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Original article

Cycloplegic influence on the accuracy of autorefractometer in myopic and hyperopic children

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Abstract

Objective: To investigate the cycloplegic effect on the accuracy of TOPCON AR RM-8000B autorefractometer in children. **Materials and methods :** This study included 219 children of age 3 to 16 years. Topical 1% cyclopentolate hydrochloride was instilled for attaining cycloplegia. The children with the refractive error of –0.75 Diopter or more were grouped as myopic and more than +1.00 Diopter as hyperopic. Autorefraction was performed in addition to manual refraction. We used the XLSTAT and Medcalc statistics software. **Results:** Out of 219 children, 149 (68%) were emmetropic, 48 (22%) hyperopic and 22 (10%) myopic (n=70). Males and females constituted 29 (60.42%) and 19 (39.58%) respectively in hyperopic group where as 11 (54.55%) and 9 (45.45%) children were myopic. The means of ages of the children were 10.29 (+/- 2.96) and 13.14 (+/- 2.36) years in hyperopic and myopic groups respectively. Cycloplegic hyperopic and myopic autorefraction revealed mean sphere of +1.45 and -4.06 diopter with correlation coefficient of 0.95 and 0.99 respectively. Non-cycloplegic hyperopic autorefraction showed 74.2% sensitivity and 8.3% specificity at >-1 diopter with area under curve of 0.517 (p<0.0001). Cycloplegic hyperopic autorefraction showed 100% sensitivity and 97.1% specificity at >+1.85 diopter with accuracy of 0.616. Non-cycloplegic myopic autorefraction showed 100% sensitivity and 0.91% specificity at >-0.75 diopter with accuracy of 0.889. Cycloplegic myopic autorefraction showed 100% sensitivity and specificity at >-1.25 diopter with perfect accuracy. **Conclusion:** Non-cycloplegic hyperopic autorefraction failed to identify true negative cases. Cycloplegic autorefraction identified true positive cases and myopic autorefraction was relatively unaffected by cycloplegia.

Introduction

Cycloplegic refraction is often performed in children to detect full refractive errors as accommodation interferes with retinoscopy. Overall prevalence of childhood refractive errors reported was 7.7%, with 13.2% hyperopic and 5% myopic in Malaysia, and 15.7% prevalence rate at 6 years and 6.8% at 12 years of age reported in Caucasian ethnicity (Hashim SE et al, 2008; Ip JM1 et al, 2008). Prevalence of myopia and hyperopic reported as 1.4% and 6% in 12-13 years of age out of 1035 children studied from a metropolitan city in Mexico (Villarreal GM et al, 2003). Sapkota YD et al,2008 studied 4501 children

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and reported 93.3% as visually impaired. This study revealed predisposition of urban children for refractive errors taking into account of their school grading levels, female gender, parental education, parental spectacle usage and Mongol ethnicity. Authors also reported 46.3% children with uncorrected refractive errors that propounded as public health importance. Previous study reported 2.5 % Myopic and 6% hyperopic prevalence respectively in 2480 children(Lan W et al, 2013).

Traditional cycloplegic refraction offers acceptable objective method of determination of refractive status in children. However, due to time consumption, autorefractors are employed for ease of obtaining faster refraction readings. Previous study of non-cycloplegic autorefraction (NCA) in children between 7 and 18 years yielded high inaccurate readings (Zhao J et al, 2004). Non-cycloplegic refraction and subjective retinoscopy performed in 6 to 13 year children showed accurate correlation. NCA displayed a drift towards minus over-correction however; accurate readings were obtained after cycloplegic refraction (Funarunart P1 et al, 2009; Choong YF et al, 2006). Pediatric plusoptiX autorefractor revealed a low success rate of 50% and not useful for routine refraction assessment (Schmidt-Bacher AE et al, 2010). Autorefractors employed as screening equipment in children to assess magnitude of the problem but true refraction revealed after cycloplegia (Steele G et al, 2003).

Cycloplegic refraction in children is time consuming and causes transient visual disability that interferes with their academic performance. Therefore we investigated whether cycloplegia has any effect on accuracy of autorefraction and compared with cycloplegic manual refraction. Further we analyzed non-cycloplegic and cycloplegic refraction,the results of which could provide an idea regarding faster spectacle prescription in addition to prevention of transient visual disability and cyclopentolate induced side effects. This study aims at investigating effect of cycloplegia on accuracy and predictability of TOPCON AR RM-8000B autorefractometer in hyperopic and myopic children between 3 and 16 years of age.

Materials and methods

Present study is a cross sectional validity test that investigated gold standard cycloplegic refraction and the test under scrutiny was non-cycloplegic autorefraction. Present study was prospective clinical investigation conducted in Ophthalmology outpatient department of a tertiary hospital between October 2011 and April 2013. Permission granted from the Institutional ethical committee for pursuing the study. Informed consent obtained from all the parents of children. The method followed according to standard study protocol. Children were included as they present to the ophthalmic outpatient department on first cum first serve basis with asthenopic symptoms although randomization not done.

Following method followed for inclusion and exclusion criteria. Children were grouped into emmetropic, hyperopic, and myopic based on cycloplegic manual refraction (MR). Children with or more than -0.75 diopter and +1.00 diopter or more considered as myopic and hyperopic respectively. Emmetropic children less than -0.75 diopters and less than +1.00 diopters excluded from the study. Astigmatism more than +/-1.50 diopter, corneal pathology, ocular surface problems, strabismus, anterior and posterior segment anomalies excluded.

A detailed ophthalmological evaluation consisted of recording best-corrected spectacle visual acuity by Snellens test types at 6 meters distance. Ductional and versional ocular movements tested with pencil in cardinal positions of gaze. Haag-streit Slit lamp biomicroscope examination performed to evaluate anterior segment structure. Dilated detailed fundoscope examination performed by Walsh Allyn direct ophthalmoscope.

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Children were instructed to place chin in the chin rest compartment of autorefractor with head positioned straight. It is important to attain coaxial alignment of subject's fixation and the instrument axis. Off-axis measurements could lead to erroneous refraction readings. Central target comprised of red colored house and greenery on both sides with blue sky above, mounted in TOPCON AR RM-8000B autorefractometer. The device has auto-fogging technology incorporated within the instrument to relax accommodation especially in children. In performing a routine conventional retinoscopy, fellow eye is usually fogged with a low strength convex lens (+0.75 D to +1.50 Diopter) to prevent play of accommodation. Careful attention needed with use of higher strengths of convex lens that may act as stimulus and actually trigger accommodation rather than relaxing accommodation. All refractors use fogging technology to avoid accommodation prior to objective refraction. Elderly children experience target blur which is the effect induced by auto fogging mechanisms. Auto fogging system consists of a target placed at (at the end of the highway) infinity within the autorefractors so that children do not accommodate. Prevention of accommodation and enhancing the accuracy of objective refraction by autorefractometry are the advantages. Using sine-squared function, the system measures refractive power of eye in three meridians given by the formula sphere+ (cylinder x sine2θ). An average of five readings obtained from TOPCON AR RM-8000B auto refractometer before and after cycloplegia.

Children were requested to seat at 6-meter distance from Snellens visual acuity chart. Dynamic retinoscopy performed at a distance of 60 cm from the subject by spot retinoscope method (plane mirror). Pupillary reflexes studied in all meridians quickly to check for accommodation. Children asked to look at 6/60 top letter in Snellens chart and then to look at retinoscope mirror light. While they

are doing so pupillary reflexes studied briefly and quickly for any change in accommodation since children are efficient accommodators. Working distance of 60 cm between subject and examiner was maintained by fixing one end of the metallic tape to retinoscope mirror and the other end of tape held near the lateral orbital rim. Then children were requested to fixate at the retinoscope mirror light that served as a target under mesoptic conditions of illumination. Plus spherical lenses used if the reflex is 'with the motion' and minus spherical lens if the reflex exhibits 'against the motion' to achieve neutralization. Working distance of -1.66 diopter subtracted from retinoscope reading that achieved neutralization point.

Visual acuity by Snellen's chart recorded after autorefraction and manual refraction before cycloplegia to prevent stimulation of accommodation. Hyperopic children who were emmetropic before cycloplegia and revealed an error of +1.00 diopter or more after cycloplegia were classified under hyperopia. Children were instilled 1% cyclopentolate eye drops every 15 minutes for three times that achieved cycloplegia in 45 minutes. Complete cycloplegia checked on failure to appreciate N36 letter distinctly in the Jaegers near vision chart. RAF rule usually used to measure punctum proximum of accommodation that is not employed in the current study.

MedCalc software and XL statistics used for statistical analysis process. We compared two methods by drawing ROC (receiver operating characteristic) graphs for accuracy by calculating area under curve (AUC) and true positive rate against false positive rate for different possible cut points. Regression analysis for prediction and forecasting the results of two methods by regression equation y=a+bx and bland-Altman difference plots for analyzing good agreement between two methods. Sensitivity, specificity, positive and negative predictive values with false positive and false negative calculated.

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Results

Two hundred and twenty five children between 3 to 16 years of age recruited. Out of 225 children sample size, six children did not turn up for cycloplegic refraction due to their busy academic schedule and therefore the children under investigation were 219. Seventy (31.96%) ammetropic children studied with 149 (68.04%) emmetropic out of 219-chort group. Forty-eight (21.92%) were hyperopic and 22 (10.05%) myopic. Hyperopic males were 29 (13.24%) and hyperopic females were 19 (8.68%). Myopic males were 11 (5.02%) and myopic females 9 (4.11%). Hyperopic mean age of 10.29 (+/- 2.96) and myopic mean age of 13.14 (+/- 2.36) years found. Mean age of hyperopic males and females was 10.54 (+/- 2.38 and 11.48 (+/-2.86) respectively. Mean age of myopic males and females was 13.46 (+/-2.66) and 13.94 (+/-2.76) respectively. The incident of hyperopia and myopia in urban children was 11.9% (26 children) and 6.40% (14 children) vs. 10.05% (22) children and 3.65% (8 children) in rural areas.

Categorization of ammetropia done based on cycloplegic traditional retinoscopy. Refraction readings at or > +1.00 diopter and at or > -0.75 diopter defined as hyperopic and myopia respectively. Autorefraction and cycloplegic traditional refraction performed by ophthalmologist and assigned optometrist respectively with separate data entry files to minimize observers' bias. Right eyes studies for the convenience of statistical analysis. Statistical significance considered if p values less than 0.05. Autorefraction is less reliable in children due to interference of accommodation. Hence there are more chances of diagnosing false positive cases than false negative and vice versa. If our hypothesis is widely accepted as true, i.e., the results of autorefraction and manual refraction with or without cycloplegia is the same, then there must be high degree of evidence in favor of rejecting the null hypothesis. In these circumstances much smaller degree of p values may be selected than the commonly used alpha values.

Mean sphere, +/- standard deviation (SD), standard error of the mean (SEM), Pearson correlation coefficient (r), coefficient of determination (R2), confidence intervals and exact p values for hyperopic and myopic autorefraction shown before and after cycloplegia Table 1. Descriptive statistics of cycloplegic effect for hyperopic and myopic autorefraction compared with cycloplegic manual refraction shown in Table 2. Regression and Bland-Altman analysis for hyperopic and myopic autorefraction before and after cycloplegia compared. Table 3 Regression and Bland-Altman analysis of cycloplegic effect of hyperopic and myopic autorefraction compared with cycloplegic manual refraction shown in Table 4.

Non-cycloplegic hyperopic autorefraction revealed sensitivity of 74.2% and specificity of 8.3% with positive predictive value (PPV) of 91% and negative predictive value (NPV) of 9% with 9% false positive and negative cases at -1.00 diopters cut point value. Cycloplegic hyperopic autorefraction showed 100% sensitivity and 97.1% specificity at +1.85 diopters cut off point with PPV of 52% and NPV of 48% with 48% false positive and 52% false negative cases.

Non-cycloplegic myopic AR showed sensitivity of 100% and specificity of 0.91% with PPV of 100% with no false positive cases and NPV of 8% with 9% false negative cases at >-0.75 diopters cutoff point. Cycloplegic myopic AR revealed 100% sensitivity and specificity at >-1.25 diopter cut point value with PPV of 53% with 47% false negative cases and NPV of 48% with 52% false negative cases.

Accuracy of autorefraction readings determined by calculating area under the curve (AUC) of receiver operator characteristic (ROC) in hyperopia(Fig. 1 & 2) and myopia(Fig. 7 & 8).

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Linear regression analysis performed to find out the best-fit model curve and relationship of autorefraction and manual refraction in hyperopic (Fig. 3 & 4) and myopic children (Fig. 9 & 10). Bland-Altman analysis used to find out the limits of agreement (LOA) at 95% confidence intervals (CI) for autorefraction and manual refraction in hyperopic (Fig. 5 & 6) and myopic children. (Fig. 11 & 12)

Table 1: Descriptive statistics of autorefraction before and after cycloplegia

Descriptive statistics	Hyperopic (n=48)		Myopic (n=22)	
Variables	Non-cycloplegic AR	Cycloplegic AR	Non-cycloplegic AR	Cycloplegic AR
Mean (+/- Standard Deviation)	-0.004 (1.70)	1.45 (1.49)	-4.52 (4.11)	-4.06 (3.83)
Standard error of the mean (SEM)	0.25	0.21	0.88	0.82
95% Confidence intervals (CI)	-0.50 to 0.49	1.02 to 1.89	-6.34 to -2.70	-5.76 to -2.36
Pearson correlation coefficient (r)	0.89	0.89	0.99	0.99
Exact p values	<0.0001	<0.0001	0.0006	0.0017

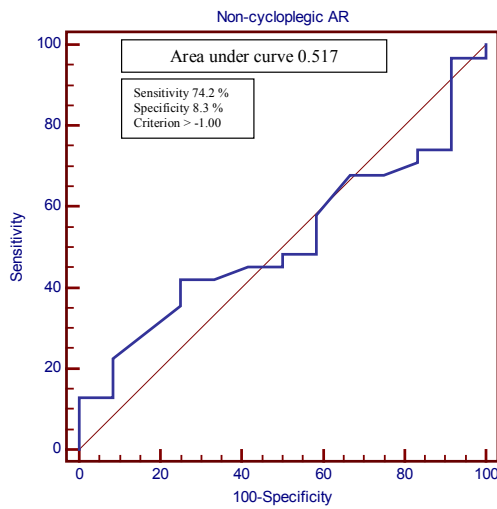**Table 2: Descriptive statistics of autorefraction and manual refraction after cycloplegia**

Descriptive statistics	Hyperopic (n=48)		Myopic (n=22)	
Variables	Cyclopegic AR	Cycloplegic MR	Cycloplegic AR	Cycloplegic MR
Mean (+/-Standard Deviation)	1.45 (1.49)	1.23 (1.15)	-4.06 (3.83)	-4.22 (3.87)
Standard error of the mean (SEM)	0.21	0.17	0.82	0.82
Confidence intervals (CI)	1.02 to 1.89	0.90 to 1.56	-5.76 to -2.36	-5.95 to -2.51
Pearson correlation coefficient ®	0.95	0.95	0.996	0.996
Exact p values	<0.0001	<0.0001	0.0017	0.0011

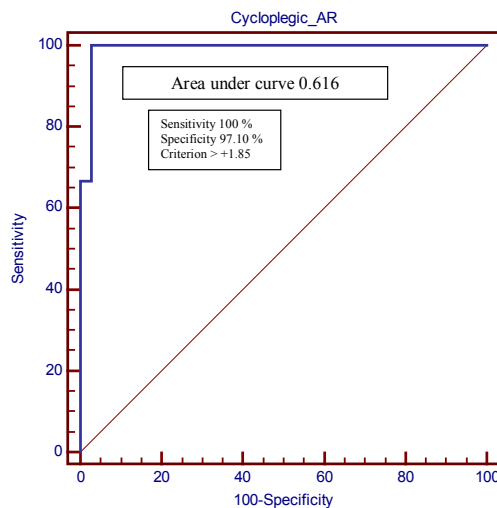**Table 3: Regression and Bland-Altman analysis of autorefraction before and after cycloplegia**

Descriptive statistics	Hyperopic (n=48)	Myopic (n=22)
Variables	Non-cycloplegic and cycloplegic AR	Non-cycloplegic and cycloplegic AR
Slope (b)	1.01	1.06
Prediction interval (a)	-1.80 to -1.15	-0.54 to 0.14
Coefficient of determination (R^2)	0.786	0.985
Regression equation y= a+bx	y = -1.4717 + 1.0128 x	y = -0.2022 + 1.0633 x
Limits of agreement Bland-Altman	0.09 to -2.99	0.64 to-1.56
Area under curve (AUC)	0.0.517	0.889
Exact p value	<0.0001	<0.0001

**Table 4: Regression and Bland-Altman analysis of autorefraction and manual refraction under cycloplegia**

Descriptive statistics	Hyperopic (n=48)	Myopic (n=22)
Variables	Cycloplegic AR and MR	Cycloplegic AR and MR
Slope (b)	1.22	0.99
Prediction interval (a)	-0.29 to 0.15	-0.10 to 0.32
Coefficient of determination (R^2)	0.899	0.994
Regression equation y= a+bx	y = -0.05334 + 1.2231 x	y = 0.1142 + 0.9878 x
Limits of agreement Bland-Altman	-0.83 to 1.27	-0.43 to 0.77
Area under curve (AUC)	0.616	1.00
Exact p value	<0.0001	<0.0001

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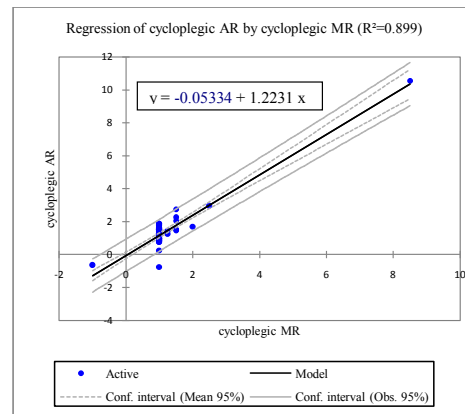*Nepal J Ophthalmol 2015;7(14): 148-158*

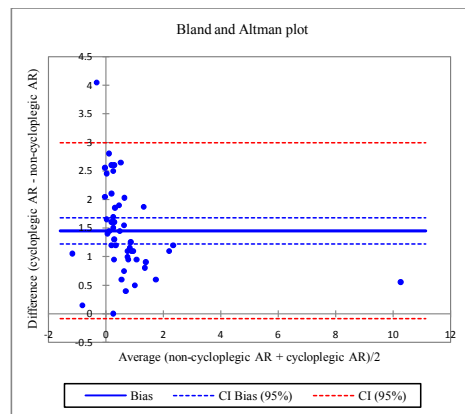**Figure 1:** ROC curve analysis of non-cycloplegic hyperopic autorefraction

Figure 2: ROC curve analysis of cycloplegic hyperopic autorefraction
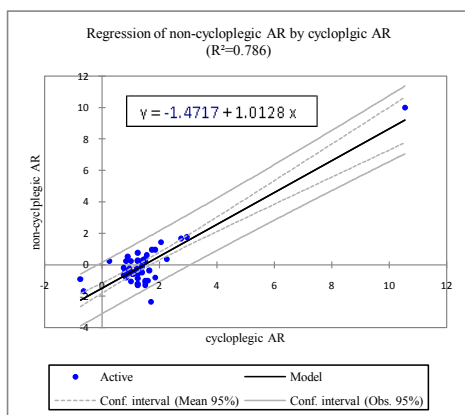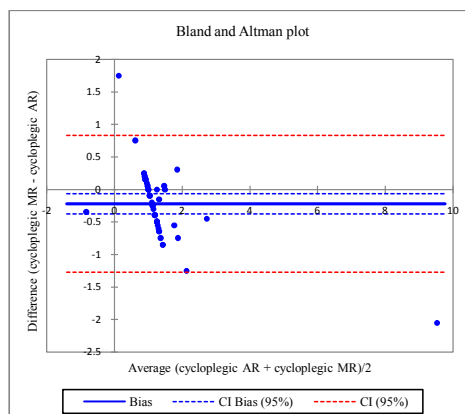

Figure 3: Regression analysis of non-cycloplegic autorefraction by cycloplegic autorefraction in hyperopic children
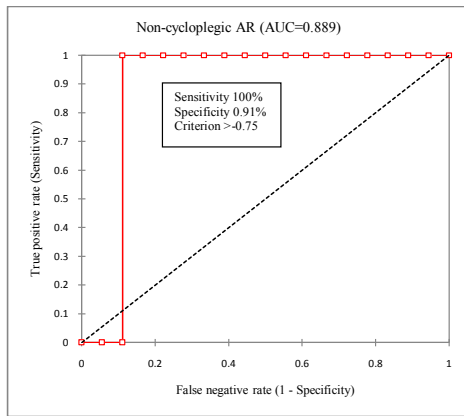

Figure 4: Regression analysis of cycloplegic autorefraction by cycloplegic manual refraction in hyperopic children
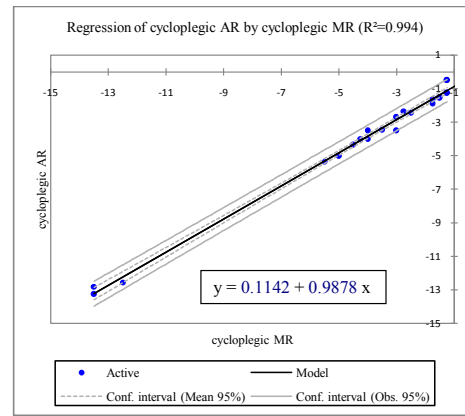

Figure 5: Difference plots of non-cycloplegic hyperopic autorefraction versus cycloplegic autorefraction
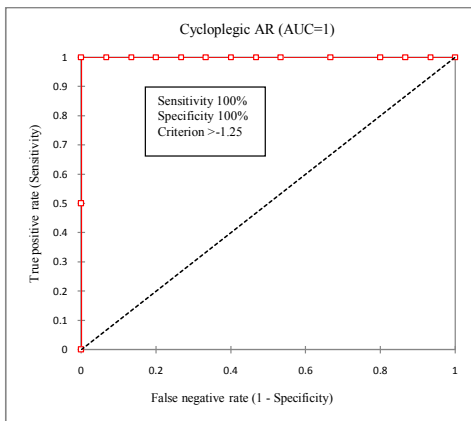

Figure 6: Difference plot of cycloplegic hyperopic autorefraction versus cycloplegic manual refraction
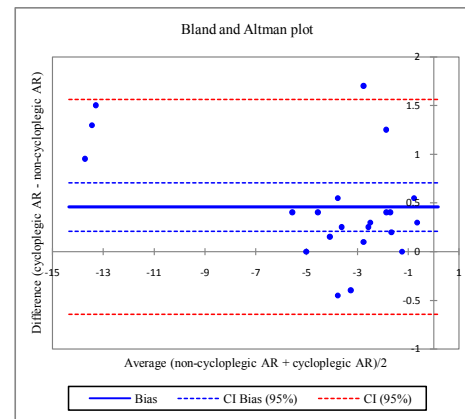
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Figure 7: ROC curve analysis of non-cycloplegic myopic autorefraction

Figure 8: ROC curve analysis of non-cycloplegic myopic autorefraction

Figure 9: Regression analysis of non-cycloplegic autorefraction by cycloplegic autorefraction in myopic children
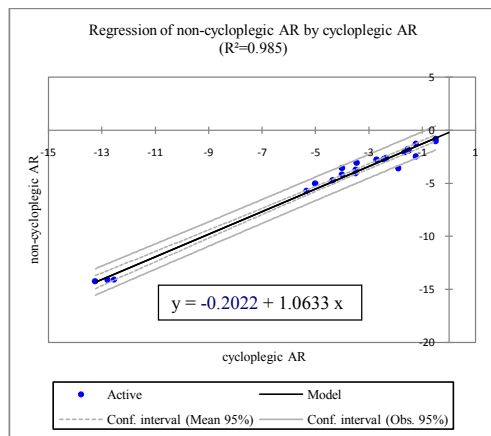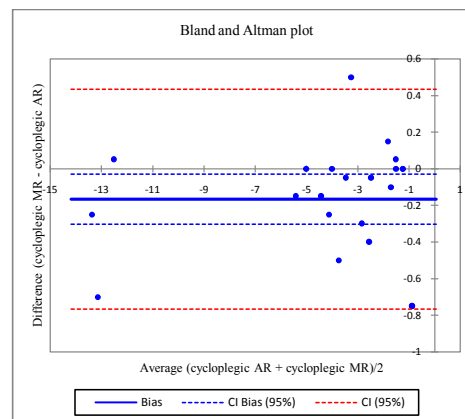

Figure 10: Regression analysis of cycloplegic autorefraction by manual refraction in myopic children

Figure 11: Difference plots of non-cycloplegic myopic autorefraction versus cycloplegic autorefraction

Figure 12: Difference plots of cycloplegic autorefraction versus cycloplegic manual refraction in myopic children

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Discussion

Present study investigated cycloplegic influence on autorefraction and traditional refraction that was conducted in 219 ammetropic children. Mean myopic age was higher in the present study compared to previous study among children between 8 and 13 years (10.9+/-1.42) (Tang WC et al, 2014) probably to cycloplegic refraction that picked up true positive cases. Calculated standard deviation was more than half of mean sphere in hyperopic and myopic groups due to presence of outliers. There was one child with +8.5 diopters of hyperopic error and two children with -13.5 diopters and one child with 12.5 diopters myopic error. Boys outnumbered girls in both hyperopic and myopic group.

Cycloplegic AR recorded hyperopic error in plus sphere compared to non-cycloplegic minus spherical reading with statistical significance. Statistical significance not found with non-cycloplegic and cycloplegic AR in myopia. However when cycloplegic AR and MR compared in hyperopics yielded similar hyperopic error with statistical significance. There was no statistical significance found with cycloplegic AR and MR in myopics.

Very low accuracy of non cycloplegic AR found in hyperopic children when compared with high accuracy measured in myopics by non-cycloplegic method. Accuracy of cycloplegic AR improved as measured by area under curve in hyperopics in addition to 100% accuracy found in myopic children. Both the methods showed high statistical significance. Interpretation of outcomes reported first for hyperopic autorefraction followed by myopic autorefraction.

Interpretation of results in hyperopia
Significant variation in the spherical component observed under non-cycloplegic and cycloplegic effect by two methods comparable to previous research works (Salvesen S et al, 1991). There was good correlation of measurements in both situations comparable to values obtained with the use of HARK autorefractor in children (Isenberg SJ et al, 2001). Pearson correlation coefficient increased after cycloplegia suggesting excellent correlation of two methods. Cycloplegic autorefraction slightly over estimated hyperopic error compared to cycloplegic manual refraction. Smaller SEM values suggested similar performance of both methods under cycloplegic effect. From previous study, cycloplegic analysis of Topcon RM-A 6000, Nidek AR 800 or Nikon NR 5000 performed similarly when tested in infants (Cordonnier M et al, 1998).

ROC curve analysis
Very low specificity rates in addition to very low accuracy rates in ROC curve implied that non-cycloplegic AR failed to identify true negative cases although PPV and NPV was in acceptable range (Fig. 1). Cycloplegic hyperopic AR correctly and equally identified true positive and negative cases. Sensitivity and specificity rates of cycloplegic autorefraction seem to correlate with non-cycloplegic measurements of retinomax handheld infrared autorefractor that revealed 70.2% sensitivity and 94.6% specificity at manifest threshold of +1.5 Diopter implying reliability of retinomax autorefractometer (Cordonnier M et al, 1998). (Fig. 2)

Regression and limits of agreement analysis
Predictive intervals by regression analysis and Bland-Altman plots showed wider variation despite high determination of coefficient (R^2), hence the two methods could not be interchangeable or replaceable (Kinge B et al, 1996). When independent variable x rose to zero, dependant y equaled to -1.47 diopter. That means, cycloplegic refraction of +0.5 diopter would result in approximately -1.00 diopter of hyperopic error before cycloplegia in the predictable equation. (Fig 3)

Regression analysis and Bland-Altman analysis of cycloplegic AR and MR revealed an acceptable range of predictable intervals

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and good limits of agreement. Hence, both the methods could be interchangeable or replaceable under cycloplegic effect. Predictability of cycloplegic AR and MR exhibited similar results with dependant variable y becoming -0.05 diopter when independent variable x rose to zero diopter. That means, when x is +0.50 diopter, predictability of autorefractometer calculated was +0.56 diopter. Single point on right upper end of regression graph is an outlier due to high hyperopic error in one child.(Fig 4)

Bland-Altman plots revealed good limits of agreement as more than 95% of data points distributed within the limits with two outliers for AR before and after cycloplegia. The difference plots for cycloplegic AR and MR revealed similar results with two outliers outside 95% limits. Overestimation or underestimation of values observed when all data points distributed either above or below bias line, not found in the present study (Fig. 5 & 6). Due to low accuracy of dry autorefraction in hyperopic, the accuracy improved with cycloplegic autorefraction taking into account of accommodation as concluded from the previous study (Salvesen S et al, 1991).

Interpretation of results in myopia
ROC curve analysis
Non-cycloplegic and cycloplegic myopic autorefraction showed equal performance in measuring minus spherical component. Pearson coefficient almost equaled to one in both situation implying 100% correlation of AR before and after cycloplegia. ROC curve analysis showed high accuracy rates with shifting of curve almost to upper left corner of graph with 100% PPV with no false positive cases and very minimal NPV with 0.99% false negative cases at -0.75 diopter cutoff points. Findings from present study were comparable to previous reports of 88.6% sensitivity and 86.1% specificity at -0.75 cut off point measured by Topcon KR-8800 (Ma Y et al, 2013). (Fig. 7)

Interestingly when cycloplegic MR compared with AR, both methods showed a similar SEM with slight overestimation of mean sphere. There were hundred percent accurate correlations of cycloplegic AR and MR with similar confidence intervals. Cycloplegic results were supported by ROC curve analysis that showed 100% accuracy rates with complete shifting of curve to upper left corner with no overlapping in the two distributions similar to previous study that reported accuracy of 0.97-0.99 (Kulp MT et al, 2014). (Fig. 8)

Regression and limits of agreement analysis
Predication interval of regression model and 95% LOA showed acceptable range hence non-cycloplegic AR could replace the cycloplegic AR at or more than -1.25 diopter. Predictability of dependant variable y equaled to -0.20 before cycloplegia when independent variable x rose to zero.That means, when x is -0.75 diopters autorefraction prediction is -0.78 diopters of myopic error. (Table 3)

Closure range of values observed when predictable interval and 95% LOA of Bland-Altman plots were considered in cycloplegic AR and MR. Hence, two methods could be interchangeable under cycloplegia or one method could replace other method. Predicted dependant variable y equaled to 0.11 diopter when independent variable x rose to zero diopter. For instance, myopia of -0.5 diopter error by cycloplegic MR would predict -0.39 diopter of myopic error by autorefraction. (Fig 9 & 10) Ninety five percent of data points were distributed within +/-1.96 SD in Bland-Altman plots with one outlier due to higher myopic refractive error. Overestimation or underestimation not found in the current study. There was good agreement between both methods under cyclopleagia and non cyclopglia as shown in Fig. 11 & 12.

Direct prescription from non cycloplegic autorefraction may be considered reliable in myopic children as revealed from present study that has yielded high sensitivity and specificity

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rates with good accuracy. Non-cycloplegic autorefraction in hyperopics involves exertion of accommodative element; hence the need for cycloplegia as revealed from this study that cycloplegic autorefraction identifies true negative cases. Non-cycloplegic autorefraction may be reliable in hyperopia of at or more than +1.50 diopters of error. Therefore direct non-cycloplegic prescription may be prescribed to these children without interrupting their academic activity, however only after accessing accommodation by traditional manual refraction.

Shrestha GS et al,2011 study revealed 8.58% (192) incidence rate in 2236 children from Jhapa, Nepal. Myopia was found in 44.79% of the children with male preponderance that was correlated with our study. However, present study revealed more hyperopic incidence of 21.92% (48) than myopic error in 22 (10.05%) children probably accounting for cycloplegic refraction and smaller sample size. Overall refractive error incidence was 8.58% (192 children); in the present study it is 31.96% (70 children) probably cycloplegic refraction diagnosing more cases. They also showed refractive error incidence is prominently seen in private schools than government schools, which we did not take into account of that.

Pokharel et al,2010 studied 440 children in 7-15 years age group and reported 19.8% overall incidence with 59.8% myopic and 31% hyperopic error. Myopic error was predominantly found in 12 to 15 year that correlated with this study results. Myopic and hyperopic incidence predominantly associated with urban children similar to present study results. Niroula DR et al,2009 studied 964 children aged 10 to 19 years and reported 6.43% prevalence rate predominantly towards female predilection similar to myopic incidence of present study.

Conclusion
High prevalence of Hyperopia found in the present study probably due to cycloplegic

assessment of children. Non-cycloplegic hyperopic autorefraction showed low accuracy rates compared to cycloplegic effect that showed higher accuracy rates of sensitivity of 100% and specificity of 97.10% at or more than +1.50 diopter cut off values. Non-cycloplegic autorefraction in myopic children revealed 100% sensitivity and 0.91% specificity at or more than -0.75 diopter criterion. Hence non-cycloplegic autorefraction readings could be considered as reliable in myopic children at or more than -0.75 diopters. Cycloplegic effect on myopic autorefraction yielded 100% sensitivity and specificity at more than -1.25 diopter cut point value. Thus myopia is considered relatively unaffected by cycloplegia on the accuracy of autorefractor compared to hyperopic autorefraction. Non-cycloplegic hyperopic autorefraction failed to identify true negative cases where as cycloplegic hyperopic autorefraction identified true positive cases and true negative cases.

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