THE ACCURACY OF SELF-ADJUSTABLE ADLENS AGAINST THE AUTO REFRACTOR RESULTS AND THE EFFECTS OF THESE SPECTACLES ON THE BINOCULAR VISION

[1]Jehangir Daraz, [2]Muneeb Ullah, [3]Sayed Jameel , [*4]Mr. Muhammad Maaz

[1]*Optometrist at Lens & Laser Eye Center, Warsak Road, Peshawar*
[2]*Clinical co-ordinator at Nation's Vision*
[3]*Student of Optometry Technology at Sarhad institute of Allied Health Sciences, SUIT Peshawar.*
[*4]*Assistant Professor at Sarhad institute of Allied Health Sciences, Sarhad University of Science and Information Technology Peshawar*
[1]jehangir9@gmail.com, [2]muneebkhan308@gmail.com, [3]Sayedjameel35@gmail.com,
[*4]maaz.siahs@suit.edu.pk

Corresponding Author: *
Mr. Muhammad Maaz

Abstract

Adlens adjustable eyeglasses are constructed for use as a short term or supplementary pair of glasses. The power of the lenses can be adjusted from -6 to +3 diopters. There were 25 subjects aged between 18 to 35 years. All the participants had refractive errors were between the range of -6 to +3 D. There was no history of any ocular disease in any of the participants. The maximum amount of astigmatism in all the participants was not more than 2 D. Visual acuity was recorded binocularly and monocularly for both eyes. Phoria was measured using Maddox rod for distance and near and fixation disparity was also tested. Autorefraction based prescription was set in a trial frame and visual acuity and binocular tests were carried out in the same way. All the examinations were done randomly and the power of Adlens was assessed using a focimeter. The MSE for the right eye with both methods of refraction had a mean difference of -0.01 with standard deviation of ±0.46. The MSE for the left eye was -0.22 with standard deviation of ±0.43. The mean difference for J0 right eye was -0.03 with ±0.44 SD. The mean difference for J0 left eye was 0.04 with ±0.18 SD. The mean difference of J45 for right eye was -0.14 with ±0.17 SD. J45 left eye mean difference was 0.23 with ±0.19 SD. Similarly, binocular visual acuity mean difference was 0.06 with ±0.07 SD. Mean difference in VA for right eye was 0.05 with ±0.07 SD and for left eye mean difference was 0 and ±0.08 SD. Bland Altman plots were created for all the variables regarding the two methods of refraction with 95% confidence interval.

Introduction:

Adlens adjustable eyeglasses are constructed for use as a short term or supplementary pair of glasses. The Adlensadjustables uses a poly- carbonate lenses that slides over each other to give a power range between -6.00 t0 +3.00 Diopters. It has zero astigmatic power at all spherical power settings and separate power adjustments for both right and left eye to carter the needs of an astigmatic patient. Self-Refraction through adjustable lenses enables patients to gain maximum image sharpness and get a required vision for varying distances. It is identical to refractionwithtriallensesalone,buttheprocessislengthyanddemandsaccurate adjustment. Its success relies on frequency of routine reliable adjustment and caseswherethereisminimalastigmatismpresentasthereisonlyneedofchange in spherical power. These not only enables self-refraction but also provide the treatment. After the final adjustment the patient needs to keep the power of the Adlens fixed and used as corrective eyeglasses Durr, Nicholas J. (2014). AccordingtoRadhakrishnanandHema(2017)therearesomeissuesrelatedto the use of Adlens such as incorrect adjustment of power for the vision which in turncancauseoculardisorders.Myopesarealwaysatgreaterriskofdeveloping ocular pathologies and needs a routine eye examination. Similarly, children and olderpeoplewithdementiaarealsoatagreaterriskofincorrectpoweradjustment which can lead to ocular issues. Self-correction is also unsuitable for children, people with dyslexia, older people and people suffering from dementia.The effects of Adlens self-prescribing on binocular vision is an important factor in the progression and advancement of Adlens as binocular vision produces importantvisualperceptualskillswhichareacornerstoneofnormalhumanvision and enables one to live a normal, healthy and independent life. So far there have been many studies regarding the use of Adlens self-adjustable but unfortunately not much research is done on its effects on binocular vision.According to the estimates of World Health Organization there are almost 150 millionpeoplevisuallyimpairedduetomyopia,hyperopiaorastigmatismoutof which eight million are considered blind. There are almost one billion people affected by presbyopia out of which half does not have any type of visual correction for it. The deficiency of visual correction in these people depends on various factors which includes; high economical costs, infrastructure problems and inaccessibility to optical services. (S Barbero and J Rubinstein (2011).One of the main drawback of the design of Adlens is that it is only possible to achieveaclearvisionataspecificdistanceatlimitedrangeofgazedirectionsas the eye needs to be directed through the desired area of the lens having appropriatecorrectingpower.Ithasbeenadvocatedthatifitwaspossibletomake Adlens with full aperture lenses then the presbyopes could have also adjust the lens for any distance without any limitation of the gaze direction. He also suggested that these lenses have an advantage of correcting a wide range of spherical ametropia which in turn can be beneficial for the people living in the developingcountrieswheretheydonothaveaccesstoeyetestinganddispensing services due to high economic costs and because of limited amount of these facilities. There has been attempts to invent lenses with various combinations of optical,mechanicalandelectricalmethodstochangethelenspoweraccordingto the need. 50 years ago, Alvarez lenses were introduced to carter for this need which includes two closely-spaced components translated laterally with respect to one another. The component in the zero-power position the thickness of the two elements. Radhakrishnan and Hema (2017).

Methodology

There were 25 participants in the study aged between 18-35 years. All these participants were volunteers sourced from friends and colleagues in the university. All the participants were briefed about the research study and procedures involved in the testing. Consent forms were also given to all the participants, which were read, understood and duly signed by them.All the participants were assigned a separate day for their participation in the tests involved in the research study Adlensadjustables were given to each participant and they were made seated at 6metersfromthelogmarchart.Theywereinstructedaboutthewholeprocedure

ofitsadjustment.Theywereaskedtoclosetheirlefteyeandfixatethroughtheir righteyewhilelookingatthelogmarchart.TheAdlensinitialpowerwassetat +3D,toeliminateunwantedaccommodation.AccuratepoweroftheAdlenswas adjusted with the turn of the dial. Similarly, the same procedure was done while lookingthroughthelefteyeandclosingtherighteye.Theywerealsoallowedto go out in the daylight and check whether the adjustment they have done is accurate according to their refractive error.

Focimetry Adlens:

The adjusted power of the Adlens spectacles were assessed using the manual focimeter.Thesphericalpowerwasnoteddownalongwiththecylindricalpower and its axis calculated from power vectors obtained from measurement of the three meridians i.e. 0°, 60° and 120°.

VisualacuitywithAdlens:

Wearing their adjusted Adlens spectacles, the VA was recorded while seated at 6meters from the logmar chart, first binocularly and then for the right eye and then the left eye.

BinocularvisiontestswithAdlens:

TwotypesofBinocularvisiontestswereperformedonthesubjectswearingtheir Adlens spectacles. First, the Maddox rod, was used to subjectively detect and measurealatent,manifest,horizontalorverticalstrabismusfornearanddistance. Similarly,fixationdisparitytestsfordistanceandnearwerealsocarriedoutusing the Mallett UnitFixation Disparity Test wearing polarised glasses on top of Adlens.

Autorefractor:

Objective measurement of each subject refractive error was recorded with the cannon Autorefractor for both eyes. Autorefractor results were noted in the data sheet. Trial lenses were placed in the trial frame based on the prescription of autorefractor were given to wear by each subject.

VisualacuitywithAutorefractor:

Visual acuity was recorded for each subject wearing trial lenses based on autorefractor'sprescription.First,binocularVAwasrecordedaskingthesubject to read the smallest letter visible to them on the logmar chart while sitting at a distanceof6meters.Similarly,VAfortherightandlefteyewasrecordedinthe same way.

BinocularvisiontestswithAutorefractorbasedprescription:

TwotypesofBinocularvisiontestswereperformedonthesubjectswearingtrial framewithlensesbasedontheirautorefractionbasedprescription.First,the Maddox rod, was used to subjectively detect and measure a latent, manifest, horizontal or vertical strabismusfor near and distance. Similarly, fixation disparitytestsfordistanceandnearwerealsocarriedoutusingtheMallett Unit Fixation Disparity Test wearing polarised glasses on top of the trial lens.

All the results were recorded on a separate data sheet with the initials of each subject's name.

Power vectors:

AllthedatafromtheSRandARwasconvertedtothepowervectornotationand was analysed for the three components i.e. MSE, J0 and J45.

Theformulaeusedforallthethreecomponentswereasfollowing:

MSE= +(A3+(B3+0.000001)/2)

J0=-(B3+0.000001)/2*COS(C3*2*PI()/180) J45=-(B3+0.000001)/2*SIN(C3*2*PI()/180)

In the above formulae A3 refers to the spherical power, B3 refers to the cylindricalpowerandC3referstotheaxisofthefirstsubject.Thesamemethod ofconversiontopowervectorswasappliedonthedataofallthesubjectsandfor both eyes separately.

Results:

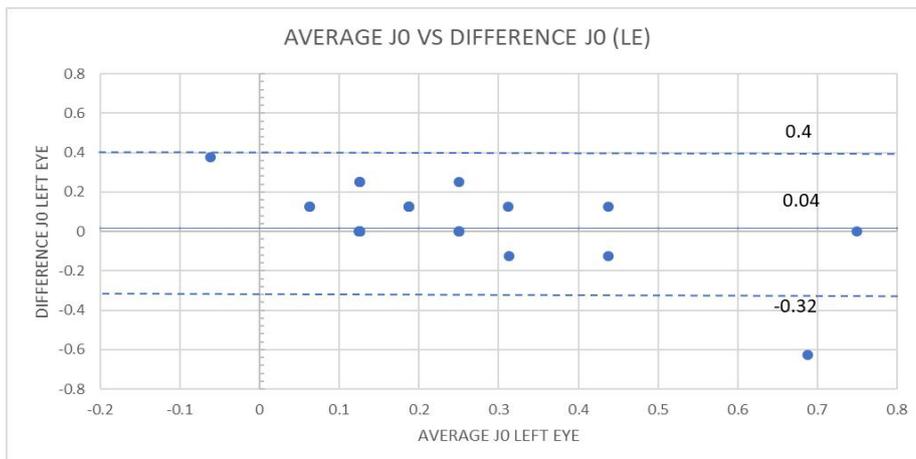**Fig1: Bland-Altman plot of the data obtained from the comparison of Average J0 and difference in J0 left eye. Correlation R=0.6090 (P<0.01). Slope=-0.6022 (P<0.01). Intercept=-0.1819 (P<0.01).**

The regression of Average J0 and difference in J0 left eye shows that the correlation coefficient R is equal 0.6090 with P<0.05, which shows that there is asignificantdifferencebetweenthetwovariables.Similarly,theslopeisequalto-0.6022withP<0.05alsoshowsasignificantdifference.Theinterceptisequalto -0.1819, P<0.05.

**Fig2: Bland-Altman plot of the data obtained from the comparison of Average J45 and difference in J45 right eye. Correlation R=0.1877 (P=0.36). Slope=0.2874 (P=0.36).**
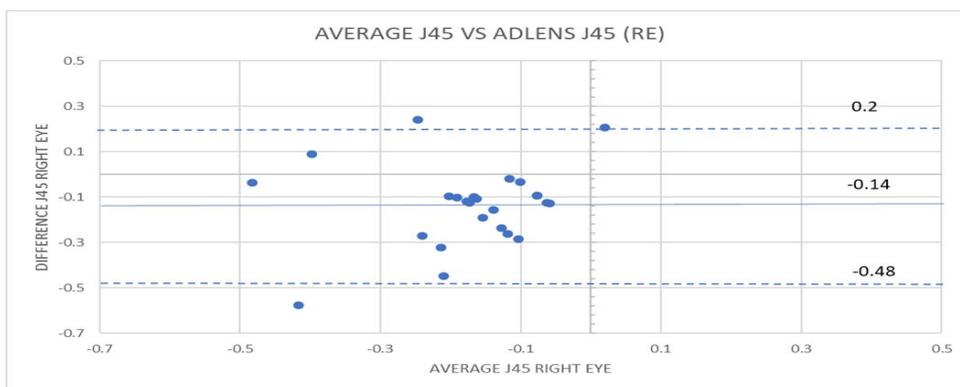
Intercept=-0.0849 (P=0.20).

The regression of Average J45 and difference in J45 right eye shows that the correlation coefficient R is equal 0.1877 with P>0.05, which shows that there is no significant difference between the two variables. Similarly, the slope is equal to0.2847withP>0.05alsoshowsnosignificantdifference.Theinterceptisequal to -0.0849, P>0.05.

Fig3:ScatterplotshowingcorrelationbetweenAutorefractorJ45andAdlensJ45forthe right eye.
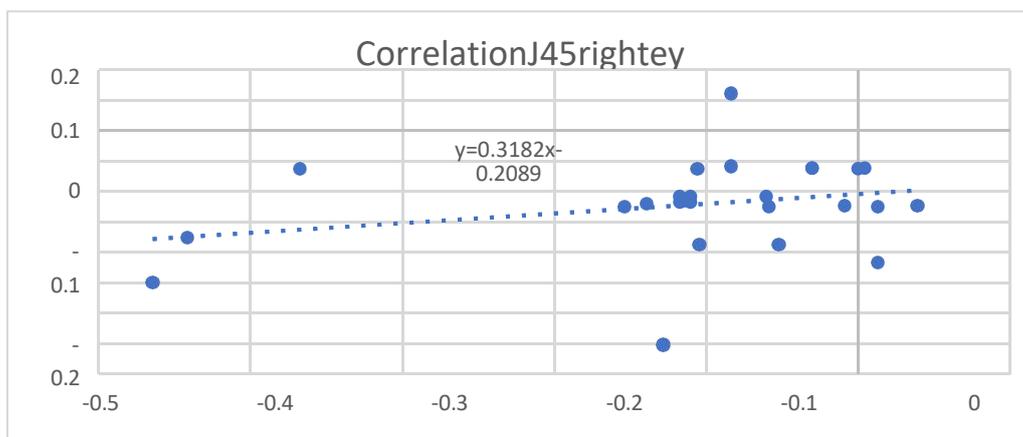
Both the variables show a positive correlation and the data is evenly distributed along the trendline. The coefficient of determination R² value for the correlation between J45 of the two methods for right eye is 0.0702, which shows the goodness of fit of the data.
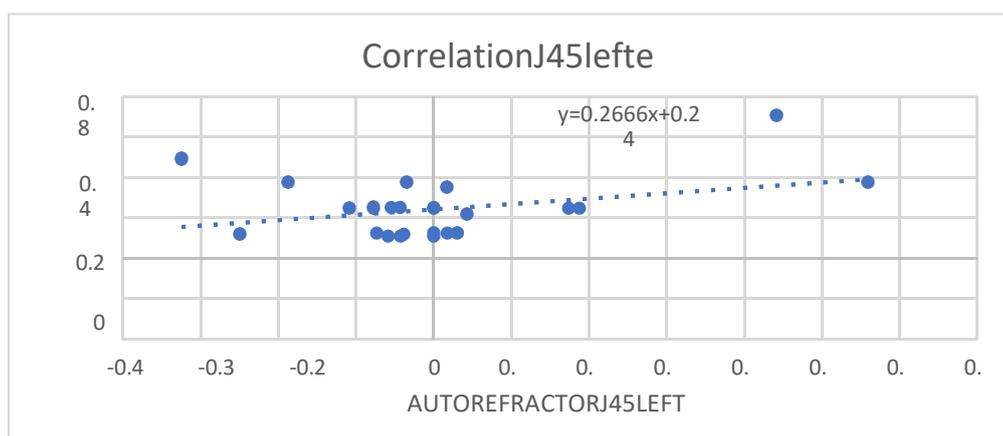

Fig4: Scatter plot showing correlation between Autorefractor J45 and Adlens J45 for the left eye.

Both the variables show a positive correlation and the data is evenly distributed along the trendline. The coefficient of determination R² value for the correlation betweenJ45ofthetwomethodsforlefteyeis0.1163,whichshowsthegoodness of fit of the data.
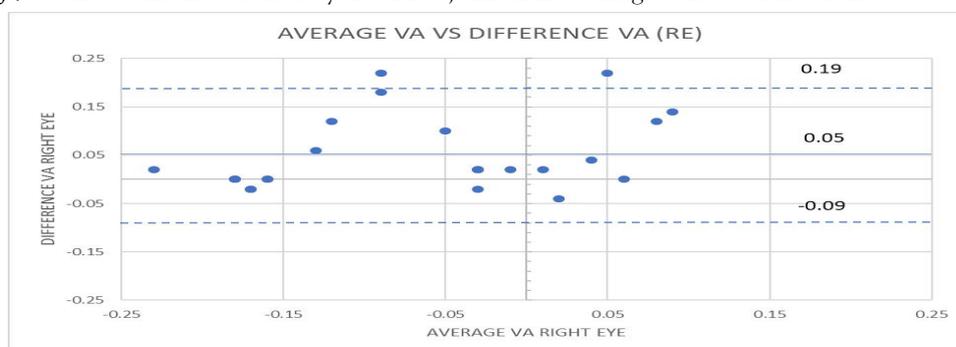

Fig5: Bland-Altman plot of the data obtained from the comparison of Average VA and difference in VA right eye. Correlation R=0.3101 (P=0.13). Slope=0.2453 (P=0.13). Intercept=0.0654 (P<0.01).

Regression of average VA and difference in VA right eye, shows that the correlation coefficient R is equal 0.3101 with P>0.05, which shows that there is no significant difference between the two variables. Similarly, the slope is equal to0.2453withP>0.05alsoshowsnosignificantdifference.Theinterceptisequal to 0.0654, P<0.05.

Fig6: Bland-Altman plot of the data obtained from the comparison of Average VA and
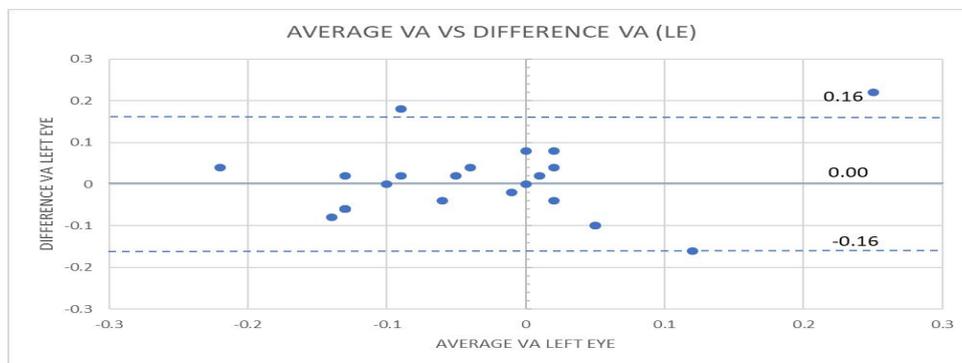
difference in VA left eye. Correlation R=0.2195 (P=0.29). Slope=0.1852 (P=0.29). Intercept=0.0046 (P=0.80).

Discussion

Various studies regarding the self-correction of refractive errors are mainly interested in the measurement of spherical equivalent error and do not focus on the assessment of the astigmatic error and its axis. In this study the spherocylindrical refractive errors of the eye were assessed using self-refraction methodusingAdlensandautomatedrefractionusingAutorefractors.Theresults of both methods were further converted into power vector notation and the final results were analysed using excel. Out of 25 subjects only 3 subjects had astigmatismofmorethan1D,whereonesubjecthadMSEof-4.625Dintheright eye and -4.5D in the left eye with autorefraction. The MSE for the same subject withAdlenswas-3.125intherightandlefteyeboth.Thisspecificsubjecthada sphericalerrorof-7and-7.5intherightandlefteyerespectivelyandastigmatism of2Dinbotheyes.Apartfromthesethreesubjects,theresultsofallthesubjects showed good correlation with both methods of refraction and each subject achieved a visual acuity of ≤0.00 on the logmar scale except the subjects with astigmatism of more than 1D and also due to incorrect adjustment of the Adlens self-adjustable glasses. The MSE for self-refraction and autorefraction did not differfromeachotherexceptinthreecaseswheretherewasaveryhighrefractive error which was beyond the capacity of the Adlens and also due to Astigmatism of more than 1D which was an issue in only three cases.The results of the binocular vision tests with autorefraction and Adlens self- adjustable glasses which were carried out on all subjects did not show any difference with respect to each other. The results of phoria for distance and near with both autorefraction and Adlens self-adjustables did not have a significant differenceexceptforthethreesubjectsthatwerehavingastigmatismofmorethan 1D and also in the one specific subject who had a refractive error of more than - 6D. As far as fixation disparity is concerned, the results with both the refraction methods were similar and were not affected with the use of either theself- refraction prescription or the autorefraction prescription.

Limitations of the study:

The sample size in this study was small as the data was only taken from 25 subjects. The refractive error of most of the participants in this study was minimal.

Conclusion

TheresultssuggestthatAdlensself-adjustablesdoesnothaveanyadverseeffects on the binocular vision of the user. It is also indicated that the visual acuity can be improved using Adlens self-adjustable glasses. Though visual acuities can be improved it is still not possible to say whether such positive results will remain the same for all the users for alonger period of

time.Thereisdireneedoffurther investigation in this regard where higher refractive errors and astigmatism of up to 2D is present. Similarly, contrast sensitivity andother binocular tests can also give good outcome about its use. It is also deduced that Adlens which works on Alvarez principle have constant spherical power and good image quality throughoutwhichmightdecreaseduetodistancefromopticalcentreandifsome astigmatism is present.

References

2014.Adlenslaunchesvariable-focuseyewearwithimprovedoptics.(Briefarticle)**39(4)**,pp.37. 2014. Adlens Lenses that adjust to change power in glasses. *Business Today.*

Spec savers? The glasses that can change prescription | Business [viewed 11/23/2017]. Available from: about:reader?url=https://www.theguardian.com/business/2015/mar/15/spec-savers-one-pair-of-glasses-comes-into-view.

To adjust or not to adjust [viewed 11/22/2017].Available from: about:reader?url=https://www.aop.org.uk/ot/science-and-vision/technology/2016/08/18/to-adjust-or-not-to-adjust.

Barbero,Sergio&Rubinstein,J.(2011).Adjustable-focuslensesbasedontheAlvarezprinciple. *JournalofOptics*.13.10.1088/2040-8978/13/12/125705.

DOUALI, M.G. and SILVER, J.D., 2004. Self-optimized vision correction with adaptive spectacllensesindevelopingcountries.*Ophthalmic&PhysiologicalOptics:TheJournaloftheBritishCollege ofOphthalmic Opticians (Optometrists).* **24**(3), pp. 234.

GAJWANI, P., et al., 2018. Autorefraction-Based Prescription and Mailed Delivery of Eyeglasses. *Ophthalmology.* **125**(1), pp. 137-138.

GUDLAVALLETI,V.S.M.,ALLAGH,K.P.andGUDLAVALLETI,A.S.V.,2014.Self-adjustableglassesin the developing world. *Clinical Ophthalmology (Auckland, N.Z.).* **8** pp. 405-413.

HE, M., et al., 2011. The Child Self-Refraction Study: Results from Urban Chinese Children in Guangzhou. *Ophthalmology.* **118**(6), pp. 1162-1169.

LEUBE, A., KRAFT, C., OHLENDORF, A. and WAHL, S., 2018. Self‑assessment of refractive errorsusing a simple optical approach. *Clinical and Experimental Optometry.* **101**(3), pp. 386-391.

MILLER,M.,J.,2009.ClinicalApplicationsofPowerVectors.*OptometryandVisionScience*.**86**(6),pp.599-602.

POINTER,J.S.,2012.TheinterpupillarydistanceinadultCaucasiansubjects,withreferenceto 'readymade'readingspectaclecentration.*OphthalmicandPhysiologicalOptics.***32**(4),pp.324-331.

RADHAKRISHNAN, H. and CHARMAN, W.N., 2017. Optical characteristics of Alvarez variable-power spectacles. (Report). *Ophthalmic and Physiological Optics.* **37**(3), pp. 284.

REMÓN, L., MONSORIU, J.A. and FURLAN, W.D., 2017. Influence of different types of astigmatism on visual acuity. *Journal of Optometry.* **10**(3), pp. 141-148.