International
Journal of Medical and Exercise Science
(Multidisciplinary, Peer Reviewed and Indexed Journal)

ORIGINAL ARTICLE

THE COMBINED EFFICACY OF BATES THERAPY AND CILIARY MUSCLE TRAINING ON IMPROVEMENT OF VISUAL ACUITY IN SUBJECTS WITH MYOPIA

Search engine:
www.ijmaes.org

Jabir S[1], Ansha Akbar [2], Parvathy G.M[3], Arya P.V[4], Fidha Sidheek[5], Amina Shajahan[6]

Corresponding Author:

Lecturer, Hillside College of physiotherapy Bangalore, India , Email: jabirsulaiman10@gmail.com

Co-Authors:

Physiotherapist, Apollo clinic, Zabeel street, Dubai

Assistant Professor , Bethany Navajeevan College of Physiotherapy, Trivandrum, Kerala, India

Physiotherapist, Attukal Devi Institute of medical sciences, Attukal, Trivandrum, Kerala, India

Physiotherapist, Physio abroad, Surat, Gujarat, India

Physiotherapist, Gokulam Health Centre, Attingal, Kerala, India

ABSTRACT

Introduction: Myopia is also known as near-sightedness and short-sightedness. This happens when the shape of your lens fails to keep light from focusing correctly on your retina and hence makes far-away objects look blurry. The vast majority of myopia is due to long-term contraction of ciliary muscle under the condition of close visual activities without relaxing, which weakens the stretching ability of ciliary muscle and results in its loss of relaxation ability. Visual acuity is the ability to perceive the information of moving objects. The Bates method is a natural method for better eyesight without glasses as discovered by Dr William H. Bates. However, this kind of therapy is yet undervalued .Thus came about a need for this study. **Methodology:** 30 subjects with visual acuity problems were screened with the help of a questionnaire and were included in this study. They were then randomly allocated into two groups with 15 subjects in each group. Group A was the experimental group and group B was the control group. After explaining the treatment procedures to the subjects in detail, group A was treated with Bates therapy, ciliary muscle training and conventional exercises. Group B, was treated with conventional exercises only. Both groups were treated for six consecutive days in a week for treatment duration of 12 weeks. **Result:** Experimental group showed a greater improvement of visual acuity while measured using Bailey Lovie chart. **Conclusion**: Bates therapy combined with ciliary muscle training is effective in improving visual acuity in subjects with myopia.

Keywords: Myopia, Ciliary muscle, Visual acuity, Bailey Lovie chart

Received on 15th October 2024; Revised on 10th November 2024; Accepted on 20th November 2024
DOI:10.36678/IJMAES.2024.V10I04.004

INTRODUCTION

The human eye is a sensory organ**,** part of the sensory nervous system, which reacts to visible light and allows humans to use visual information for seeing things, keeping balance, and also plays a major role in maintaining rhythm in daily life activities. The eye can be considered as a living optical device of human body .The human eyes sits in a protective bony socket called the orbit. Six extra ocular muscles in the orbit are attached to it. These muscles move the eye balls up and down, side to side, and rotate[1].

Human eye captures light rays as they come and fall on the retina and then the optic nerve carries the visual impulses from the retina to the brain which converts the received impulses to image. There are many pathological conditions that can affect vision. The most common among them is myopia. However, in myopia, light rays fall in front of retina, causing blurring of image. Correction of this is generally done using corrective devices such as corrective glasses and contact lenses[2].In myopia that is also called as short sightedness, there is a problem in the refraction of light, in which when the accommodation is at rest, and the parallel rays of light from the space come to focus in front of the retina[2].

About 69% of the general population in India has been reported to be affected with myopia[3]. The prevailing treatments of refractive errors which are commonly used these days are glasses, contact lenses and lasik surgeries.

Based on the investigations on current situation of myopia in the world, myopia presents clear regional characteristics, that is, the detection rate of myopia in Asia is much higher than that of Africa, Europe and America. For instance, in China, there are about 500 million patients suffer from refractive errors, of which 90% are myopic. Even worse, the morbidity of myopia is increasing, and persons with eye problems tend to be younger. The myopia rate of Chinese children ranks first in the world. The large scale prevalence of myopia has become a key factor triggering the downturn of eye health among children and adolescents[4].

The vast majority of myopia is due to the long term contraction of ciliary muscles under the condition of close visual activities without relaxing, which weakens the stretching ability of ciliary muscle and results in its loss of relaxation ability. In this case, improving ciliary muscle adjusting function is the key to prevent and slow down the progression of myopia. Kinetic visual acuity (KVA) and uncorrected distance visual acuity (UDVA), as the main indicators of visual acuity, are closely related to the adjusting function of ciliary muscle. Kinetic visual acuity is the ability to perceive the details of moving objects, which mainly depends on the regulating function of ciliary muscle[4], while the uncorrected distance visual acuity is the ability to perceive the details of static objects, which requires the ciliary muscle adjustment to ensure a clear vision at both far and near visual distances. Kinetic visual acuity can help to predict uncorrected distance visual acuity to some extent[4].

Accommodation of vision is the process of adjusting the focus of eyes as the distance between the individual and the object changes. The intrinsic muscles of the eye are

muscles that control the movements of the lens and pupil and thus participate in the accommodation of vision[5]. There are three smooth muscles that comprise this group; ciliary, dilatator pupillae and sphincter pupillae muscles[5].

The ciliary muscle plays a major role in the process of accommodation. It also occupies the biggest portion of the ciliary body, which lies between the anterior border of the choroid and iris. It is composed of smooth muscle fibers oriented in three different directions; longitudinal, radial and circular. Together with the sphincter pupillae, the ciliary muscle functions are mainly instructed by the parasympathetic nerve fibers of oculomotor nerve (CN III)[6].

Contraction of the ciliary muscle loosens the zonular fibers increasing the convexity of the lens which induces accomm-odation for near vision. It also regulates the pore size of the trabecular meshwork[6].

To focus light, eye uses a flexible lens, and a circular muscle (the ciliary). For distant vision, the shape of the lens allows the muscle to be relaxed. When you look up close, the ciliary muscle becomes tensed or contracted to change the lens shape to give clear close-up vision. Eventually there is spasm of ciliary muscle due to its constant contraction when looking at close objects. When it fails to fully relax, the lens cannot entirely return to focus on distant objects. This is when our distance vision becomes blurred and role of Eye exercises comes into action[6].

Eye exercises are often used in physiotherapeutic optometric vision therapy, which establishes effective ways of using the eyes as well as muscle relaxation techniques, biofeedback, eye patches, or eye massages, alone or in combination, to improve visual clarity[7].

In 1920, William Bates wrote a book “Perfect sight without glasses”[8] where he states that the eye does not focus by changing the power of the lens, but rather by elongating the eyeball, through use of the extra ocular oblique muscles. He believed that refractive errors of eye are caused by tension of these extra ocular muscles surrounding the eyeball, which he believed that it prevents the eyeball from sufficiently changing shape when gaze is shifted nearer or farther. Muscular tension is a consequence of a "mental strain", the relief of which he claimed would instantly improve sight. Bates felt that corrective lenses, which he characterized as "eye crutches", are an impediment to curing poor vision. In his view, "strain" would increase as the eyes adjust to the correction in front of them. He thus recommended that glasses be discarded by anyone by applying Eye exercise method[8].

METHODOLOGY

Materials Used: Couch, Consent form, Tennis ball, Myopia control questionnaire, Pen, Pencil, Bailey Lovie chart, Cotton, Candle, Football

Study design: Pre vs post experimental study design

Study setting: First care polyclinic, Kannammoola, Bethany Navajeevan College of Physiotherapy. KSBC sports arena, Enchakkal

Sampling design: Purposive sampling

Sample size: 30 subjects were selected.

Inclusion criteria: Subjects with refractive errors while measuring on Bailey Lovie chart,

Subjects within the age limit of 20 – 40, Subjects who are physically fit to complete the experimental tasks, Both sexes are selected.

Exclusion criteria: Subjects with astigmatism, Subjects with macular degeneration, Subjects with optic neuritis, Subjects with glaucoma, Subjects with optic nerve atrophy, Subjects with cognitive or motor dysfunction, Presbyopia.

Procedure: Based on the inclusion criteria, 30 subjects within the age limit of 20-40 with myopia were screened with the help of a questionnaire and included in the study. They were selected after visual acuity examinations done by an ophthalmologist for ruling out other related pathologic conditions if any. Subjects matching the exclusion criteria were excluded. After describing about the treatment procedures, the subjects were allocated into two groups after getting the consent form signed. Group A (Experimental group). Group B (Control group). 15 subjects in each group. An initial assessment was taken using Bailey Lovie chart.

Intervention

The intervention program was briefly explained to the subjects. Experimental group A was given Bates therapy combined with Ciliary muscle training and other conventional exercises while group B were asked to perform conventional exercises only. Both groups were asked to follow 20-20-20 rule[3] as a precaution to prevent the eyes from getting dry. 20 – 20 - 20 rule[3] is a technique when every 20 minutes being in front of a screen, resting the eyes by closing them for 20 seconds or seeing a far object 20 feet long .

The exercises given to group A were based on Bates technique; they were near to far shifting, palming, solarization, eye wash, eye squeezing and eye circles. The treatment was done for 6 consecutive days for treatment duration of 12 weeks.

The group A was also treated with ciliary muscle training[4]. This technique was done once in a week for treatment duration of 12 weeks. Several letters from English alphabets or numbers were pasted on football. The subjects were then asked to practice football and were also asked to catch the moving track of the ball during football rolling process[4]. The subjects were also asked to read the letters or numbers pasted on the ball.

The group B was asked to perform conventional eye exercises[11] which includes the following:

Turn and stretch the eyes far to the left and right continuing the movement back and forth from left to right for a repetition of ten times .

Turn the eyes upward that is to say look as far upward as possible without turning the head for ten times .

Raising the eyes, look upward obliquely to the left-then lower them obliquely to the other side for ten times

Raise the eyes upward obliquely to the right-then lower them obliquely to the other side repeat for ten times.

Roll the eyes around in a circle, to the left upward, to the right downward so on around. Then reverse rolling them the other way around continue until ten repetitions.

Shut the eyes tightly and vigorously squeezing the eyelids together as firmly as possible. Hold for ten seconds open and repeat ten times.

RESULT

Comparison of pre-test vs post test score of Bailey Lovie chart between experimental group and control group right side.

Bailey Lovie chart (right side) DIOPTER		No. of Samples	Median (Inter Quartile Range)	Mean Rank	Sum of Ranks	*U* value	*Z* value	*P* value*
Time Point	Group							
Pre	Exp	15	-1.5 (-1.9- -1.3)	13.8	207	87	-1.061	0.289
	Cont	15	-1.4 (-1.7- -1)	17.2	258			
Post	Exp	15	-0.6 (-0.8- -0.4)	20.27	304	41	-2.979	0.003
	Cont	15	-1.3 (-1.6 - -0.9)	10.73	161			

Table 5: Comparison of Bailey Lovie chart (rightside) between Experimental group and Control group

Analyzed by Mann-Whitney U test, Exp=Experimental group, Cont=Control group, Bailey Lovie chart

Comparison of pre-test vs post-test score of Bailey Lovie chart between experimental and control group right side.

Table 5: shows the comparison of pre and post test values of Bailey Lovie chart (right side) between experimental group and control group. The pre test values of experimental group were, Median (interquartile range) -1.5(-1.9- -1.3), mean rank 13.8, sum of ranks 207. The pre test values of control group were, Median (interquartile range) -1.4(-1.7- -1), Mean rank 17.2, sum or ranks 258. The pre test Mann-Whitney *U* value was 87, *Z* value was -1.061, *P* value was 0.289 which shows that there is no significant difference in pre test values of Bailey Lovie chart(right side) between experimental and control groups. The post test values of experimental group were, median (interquartile range) -0.6(-0.8-0.4), mean rank 20.27, sum of ranks 304. The post test values of control group were, median (interquartile range)-1.3(-1.6- -0.9), mean rank 10.73, sum of ranks 161. The post test Mann-

Bailey Lovie chart (right side)DIOPTER		No. of Samples	Median (Inter Quartile Range)	Mean Rank	Sum of Ranks	*U* value	*Z* value	*P* value*
Time Point	Group							
Pre	Exp	15	-1.6 (-2.4- -9)	14.17	212.5	92.5	-0.832	0.405
	Cont	15	-1.4 (-1.9- -0.7)	16.83	252.5			
Post	Exp	15	-0.6 (-0.8- 0.4)	19.13	287	58	-2.266	0.023
	Cont	15	-1.2 (-1.7 - 0.5)	11.87	178			

Table 6: Comparison of Bailey Lovie chart (left side) between Experimental group and Control group

Whitney *U* value was 41, *Z* value was -2.979; *P* value was 0.003 which shows that there is a statistically significant difference in post-test values of Bailey Lovie chart (right side) between experimental and control groups. Also the result shows that post test value of Bailey Lovie chart(right side) in experimental group is higher than the post test value of Bailey Lovie chart(right side) in control group.

Comparison of pre-test Vs post test score of bailey Lovie chart between experimental group and control group left side.

*Analyzed by Mann-Whitney U test, Exp=Experimental group, Cont=Control group, Bailey Lovie chart.

Table 6: Comparison of pre-test vs post-test score of Bailey Lovie chart between experimental and control group left side.

Table 6 shows the comparison of pre and post test values of Bailey Lovie chart (left side). Between experimental group and control group. The pre test values of experimental group were, Median (interquartile range) -1.6(-2.4- -9), mean rank 14.17, sum of ranks 212.5. The pre test values of control group were, Median (inter quartile range) -1.4(-1.9- -0.7), mean rank 16.83, sum or ranks 252.5. The pre test Mann-Whitney *U* value was 92.5, *Z* value was -0.832, *P* value was 0.405 which shows that there is no significant difference in pre test values of Bailey Lovie (left side) between experimental and control groups. The post test values of experimental group were, median (inter quartile range) -0.6(-0.8- 0.4), mean rank 19.13, sum of ranks 287. The post test values of control group were, median (inter quartile range)-1.2(-1.7 - -0.5), mean rank 11.87, sum of ranks 178.

The post test Mann-Whitney *U* value was 58, *Z* value was -2.266; *P* value was 0.023 which shows that there is a statistically significant difference in post-test values of Bailey Lovie chart (left side) between experimental and control groups. Also the result shows that post test value of Bailey Lovie chart (left side) in experimental group is higher than the post test value of Bailey Lovie chart (left side) in control group.

Illustrations

Bates Therapy and Ciliary Muscle Training

Figure 1- Assessment

Figure 2 Concentrating exercise for improving dynamic visual acuity

Figure 3 Tennis ball exercise with stable gaze to improve dynamic visual acuity

Figure 4 Ciliary muscle training combined with football practice

Figure 5-Ciliary muscle training combined with handball practice

Figure 6 Ciliary muscle training combined with football practice

Figure 7 Ciliary muscle training combined with football practice

Figure 8 Materials used in ciliary muscle training

DISCUSSION

Myopia is one of the leading causes of blindness across the world .The pathological phenomena observed in myopia are not just limited to the changes in refractive characters of eyeballs, But also in most cases changes in geometry of the eye are accompanied by significant pathological transformations.

Myopia is caused by the long term contraction of ciliary muscles while focusing on nearby objects for prolonged time. Prolonged contraction of ciliary muscles causes spasm which affects the ability of eyeballs in the process of accommodation, which occurs by the contraction (forward and inward movement) of the ciliary muscle and relaxation of zonular fibers simultaneously.

When the light rays from nearby objects falls into the lense of eyeballs, the light rays has to converge and focus into the retina for forming an image. In order for this to happen, the curvature of the eyeballs has to be decreased in diameter which is done by the contraction of ciliary muscles. Ian G Morgan et al have also proposed in his literature that the cause of myopia is due to an increase in intraocular pressure resulting from a long term concentration of nearby objects making the ciliary muscles to contract for a prolonged period of time.

There are so many management options existing for myopia .including pharmacological, contact lenses, lasik surgeries and so on .Most commonly practiced management for myopia is the usage of contact lenses, whereas, contact lenses does not treat the cause, further reviews have shown that subjects with myopia having an inability to focus light rays into the retina, have resulted in the image forming in front of the retina. Thus the vision appears to be blurred. In such a case when using contact lenses ,the lenses captures light rays which are then converged into the retina for getting focused and for forming a clear image.

In case of myopia, blurring of vision is only a symptom occurring due to the pathology of ciliary muscles. The primary focus in any treatment strategy should be aimed at curing of the underlying pathology .Usage of contact lenses does not have any proven evidences in

treating the ciliary muscle spasm which is the actually an underlying pathology causing myopia, but dealing only with the symptoms related to it .

The purpose of this study was to develop a standard treatment protocol in treating subjects with myopia focusing on the underlying pathology .Muscle spasm is a condition which is usually treated by physical therapists. But lack of evidences and practices of physical therapists in dealing with ocular muscles and other such ophthalmic conditions drains the confidence of many physical therapists coming up with interventions in this field. A physical therapist should be able to train the ciliary muscles and should make the myopic subjects able to focus on any object in the field of vision at any distance by maintaining proper contraction, relaxation of ciliary muscles along with the zonular fibers.

This study was conducted to determine the efficacy of bates therapy (Figure 11.2) combined with ciliary muscle training (Figure 11.6) intended in improving visual acuity in subjects with myopia. Traditionally used conventional eye exercises were given for all the subjects in this study irrespective of the groups in which they were allocated. After the study duration of study, the pre and post test values were analyzed by both Wilcoxon signed ranks test and Mann-whtney U test. Based on the comparison of pre and post test values of Bailey Lovie chart (right side) between experimental group and control group were statistical analyzed. The pre test values of experimental group were, Median (inter quartile range) -1.5(-1.9- -1.3), mean rank 13.8, sum of ranks 207. The pre test values of control group were, Median (inter quartile range) -1.4(-1.7- -1), mean rank 17.2, sum or ranks 258. The pre test Mann-Whitney *U* value was 87, *Z* value was -1.061, *P* value was 0.289 which shows that there is no significant difference in pre test values of Bailey Lovie chart (right side) between experimental and control groups. The post test values of experimental group were, median (inter quartile range) -0.6(-0.8- -0.4), mean rank 20.27, sum of ranks 304. The post test values of control group were, median (inter quartile range)-1.3(-1.6- -0.9), mean rank 10.73, sum of ranks 161. The post test Mann-Whitney *U* value was 41, *Z* value was -2.979; *P* value was 0.003 which shows that there is a statistically significant difference in post-test values of Bailey Lovie chart (right side) between experimental and control groups. Also the result shows that post test value of Bailey Lovie chart (right side) in experimental group is higher than the post test value of Bailey Lovie chart(right side) in control group.

The comparison of pre and post test values of Bailey Lovie chart (left side) between experimental group and control group were analyzed. The pre test values of experimental group were, Median (inter quartile range) -1.6(-2.4- -9), mean rank 14.17, sum of ranks 212.5. The pre test values of control group were, Median (inter quartile range) -1.4(-1.9- -0.7), mean rank 16.83, sum or ranks 252.5. The pre test Mann-Whitney *U* value was 92.5, *Z* value was -0.832, *P* value was 0.405 which shows that there is no significant difference in pre test values of Bailey Lovie (left side) between experimental and control groups. The post test values of experimental group were, median (interquartile range) -0.6(-0.8-0.4), mean rank 19.13, sum of ranks 287. The post test values of control group were, median (interquartile range)-1.2(-1.7 - -0.5), mean rank 11.87, sum of ranks 178. The post test Mann-

Whitney *U* value was 58, *Z* value was -2.266; *P* value was 0.023 which shows that there is a statistically significant difference in post-test values of Bailey Lovie chart (left side) between experimental and control groups. Also the result shows that post test value of Bailey Lovie chart (left side) in experimental group is higher than the post test value of Bailey Lovie chart (left side) in control group.

CONCLUSION

Based on the statistical analysis, the result of present study shows that there is a statistically significant difference in the frequency of pre-test and post-test values of experimental and control groups. The experimental group showed more significant reduction in visual acuity problems in subjects with myopia.

Thus the study concludes that the combined efficacy of Bates therapy and ciliary muscle training is more effective in reducing visual acuity problems in subjects with myopia.

Therefore the study rejects null hypothesis and accepts the alternate hypothesis.

Conflict Of Interest: There was no personal or institutional conflict of interest for this study.

Fund of the Study: This was a self funded study.

Ethical Approval: Institutional ethics committee of Bethany Navajeevan College. Ref no: BNCP/N/2021/04

REFERENCES

1. Forrester JV, Dick AD, McMenamin PG, Roberts F, Pearlman E. The eye e-book: basic sciences in practice. Elsevier Health Sciences; 2020 Oct 18.
2. Krishna K, Shaik R. A Comparative Study on the Effects of Vintage Nonpharmacological Techniques in Reducing Myopia (Bates eye exercise therapy vs. Trataka Yoga Kriya).
3. Alrasheed SH, Alghamdi WM. Impact of an educational intervention using the 20/20/20 rule on Computer Vision Syndrome. African Vision and Eye Health. 2020 Jan 1;79(1):1-6.
4. Yin R, Xu J, Wang H, Zhou S, Zhang M, Cai G. Effect of physical activity combined with extra ciliary-muscle training on visual acuity of children aged 10–11. Frontiers in Public Health. 2022 Aug 30; 10:949130.
5. Suresh B, Jadhav V, Naganur VP. Eye Care through Eye Exercise: A Critical Review. Eye. 2022 Mar; 6(3).
6. Teng YK, Chang CW, Lee SD. A Multi-Component Physiotherapeutic Intervention among Schoolchildren with Myopia: 3D-Based Vision Training Program with Auditory Frequency Entrainment and Electrical Stimulation. Applied Sciences. 2021 Dec 25; 12(1):201.
7. Bates WH, Lierman EC. Perfect Sight without Glasses: The Cure of Imperfect Sight By Treatment Without Glasses-Dr. Bates Original, First Book-Natural Vision Improvement (Color Edition). Ophthalmologist William H. Bates; 2021 Jan 16.
8. Umamaheswari R. Effectiveness of Bates Therapy (Ophthalmic Exercises) on Visual Acuity among Elderly People. Pondicherry Journal of Nursing. 2021 Aug 6;14(2):34-6.
9. Mohamed SA. Vision Therapy-Based Program for Myopia Control in Adolescents. Middle-East Journal of Scientific Research. 2013;13(3):390-6.
10. Desai VJ, Alagesan J. Effect of Eye Exercises on Myopia-Randomized Controlled Study.

Journal of Pharmaceutical and Biomedical Sciences (JPBMS).;10(10).
11. Morgan IG, Ohno-Matsui K, Saw SM. Myopia. The Lancet. 2012 May 5;379(9827):1739-48.
12. Saw SM, Chua WH, Hong CY, Wu HM, Chan WY, Chia KS, Stone RA, Tan D. Nearwork in early-onset myopia. Investigative ophthalmology & visual science. 2002 Feb 1;43(2):332-9.
13. Wu PC, Huang HM, Yu HJ, Fang PC, Chen CT. Epidemiology of myopia. The Asia-Pacific Journal of Ophthalmology. 2016 Nov 1;5(6):386-93.
14. Damara S, Ismail A. Sriwijaya Journal of Ophthalmology. Laterality.; 11(12):22-4.
15. Lovie-Kitchin JE. Validity and reliability of visual acuity measurements. Ophthalmic and physiological optics. 1988 Oct; 8(4):363-70.
16. Johnson AT, Dooly CR, Simpson CR. Generating the Snellen chart by computer. Computer Methods and programs in Biomedicine. 1998 Nov 1;57(3):161-6.
17. Holladay JT. Proper method for calculating average visual acuity. Journal of refractive surgery. 1997 Jul 1;13(4):388-91.
18. Vargas V, Radner W, Allan BD, Reinstein DZ, Dick HB, Alió JL. Methods for the study of near, intermediate vision, and accommodation: an overview of subjective and objective approaches. Survey of ophthalmology. 2019 Jan 1;64(1):90-100.
19. Rani P, Raghav D, Khanam KP. Comparison In Effect of Ocular Muscle Exercise With Conventional Treatment in Mechanical Neck Pain with Myopic Individuals.
20. D'Amico DJ. Primary retinal detachment. New England Journal of Medicine. 2008 Nov 27; 359(22):2346-54.
21. Oduntan OA, Mashige KP, Raliavhegwa-Makhado M. A comparison of two methods of logMAR visual acuity data scoring for statistical analysis. African Vision and Eye Health. 2009 Dec 13;68(3):155-63.
22. Strenk SA, Semmlow JL, Strenk LM, Munoz P, Gronlund-Jacob J, DeMarco JK. Age-related changes in human ciliary muscle and lens: a magnetic resonance imaging study. Investigative ophthalmology & visual science. 1999 May 1;40(6):1162-9.
23. Doornaert D, Glorieux C, De Gersem H, Puers R, Spileers W, Blanckaert J. Intraocular electro-optic lens with ciliary muscle controlled accommodation. In2013 35th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC) 2013 Jul 3 (pp. 3190-3193). IEEE.
24. Glücksmann A. Development and differentiation of the tadpole eye. The British journal of ophthalmology. 1940 Apr; 24(4):153.
25. Reeves BC, Wood IM, Hill AR. Reliability of high-and low-contrast letter charts. Ophthalmic and Physiological Optics. 1993 Jan; 13(1):17-26.
26. Evans JA. Standards for visual acuity. Report prepared for Elena Messina, Intelligent Systems Division. National Institute for Standards and Technology, in support of ASTM International Task Group E. 2006; 54.
27. Laidlaw DA, Abbott A, Rosser DA. Development of a clinically feasible log MAR alternative to the Snellen chart: performance of the “compact reduced log MAR” visual acuity chart in amblyopic children. British journal of ophthalmology. 2003 Oct 1; 87(10):1232-4.
28. Fisher RF. The force of contraction of the human ciliary muscle during accommodation. The Journal of physiology. 1977 Aug 1; 270(1):51-74.

29. Adelman RA, Parnes AJ, Sipperley JO, Ducournau D, European Vitreo-Retinal Society (EVRS) Retinal Detachment Study Group. Strategy for the management of complex retinal detachments: the European vitreo-retinal society retinal detachment study report 2. Ophthalmology. 2013 Sep 1; 120(9):1809-13.
30. May CA. Morphologic characteristics of the human ciliary muscle. New Front Ophthalmol. 2017; 3(3):1-6.
31. Flügel-Koch CM, Croft MA, Kaufman PL, Lütjen-Drecoll E. Anteriorly located zonular fibres as a tool for fine regulation in accommodation. Ophthalmic and Physiological Optics. 2016 Jan;36(1):13-20.
32. ZHOU S, ZHOU C, TAN Q, QIU FB, CAI G. Effect of Closed Skills Physical Activity Exercises with Dynamic Visual Task on Visual Function for Pupils with Myopia at Grade Four at Primary School. Chinese Journal of Rehabilitation Theory and Practice. 2020:1383-9.

Jabir S, Ansha Akbar, Parvathy G.M, Arya P.V, Fidha Sidheek, Amina Shajahan (2024). The Combined Efficacy of Bates Therapy And Ciliary Muscle Training On Improvement Of Visual Acuity In Subjects With Myopia , ijmaes; 10(4); 1962-1973.