Journal of Research Administration
Society of Research Administrators International

COMPARISON OF TRADITIONAL VISION THERAPY AND HTS2 VISION THERAPY IN YOUNG ADULTS WITH NON STRABISMIC BINOCULAR VISION DYSFUNCTION

Alpa(M.Optom.)[a]*, D. P. Gupta(Ph.D)[b*], Rakesh Gupta(MBBS,MD [Ophthalmology])[c]
[a]Department of Sciences, Chandigarh School of Business, CGC, Jhanjheri, Mohali.
[a]Department of Optometry, Chitkara School of Health Sciences, Chitkara University, Rajpura, Punjab
[b]Chitkara University Institute of Engineering and Technology, Chitkara University, Punjab,
[c]Department of Public Health, SIPHER, Punjab, India
*Corresponding author

Abstract

Purpose: To assess and compare the effect of HTS2 vision therapy with traditional vision therapy in young adults with convergence insufficiency and co-existing accommodative dysfunction.

Methods: In this study, 54 subjects with convergence insufficiency (CI) and co-existing accommodative dysfunction were recruited. 27 Subjects were assigned to traditional vision therapy (VT) and 27 subjects were assigned to HTS2 vision therapy for 4 days per week for a period of one month. After one month of therapy, vergence parameters such as near exophoria, near point of convergence (NPC), near positive fusional vergence (PFV), vergence facility (VF) and accommodative parameters such as amplitude of accommodation (AA), negative relative accommodation (NRA), positive relative accommodation (PRA), monocular accommodative facility (MAF), accommodative response (MEM) and convergence insufficiency symptom survey questionnaire (CISS) scores were assessed. Data analysis was performed with Mann Whitney U Test and Wilcoxon Sign Rank Test.

Results: After one month of therapy, any statistically significant difference was not found in the mean values of vergence, accommodative parameters and CISS scores between traditional VT group and HTS2 VT group ($p > 0.05$). However, in both the groups a significant improvement was observed in near phoria, vergence, accommodative parameters and CISS scores of the subjects underwent VT ($p < 0.05$).

Conclusion: HTS2 VT is also found to be an effective treatment for improving vergence, accommodative function and reducing symptoms in the patients with CI and co-existing accommodative dysfunction and may be used as an alternative treatment to more time consuming, expensive traditional VT which is office-based for those who cannot visit the office.

Keywords: *Convergence insufficiency, accommodative dysfunction, office-based vision therapy, HTS2*

Introduction

CI is a common neuromuscular disorder of binocular vision mostly characterized by decresed ability to converge the eyes and maintain binocular fusion while focusing on a near object leading to high exophoria at near, reduced PFV, fusional facility and NPC, low AC/A

ratio, low NRA [1]. The previous studies have reported that CI is mostly associated with accommodative disorders [2]. Prevalence of CI has been reported to vary from 2.5% to 33% [3,4] and accommodative disorders around 2.3% - 20.2% among children and adults globally [5]. A recent study done by Rizwana et al. [6] in South India reported that prevalence of binocular disorders was found to be higher in the age group of 13-17 years (36.2%) as compared to the children 7-12 years old (25.1%). The symptoms associated with these disorders are like eyestrain, headache, poor comprehension, intermittent blurring and diplopia which also affect the quality of life [7, 8]. The treatment strategies for nonstrabismic binocular vision disorders include base-in prism [9, 10], overcorrecting minus lenses [11, 12], office-based VT (OBVT) or home-based VT [13-22]. Over a period of years, office-based exercises are most extensively evaluated [23, 24]. However, these exercises are highly expensive, require more office visits and not readily available. In comparison home-based exercises require less office visit, cost effective and are easily available. Software-based vision therapies can be used at home and the progress can be monitored online. HTS2 is a software based eye exercise program which is based on behavioural modification in the subject treatment model. The program uses random dot stereograms and other objective targets [18]. Only a few studies evaluated the efficacy of software-based vision therapy [18, 25]. Hence, the purpose of this study is to compare the effect of HTS2 VT with traditional VT among young adults in North-West India.

Materials and Methods

This prospective, single center, non blinded and experimental study was conducted at a private tertiary eye care hospital, Fatehabad, Haryana, India, from December 2022 to March 2023. The study was approved by the Institutional Ethical Committee, Chitkara University, Punjab, India. This study followed the tenets of declaration of Helsinki and a written informed consent was obtained from all subjects. 54 Young adults of age group (18-30 years) associated with only CI and co-existing accommodative dysfunction (CI with accommodative excess and CI with accommodative insufficiency), best corrected distance visual acuity 6/6 and near visual acuity N/6, near exophoria greater than 4 D than at the far, receded NPC (Break Point > 6 cm), PFV break < 15 Prism Dioptre (PD) at near, VF < 12 cpm, AA ≤ 2 D expected Hofstetter's minimum expected (AA: 15- Age × (1/4), MAF <7 cpm, CISS Scores > 21 points were included. Subjects with history of strabismus, amblyopia, nystagmus or any other binocular anomaly, previously treated with VT, endocrinal disorders, refractive/ strabismus surgery, presence of ocular diseases were excluded.

Examination Procedure

Baseline Visit

At baseline visit, demographic information of all participants were recorded. A complete ophthalmology examination including best corrected visual acuity, cycloplegic refraction with cyclopentolate 1% (Intas, India) eye drop, anterior and posterior segment examination were

performed. In addition to it standardized binocular vision examination procedure were also conducted as follows [25 -27]-

1) Evaluation of sensory fusion by worth four dot test.
2) Cover test at the distance and near for determining type and amount of phoria using accommodative target of 20/30 size and prism neutralization.
3) Measurement of NPC with push-up technique using a 20/30 accommodative target at 40 cm.
4) Measurement of positive and negative FV at distance and near using prism bar.
5) Monocular and binocular AA with push-up technique.
6) Measurement of monocular and binocular AF with ± 2 D flipper lens.
7) Measurement of lag of accommodation by monocular estimation method (MEM).
8) Measurement of NRA and PRA. (Lenses were added binocularly in increment of 0.25 D steps until sustained blur was reported).
9) Evaluation of saccade and pursuit function by NSUCO (North-eastern State University College of Optometry) test.
10) CISS scores are pretty good tool to evaluate the clinical symptoms of CI. A standardized 15 item version of CISS Questionnaire (CISS-V15) was administered in Hindi & English languages to record the symptoms. The patients were asked to choose one of the five possible answers with lowest and highest scores 0 and 4 representing the lowest and highest frequency of occurrence respectively, with 0 representing no symptoms and 4 representing highest symptoms. Symptom score was calculated by sum of answer of 15 items. A symptom score of 21or higher was considered significant [22].

Therapy Protocol

27 subjects were allocated to traditional VT and 27 subjects were allocated to HTS2 VT in 1:1 ratio. In one group (traditional VT) the patients were subjected to office based traditional VT for approximately 45 minutes for 4 days per week. At each session, subjects performed procedures such as brock string, life save card, aperture rule, accommodative rock and hart chart saccades [24] with a break of one to two minutes after 5 minutes of therapy.

The patients belonging to the other group (**HTS2 VT)** performed software-based exercises fusional vergence, accommodative and ocular movement therapy by using random dot target and other objective targets. The HTS2 software program was used for 20 minutes daily for 4 days per week for a period of one month.

Subjects Characteristics

A total of 65 subjects were assessed of which 54 subjects were enrolled in the study and 11 subjects were excluded of which 7 subjects did not meet inclusion criteria and 4 declined to participate. 27 subjects were allocated to traditional VT and 27 subjects were allocated to HTS2 VT. All 54 subjects were compliant to therapy and were included in analysis (Fig.1).

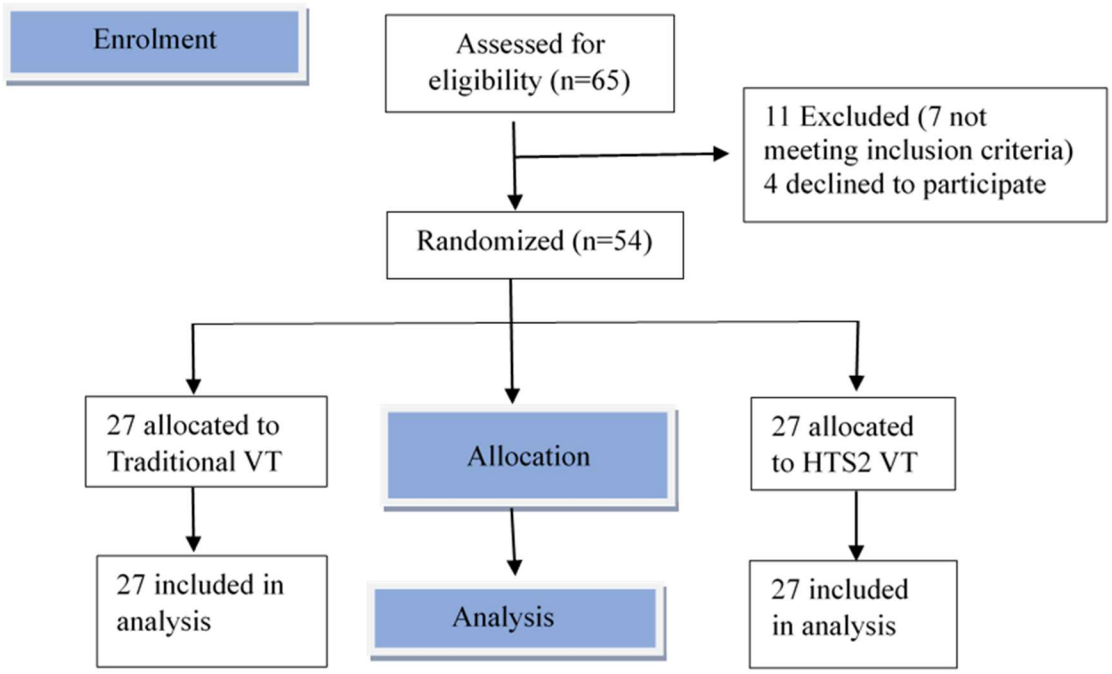

Fig.1**:** Flow chart of Randomization, allocation and analysis of participants

There was total 14 (23.1%) males and 40 (76.9%) females. Mean age for traditional VT group was 22.7 ± 2.85 and for HTS2 VT group was 18 ± 1.01. There were 4 (7.7%) employed subjects and 23 (42.6%) unemployed in traditional VT group and 26 (92.3%) employed subjects and 1 (1.9%) unemployed in HTS2 VT group. No. of subjects who were UG 18 (33.3%) and PG 9 (16.7%) in traditional VT group and UG 27 and no PG in HTS2 VT group. The number of subjects who involved in work < 4 hours 18 (33.3%), > 4 hours 9 (16.7%) and < 4 hours 16 (29.6%), > 4 hours 11 (20.4%) in traditional VT and HTS2 VT groups respectively (Table 1).

Table 1 Subject's demographic characteristics at baseline

Characteristics	Traditional VT group (Mean ± SD)	HTS2 VT group (Mean ± SD)
Age (In years)	22.6 (2.9)	20.1 (2.8)
Gender		
Males	6 (11.1%)	6 (11.1%)
Females	21 (38.9%)	21(38.9%)
Employment Status		
Employed	5 (9.3%)	5 (9.3%)
Unemployed	22 (40.7%)	22 (40.7%)

Academic Qualification		
UG	18 (33.3%)	18(33.3%)
PG	9 (16.7%)	9 (16.7%)
Working Hours		
<4 hours	16 (29.6%)	16 (29.6%)
>4 hours	11 (20.4%)	11(20.4%)
Monthly Income Status		
<20000 INR	9 (16.7%)	9 (16.7%)
>20000 INR	18 (33.3%)	18 (33.3%)

Outcome Measures and Success Criteria

The vergence parameters like near exodeviation, NPC, near PFV, VF and accommodative parameters: AA, MAF, MEM, NRA, PRA and CISS scores were the outcome measures of this study which were assessed after one month of therapy. We used the set of criteria to define patients as "cured" or "improved" on the basis of recent literatures [22]. Subjects who achieved NPC break of ≤ 6 cm, normal PFV measurement 15 PD break or greater on PFV amplitudes at near, VF >12 cpm, expected AA based on Hofstetter's formula, accommodative facility >7 cpm and CISS scores <21 were considered cured. Subjects who achieved the normal values in either of vergence, accommodative parameters and CISS scores were considered improved.

Data Analysis

After the data collection, the data was analysed using SPSS version 21 with confidence interval 95% and 80% power. Normality of data was determined with Kolmogorov-Smirnov test which showed that data were not normally distributed ($p < 0.05$). Wilcoxon sign rank test was used to compare the mean values of vergence parameters which include near exodeviation, NPC, near PFV, VF and accommodative parameters including AA, NRA, PRA, MAF, MEM and CISS scores between baseline visits and post VT. Mann Whitney U test was used to analyse and compare the treatment effect between traditional VT and HTS2 VT groups.

Results

The means and standard deviations for vergence parameters, accommodative parameters and CISS score for traditional VT group and HTS2 VT group at baseline are summarized in table 2.

Table 2 Comparison of vergence, accommodative parameters and CISS scores at baseline visit between traditional and HTS2 VT groups.

Clinical Parameters	Traditional VT group (Mean ± SD)	HTS2 VT group (Mean ± SD)	p value
Near exophoria	5.11 ± 0.9	5.45 ± 1.4	0.09
NPC Break	10.92 ± 1.41	11.00 ± 1.43	0.6
Near PFV	12.22 ± 1.5	12.25 ± 1.7	0.5
VF	5.4 ± 1.2	4.37 ± 1.3	0.5
AA	8.3 ± 2.3	8.0 ± 2.5	0.5
NRA	1.71 ± 0.4	1.61 ± 0.5	0.4
PRA	-1.95 ± 0.4	-1.89 ± 0.5	0.4
MAF	5.0 ± 0.8	3.9 ± 1.4	0.3
MEM	0.52 ± 0.4	0.54 ± 0.6	0.5
CISS scores	30.0 ± 4.9	31.1 ± 5.6	0.4

The table 2 shows that the values of near exodeviation, NPC, near PFV, VF, AA, MAF, NRA, PRA, MEM and CISS scores for traditional VT group at baseline are 5.11 ± 0.9, 10.92 ± 1.4, 12.22 ± 1.5, 5.4 ± 1.2, 8.3 ± 2.3, 1.71 ± 0.4, -1.95 ± 0.4, 5.0 ± 0.8, 0.52 ± 0.4 and 30.0 ± 4.9 respectively. While the values of the same for HTS2 VT group at baseline are 5.45 ± 1.4, 11.00 ± 1.43, 12.25 ± 1.7, 4.37 ± 1.3, 8.0 ± 2.5, 3.9 ± 1.4,1.61 ± 0.5, -1.89 ± 0.5, 0.54 ± 0.6 and 31.1 ± 5.6 respectively. There is no statistically significant difference found between the clinical parameters of participants at baseline in both the groups ($p > 0.05$).

Table 3 Comparison of vergence, accommodative parameters and CISS scores at baseline visit and post VT within traditional VT group.

Clinical Parameters	At baseline (Mean ± SD)	Post 1 month (Mean ± SD)	p value
Near exophoria	5.11 ± 0.9	4.48 ± 0.7	<0.01
NPC Break	10.92 ± 1.41	6.44 ± 0.84	<0.01
Near PFV	12.22 ± 1.2	21.25 ± 2.0	<0.01
VF	5.4 ± 1.2	12.83 ± 2.1	<0.01
AA	8.3 ± 1.3	11.40 ± 2.5	0.02
MAF	5.0 ± 0.8	10.78 ± 2.3	<0.01
NRA	1.71 ± 0.4	2.42 ± 0.2	<0.01
PRA	-1.95 ± 0.4	-2.51 ± 0.15	<0.01

MEM	0.52 ± 0.4	0.44 ± 0.1	0.03
CISS scores	30.0 ± 4.9	20.9 ± 3.3	<0.01

A comparison of vergence, accommodative parameters and CISS scores at baseline and post VT within the traditional VT group is shown in table 3. It shows an improvement in means of the parameters near exophoria from 5.11 ± 0.9 to 4.48 ± 0.7, NPC from 10.92 ± 1.41 to 6.44 ± 0.84, PFV from 12.22 ± 1.5 to 21.25 ± 2.0, VF from 5.4 ± 1.3 to 12.83 ± 2.1, AA from 8.3 ± 1.3 to 10.40 ± 1.7, MAF from 5.0 ± 0.8 to 9.88 ± 1.1,NRA from 1.71 ± 0.4 to 2.42 ± 0.2 and PRA from -1.95 ± 0.4 to -2.51 ± 0.15, MEM from 0.52 ± 0.4 to 0.44 ± 0.1 and CISS scores from 30.0± 4.9 to 20.9 ± 3.3 after one month of therapy in traditional VT group. The p value for all the parameters is found to be < 0.05 which shows a significant improvement in the vergence, accommodative parameters and CISS scores of the subjects underwent one month of traditional VT. The results shown in table 3 are plotted in figure 2 which again shows the same trend.

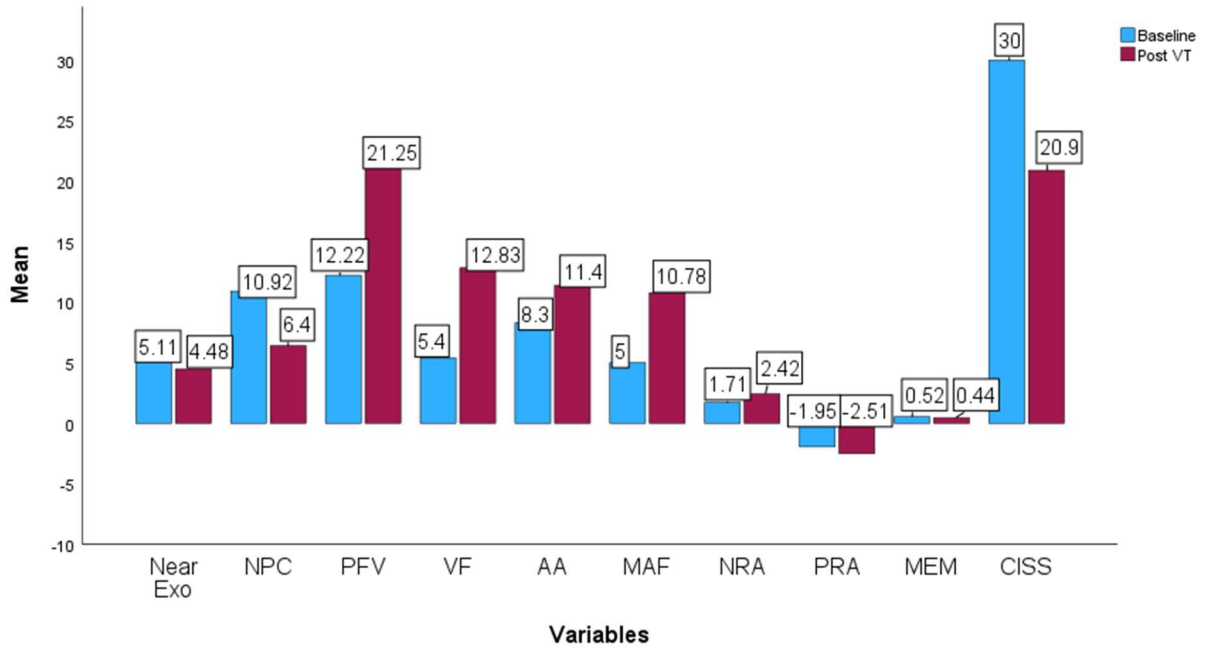

Fig. 2 Bar diagram of comparison of baseline data and data after one month of treatment of traditional VT group.

The vergence, accommodative parameters and CISS scores at baseline visit and post VT within HTS2 VT group are given in table 4. An insight of table 4 shows that like the post VT impro-

Table 4 Comparison of vergence, accommodative parameters and CISS scores at baseline visit and Post VT within HTS2 VT group.

Clinical Parameters	At baseline (Mean ± SD)	Post VT (Mean ± SD)	p value
Near exophoria	5.45 ± 1.4	4.78 ± 1.0	<0.01
NPC Break	11.00 ± 1.43	6.66 ± 0.96	<0.01
Near PFV	12.25 ± 1.4	21.10 ± 1.9	<0.01
VF	4.37 ± 1.3	10.20 ± 2.0	<0.01
AA	8.0 ± 1.2	11.25 ± 2.4	0.03
MAF	3.9 ± 1.4	10.69 ± 2.1	<0.01
NRA	1.61 ± 0.5	2.45 ± 0.2	0.01
PRA	-1.89 ± 0.3	-2.48 ± 0.15	0.02
MEM	0.54 ± 0.6	0.42 ± 0.15	0.04
CISS scores	31.1 ± 5.6	22.7 ± 4.1	<0.01

vement in the symptoms of the young adults subjected to traditional VT, there is again a significant post VT improvement ($p < 0.05$) observed in the parameters from the baseline after one month of HTS2 VT. The bar diagram of comparison of different parameters at baseline and after one month of treatment of HTS2 VT group (Fig.3) again shows a good agreement with our findings.

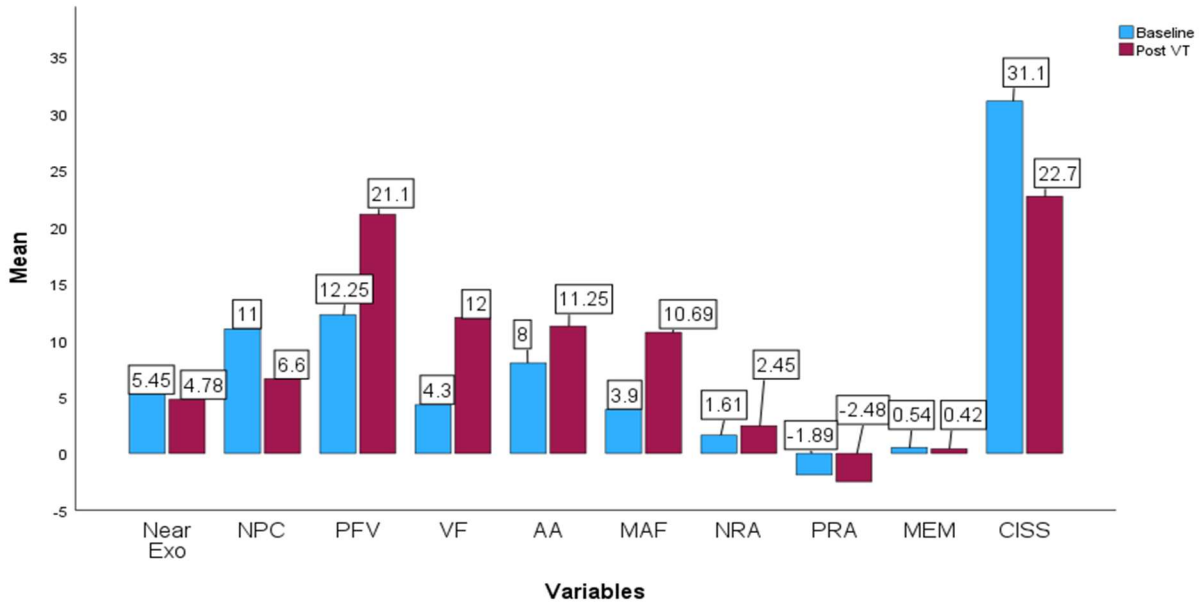

Fig. 3 Bar diagram of comparison of baseline data and data after one month of treatment of HTS2 VT group.

Contrary to the results shown in table 3 and table 4, any significant difference between the different clinical parameters vergence, accommodative parameters and CISS scores post VT between the traditional and HTS2 VT groups (Table 5) was not observed ($p > 0.05$).

Table 5 Comparison of vergence, accommodative parameters and CISS scores post VT between traditional and HTS2 VT groups.

Clinical Parameters	Traditional VT group (Mean ± SD)	HTS2 VT group (Mean ± SD)	p value
Near exophoria	4.48 ± 0.7	4.78 ± 1.0	0.06
NPC Break	6.44 ± 0.84	6.66 ± 0.96	0.4
Near PFV Break	16.25 ± 2.0	14.96 ± 2.2	0.1
VF	11.22 ± 2.0	10.44 ± 2.5	0.2
AA	10.40 ± 1.76	10.25 ± 1.78	0.3
NRA	2.28 ± 0.21	2.23 ± 0.25	0.3
PRA	-2.39 ± 0.15	-2.00 ± 1.5	0.2
MAF	9.88 ± 1.1	9.07 ± 1.3	0.04
MEM	0.22 ± 0.15	0.30 ± 0.19	0.3
CISS scores	20.9 ± 3.3	22.7 ± 4.1	0.3

It shows that there is no statistically significant difference in the effect of treatments between traditional VT group and HTS2 VT group.

Success Criteria

After one month of therapy, 16 subjects (60%) in HTS2 VT group and 19 subjects (70%) in traditional VT group achieved cured criteria. 11 subjects (40%) in HTS2 VT group and 8 subjects (30%) in traditional VT group were in improved criteria**.**

Table 6 The success criteria at the end of the 1 month of therapy.

	traditional VT Group	HTS2 VT Group
Cured	19 (70%)	16 (60%)
Improved	8 (30%)	11(40%)

Discussion

In this experimental study, the results obtained statistically and clinically in the means of vergence, accommodative parameters and CISS scores at baseline and post one month of VT for both traditional and HTS2 VT groups were not found significantly different. However, if we compare

the means of the clinical parameters undertaken in this investigation from the baseline to post one month of VT within both the traditional and HTS2 VT groups, significant difference are observed in the means of the observed parameters. The measurements of parameters at baseline and post VT of both the groups are not significantly different. But it is observed that the post VT measurements of the parameters are significantly different from the baseline values within both the traditional and HTS2 VT groups. It is therefore a clear indicative of improvement in symptoms as an effect of VT in both traditional and HTS2 VT groups.

In traditional VT Group,19 subjects (70%) were found to be cured and 8 (30%) were improved. In HTS2 VT Group16 subjects (60%) were found to be cured and 11 (40%) improved. Thus in both the groups a good number patients were found to be cured and improved. There are various treatments for non strabismic binocular vision anomalies of which the traditional VT is extensively evaluated and is considered as most preferred treatment. However, the traditional VT are costly, time consuming, and may not be readily available at all places. The software based HTS2 VT as compared to the traditional VT can a popular choice of treatment due to it's easy accessibility and financial constrains and can also be used for home based VT which require less office visits.

All subjects were compliant to the therapy and standardized diagnostic procedures were used in our study but there are limitations also in this study such as small sample size, no masking and no control or placebo group. The foremost shortcoming of home based VT can be such as the Subject's procrastination, making excuses and getting tired at times leading to the break in exercise there by resulting in flawed results.

In conclusion, HTS2 vision therapy was also found to be an effective treatment for improving vergence, accommodative function and reducing the symptoms scores in patients with CI and co-existing accommodative dysfunction. It may also be used as a first line of treatment in those patients wherein office therapy is not practical.

Conflict of Interest

There is no conflict of interest.

Funding/ Support

This study did not receive specific grant from any funding agency.

References

[1] Charles Darko-Takyi, Andrew Owusu Ansah, Frank Boampong, Enyam Komla Morny , Francisca Hammond, Stephen Ocansey (2022) Convergence insufficiency symptom survey (CISS) scores are predictive of severity and number of clinical signs of convergence insufficiency in young adult Africans. Journal of Optometry 15 228 -237.

[2]. Scheiman M, Cotter S, Kulp MT, Mitchell GL, Cooper J, Gallaway M, et al (2011) Treatment of accommodative dysfunction in children: results from a randomized clinical trial. Optom Vis Sci 88(11): 1343–1352.

[3]. Lara F, Cacho P, García A, Megías R (2001) General binocular disorders: prevalence in a clinic population. Ophthalmic Physiol Opt 21(1): 70–74

[4] Cooper J, Duckman R (1978) Convergence insufficiency: incidence, diagnosis, and treatment. J Am Optom Assoc49(6):673–680.

[5] Wajuihian SO, Hansraj R(2016)Accommodative Anomalies in a Sample of Black High School Students in South Africa. Ophthalmic Epidemiol23(5):316–23.

[6] Hussaindeen JR, Rakshit A, Singh NK, George R, Swaminathan M, Kapur S, et al (2017) Prevalence of non-strabismic anomalies of binocular vision in Tamil Nadu: report 2 of BAND study. Clin Exp Optom 100(6):642–648.

[7] Scheiman M, Wick B (2002) Clinical management of binocular vision: heterophoric, accommodative and eye movement disorders. Philadaephia, Pa: Lippincott Williams and Wilkins 241-60 p.

[8] Chase C, Tosha C, Borsting E, Ridder WH 3rd(2009) Visual discomfort and objective measures of static accommodation. Optom Vis Sci86(7):883–9.

[9] Pang Y, Teitelbaum B, Krall J (2012) Factors associated with base-in prism treatment outcomes for convergence insufficiency in symptomatic presbyopes. Clin Exp Optom95(2):192–197.

[10] Tamhankar MA, Ying GS, Volpe NJ(2012) Effectiveness of prisms in the management of diplopia in patients due to diverse etiologies. J PediatrOphthalmol Strabismus 49(4):222–228.

[11] Caltrider N, JampolskyA(1983) Overcorrecting minus lens therapy for treatment of intermittent exotropia. Ophthalmology90(10): 1160–1165.

[12] Kushner BJ(1999) Does overcorrecting minus lens therapy for intermittent exotropia cause myopia? Arch Ophthalmol117(5): 638–642.

[13] Scheiman M, Mitchell GL, Cotter S, Kulp M, Cooper J, Rouse M, et al (2005) A randomized clinical trial of vision therapy/orthoptics versus pencil push-ups for the treatment of convergence insufficiency in young adults. Optom Vis Sci82(7):583–595.

[14] Brautaset RL, Jennings AJM(2006) Effects of orthoptic treatment on the CA/C and AC/A ratios in convergence insufficiency. Invest Ophthalmol Vis Sci47(7): 2876–2880.

[15] Cooper J, Selenow A, Ciuffreda KJ, Feldman J, Faverty J, Hokoda SC, et al (1983) Reduction of asthenopia in patients with convergence insufficiency after fusional vergence training. Am J OptomPhysiolOpt60(12): 982–989.

[16] Wick B (1977) Vision training for presbyopic non strabismic patients. Am J OptomPhysiolOpt54(4): 244–247.

[17] Serna A, Rogers DL, Mc Gregor M Lou, Golden RP, Bremer DL, Rogers GL,et al(2011) Treatment of symptomatic convergence insufficiency with a home-based computer orthoptic exercise program. J Am Assoc PediatrOphthalmol Strabismus15(5):511-512.

[18] Cooper J, Feldman J (2009) Reduction in symptoms in binocular anomalies using computerized home therapy – HTS™. Optometry 80(9):481–486.

[19] Cohen AH, Soden R (1984) Effectiveness of visual therapy for convergence insufficiencies for an adult population. J Am Optom Assoc55(7):491–494.

[20] Scheiman M, Cooper J, Mitchell GL, de LP, Cotter S, Borsting E, et al (2002) A survey of treatment modalities for convergence insufficiency. Optom Vis Sci79(3):151–157.

[21] Grisham JD (1988) Visual therapy results for convergence insufficiency: a literature review. Am J OptomPhysiolOpt65(6):448–454.

[22] Birnbaum MH, Soden R, Cohen AH (1999) Efficacy of vision therapy for convergence insufficiency in an adult male population. J Am Optom Assoc70(4): 225–232.

[23] Scheiman M, Mitchell GL, Cotter S, Cooper J, Kulp M, Rouse M, et al (2005) A randomized clinical trial of treatments for convergence insufficiency in children. Arch Ophthalmol123(1): 14–24.

[24] Mani R, Hussaindeen JR, Ramani KK(2012) Effectiveness of vision therapy in the treatment of Symptomatic Convergence Insufficiency: results from the pilot study. Sci J Med & Vis Res Foun30 (2):29-32.

[25] Nehad T, Salem T, Elmohamady MN (2018) Combined office-based vergence therapy and home therapy system for convergence insufficiency in Egyptian children. Open Ophthalmol J 12(1):12-18. (ip.399)

[26] Aletaha M, Daneshvar F, Mosallaei M, Bagheri A, Khalili MR. Comparison of three visiontherapy approaches for convergence insufficiency. J Ophthalmic Vis Res. 2018 13(3):307-314. (ip.610)

[27] Anupam Singh, Vartika Saxena, Sandhya Yadav, Ajai Agrawal, Achala Ramawat, Ramanuj Samanta, Rakesh Panyala, Barun Kumar (2021) Comparison of home-based pencil push-up therapy and office-based orthoptic therapy in symptomatic patients of convergence insufficiency: a randomized controlled trial, Int Ophthalmol 41:1327–1336