 0.06 on the first month follow-up, 0.00 and 0.00 on 2nd and 3rd month of follow-up respectively (Table 4).

Table - 4: Comparison of Positive Fusional Vergence

Parameter		Sum of Squares	Mean Square	P - value
PFV recovery point at distance on very first visit	Between Groups	9.457	3.152	0.338
	Within Groups	378.514	2.783	
	Total	**387.971**		
PFV recovery point at distance on 1st month of follow up	Between Groups	27.336	9.112	0.066
	Within Groups	504.514	3.710	
	Total	**531.850**		
PFV recovery point at distance on 2nd month of follow up	Between Groups	80.686	26.895	0.000
	Within Groups	363.886	2.676	
	Total	**444.571**		
PFV recovery point at distance on 3rd month of follow up	Between Groups	89.914	29.971	0.000
	Within Groups	281.829	2.072	
	Total	371.743		

The significance of the recovery point of positive fusional vergence at near p is 0.94 on the first-month follow-up, 0.00 and 0.00 on 2nd and 3rd month of follow-up respectively (Table 5).

Table 5: Comparison of Positive Fusional Vergence at near

Parameter		Sum of Squares	Mean Square	P - value
PFV recovery point at near on very first visit	Between Groups	.686	.229	.959
	Within Groups	307.200	2.259	
	Total	307.886		
PFV recovery point at near on 1st month of follow up	Between Groups	3.086	1.029	.904
	Within Groups	739.657	5.439	
	Total	742.743		
PFV recovery point at near on 2nd month of follow up	Between Groups	65.486	21.829	.000
	Within Groups	331.657	2.439	
	Total	397.143		
PFV recovery point at near on 3rd month of follow up	Between Groups	56.914	18.971	.000
	Within Groups	232.229	1.708	
	Total	289.143		

DISCUSSION

This study aimed to evaluate the efficacy of brock string, dot card, jump convergence and pencil push exercises in convergence insufficiency patients. Hundred and Froty subjects between the age of 15 to 25 years with significant signs and symptoms of convergence insufficiency participated in this study. Trieu et al conducted a systematic review in 2018 on the current concept of convergence insufficiency. According to the most recent research, 2-17% of the general population and up to 49% of people who have suffered a traumatic brain injury affected by convergence insufficiency.[15]

Maagaard M L et al conducted a study in 2021 in which 44 CI children between the ages of 9 and 13 were randomly assigned to either vergence exercises for 6 weeks, followed by accommodation exercises. After six weeks, in the vergence exercises (11/20) full recovery was significant than uni-ocular accommodation exercises ($3/21; p = 0.01$).[16]

A Korean study explicate that vision therapy in children with symptomatic convergence insufficiency show the effective results. Study target papulation was school going children without any strabismus, and with prominent symptom of convergence insufficiency. After 8 weeks of therapy Near point of convergence improve 5.48 ± 0.96 near

and distance phoria also improve 4.19 ± 1.66 and 1.61 ± 0.71 respectively.[17]

Five interventions, i.e. vergence/accommodative therapy with home reinforcement, home-based pencil push-ups, and office based, home-based computer vergence/accommodative therapy, office-based vergence/accommodative therapy alone, and prism reading glasses, were examined across the 12 included trials. The home-based treatment reported as variable adherence rates, whereas office-based treatment has good adherence rates.[18] Another study was conducted in 2020 in which 60 Zahedan University medical science students with convergence insufficiency were selected to check the effectiveness of home-base treatment of CI and office base treatment. The NPC, and positive fusional vergence between the two groups prior to the therapy did not differ in a statistically significant way ($P > 0.05$).[19]

In 2019, a multi-center clinical trial (CITT-ART) was carried out to assess the efficacy of vergence/accommodative therapy for enhancing reading and focus on children with symptomatic convergence insufficiency. In the vergence/accommodative NPC improved 10.4 cm and in the placebo therapy group 6.2 cm (mean difference −5.2 to −3.2 cm; P< .001), mean Positive Fusional Vergence increased 23.2Δ in vergence/accommodative and 8.8Δ in the placebo therapy groups (mean difference of 14.4Δ; P < .001). However, both therapies have equal effects on reduction of self-reported symptom.[20]

The strength of this study is maximum time duration required to treat the CI had been use, researcher and participant interaction had very close interaction via phone twice a week and one office visit in 4 weeks.

CONCLUSION

In this study four different home base therapies used to treat symptomatic CI in young adults. Results demonstrated that out of the four treatments therapies, dot card exercise was effective in achieving normal clinical values for the NPC, CISS and PFV.

Conflict of Interest: None to declare

Ethical Approval: The study was approved by the Institutional Review Board / Ethical Review Board Vide No.TUF/IRB/204/23.

Author Contributions: Sara Sonum: Concept, Design, Data Collection, literature Review, article Draft.

Abeera Amir: Data Collection, Literature Review.

Amna: Data Collection, Literature Review.

Qurat Ul Ain: Data Analysis, Article Draft.

Marium Sanaullah: Data Analysis, Critical Review.

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