The need for cycloplegic refraction in adolescents and young adults

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Abstract

Cycloplegic refraction is considered the gold standard method when examining children and for ensuring accurate refractive error assessment within epidemiological studies. Recent reports underline that cycloplegia is equally important for ensuring accurate refractive error assessment in Chinese adolescents and young adults (Sun et al., 2018). The aim of this study was to assess whether cycloplegia is of equal importance for refractive error assessment in Norwegian adolescents and young adults.

Non-cycloplegic and cycloplegic autorefraction (Huvitz HRK-8000A), and cycloplegic ocular biometry (IOLMaster 700), were undertaken in 215 Norwegian adolescents (101 males) aged 16–17 years. Topical cyclopentolate hydrochloride 1% was used for cycloplegia. Two years later, autorefraction and ocular biometry were repeated in 93 of the participants (34 males), both non-cycloplegic and cycloplegic.

Non-cycloplegic spherical equivalent refractive errors (SER = sphere + ½ cylinder) were more myopic (less hyperopic) than cycloplegic SER in 93.6% of the participants (overall mean ±*SD* difference in SER: -0.59 ±0.50 D, 95% limit of agreement: -1.58–0.39 D). Refractive error classification by non-cycloplegic SER underestimated the hyperopia frequency (10.4% vs. 41.4%; SER ≥ +0.75 D) and overestimated the myopia frequency (12.1% vs. 10.7%; SER ≤ -0.75 D), as compared with refractive error classification by cycloplegic SER. Mean crystalline lens thickness decreased and mean anterior chamber depth increased with cycloplegia, with the largest changes in the hyperopes compared with the emmetropes and myopes ($p \leq 0.04$). The individual differences between non-cycloplegic and cycloplegic SER varied by more than ±0.25 D between first and second visit for 31% of the participants.

Accurate baseline measurements — as well as follow-up measurements — are imperative for deciding when and what to prescribe for myopic and hyperopic children, adolescents, and young adults. The results here confirm that cycloplegia is necessary to ensure accurate measurement of refractive errors in Norwegian adolescents and young adults.

Keywords: Cycloplegia, refractive error, hyperopia, myopia, adolescents

Introduction

In epidemiological studies, cycloplegic refraction is the gold standard method for correct classification of refractive errors (Fotouhi et al., 2012; Morgan et al., 2015; Sun et al., 2018). Cycloplegia is also generally recognised as necessary when assessing refractive error in children to ensure that accommodation is relaxed — to reveal any latent hypermetropia and/or pseudo myopia (Major et al., 2020). The Norwegian Optometry Association's clinical guidelines reflect this by recommending that retinoscopy ought to be carried out after pharmacologically inducing cycloplegia at the first visit in all children aged 18 years and younger (Norges Optikerforbund, 2021). In comparison, the American Optometric Association recommends cycloplegic retinoscopy as the preferred procedure for the first evaluation of school-age children up to 20 years of age (AOA Evidence-Based Optometry Guideline Development Group, 2017). However, in an informal online questionnaire carried out in the spring of 2022, answered by 123 optometrists and one ophthalmologist who reported examining patients aged 16–20 years daily or weekly in Norway, only 15% reported to often (on at least every other patient) use pharmacological agents for assessing refractive error on the first visit in patients in this age group. The majority reported to rarely (67%) or never (18%) use a pharmacological agent on the first visit in 16–20-year-olds. See details in Supplementary Table S1.

Cycloplegic refraction with cyclopentolate 1% is reported to be critical for proper classification of refractive error in a study of Chinese young adults (Sun et al., 2018). The data showed that the difference between non-cycloplegic and cycloplegic spherical equivalent refractive error was 1.80 D, 1.26 D and 0.69 D for those with cycloplegic hyperopia, emmetropia and myopia, respectively (Sun et al., 2018). Similar findings have been reported from Australia and Israel (Mimouni et al., 2016; Sanfilippo et al., 2014), but with the use of eye drops that have a weaker cycloplegic effect than cyclopentolate 1% resulting in smaller differences between non-cycloplegic and cycloplegic refraction in the Australian study. Here, the aims were to evaluate the difference between non-cycloplegic and cycloplegic autorefraction and ocular biometry using cyclopentolate 1% — and to explore whether the difference between non-cycloplegic and cycloplegic refraction changed over a 2-year period — in Norwegian adolescents.

Methods

A representative sample of 16–19 year old Norwegian adolescents were enrolled in a study of cycloplegic refractive errors in Norway (Hagen et al., 2018). Non-cycloplegic and cycloplegic autorefraction, as well as cycloplegic ocular biometry, were undertaken in a subsample that consisted of 215 Norwegian adolescents (101 males; 87% European Caucasians) aged 16–17 years (mean ±*SD* age: 16.2 ±0.4 years). After 2 years, non-cycloplegic and cycloplegic autorefraction were re-measured in 93 (34 males) of these (Hagen et al., 2019). Both non-cycloplegic and cycloplegic ocular biometry were also repeated at the second visit. The study followed the declaration of Helsinki and was approved by the Regional Committee for Medical and Health Research Ethics in Southeast Norway. All participants gave written consent after being informed about the study.

For cycloplegia, topical cyclopentolate hydrochloride 1% (Minims single dose; Bausch & Lomb UK Ltd, England) was instilled in each eye. One drop of cyclopentolate 1% was instilled in eyes with blue and green irises, while two drops were instilled 1–2 minutes apart for eyes with brown irises.

Non-cycloplegic and cycloplegic autorefraction were measured in each eye at both visits with the same Huvitz HRK-8000A Auto-REF Keratometer (Huvitz Co. Ltd., Gyeonggi-do, Korea). Cycloplegic ocular biometry at the first visit, and both non-cycloplegic and cycloplegic ocular biometry at the second visit, were undertaken with the same Zeiss IOLMaster 700 (Carl Zeiss Meditec AG, Jena, Germany). Cycloplegic autorefraction and ocular biometry were undertaken 15–20 minutes after instillation of the last drop.

Since sphere and astigmatism were well correlated between the right and the left eye, cycloplegic sphere: Spearman rho (ρ) = 0.92; cylinder: $\rho = 0.60$; both $p < 0.001$, data of the right eye were used in the analyses. Spherical equivalent refractive er-

Table 1: *Non-cycloplegic and cycloplegic SER, sphere, and cylinder for 215 Norwegian 16–17-year-olds.*

	SER (D)		Sphere (DS)		Cylinder (DC)	
	Mean ±*SD*	Range	Mean ±*SD*	Range	Mean ±*SD*	Range
Non-cycloplegic	+0.00 ±0.98	-5.30 – (+5.22)	+0.25 ±1.06	-4.86 – (+6.50)	-0.49 ±0.68	-6.48 – 0.00
Cycloplegic	+0.60 ±1.17	-5.53 – (+7.71)	+0.85 ±1.25	-5.12 – (+8.58)	-0.50 ±0.65	-6.26 – 0.00
Paired difference	-0.59 ±0.50	-2.60 – (+0.24)	-0.60 ±0.50	-2.74 – (+0.25)	+0.01 ±0.16	-0.81 – (+0.56)
Paired t-test	$t(214) = 17.3$, $p < 0.001$		$t(214) = 17.4$, $p < 0.001$		$t(214) = -0.68$, $p = 0.49$	

rors (SER = sphere + ½ cylinder) from autorefraction data were used to categorise the participants as myopes (SER ≤ -0.75 D), emmetropes (-0.75 D < SER < +0.75 D), and hyperopes (SER ≥ +0.75 D). The cut-off values for myopia and hyperopia were chosen as in Sankaridurg et al. (2017).

The statistical analyses were performed by the statistical software R (version 4.4.2) (R Core Team, 2021). Significance level was set at $\alpha = 0.05$. Bland–Altman plots were used to assess the agreement between non-cycloplegic and cycloplegic autorefraction measurements at the first and second visits, and the mean difference and 95% limits of agreement (LoA) are presented. Histograms, QQ-plots and the Shapiro-Wilk test were used to test normality of data. Paired *t*-tests were used to test for individual pairwise differences. The effect of cycloplegia and refractive status on ocular biometry was analysed with a linear mixed model using the lmerTest package (Kuznetsova et al., 2017), that integrates the lmer function from the lme4 package (Bates et al., 2015), but adds *p*-values and degrees of freedom estimated using the Satterthwaite's correction. The model specification was as follows:

$$Y_{ij} = \beta_0 + b_p + \alpha_{1i} + \alpha_{2j} + \alpha_{12ij} + \epsilon_{ij}$$

where Y_{ij} was the dependent variable (i.e. LT), β_0 was the intercept, $b_p \sim N(0, \sigma_p^2)$ was a random intercept of participants, α_{1i} was a 2-level factor indicating the state of cycloplegia, α_{2j} was a 3-level factor indicating the refractive error category, α_{12ij} was the interaction between the state of cycloplegia and the refractive error and $\epsilon_{ij} \sim N(0, \sigma_\epsilon^2)$ was residual random error. The *p*-values were adjusted for multiple comparisons by the Holm method. Sensitivity, specificity, and positive and negative predictive values for identifying hyperopia by non-cycloplegic autorefraction are presented.

Results

Figure 1A presents data on non-cycloplegic and cycloplegic SER at the first visit for the sample of 215 Norwegian 16–17-year-olds. The mean ±*SD* difference in SER was -0.59 ±0.50 D, whereas the 95% limit of agreement (LoA) was -1.58 – 0.39 D. Compared with cycloplegic SER, non-cycloplegic SER values were more myopic (less hyperopic) in 96.3% of the participants. As shown in Table 1, the paired differences between non-cycloplegic and cycloplegic results were significant for the SER and the sphere, but not for the cylinder.

Figure 2 presents the frequency of myopia, emmetropia, and hyperopia based on non-cycloplegic and cycloplegic SER. Categorisation of refractive errors by non-cycloplegic SER underestimated the hyperopia frequency (10.7% vs. 41.4%) and overestimated the myopia frequency (12.1% vs. 6.0%), compared with cycloplegic SER. Only 64.2% of the participants were correctly categorised by non-cycloplegic data (100% of the myopes, 90.3% of emmetropes, 25.8% of hyperopes). The sensitivity to identify hyperopia from non-cycloplegic data was 25.8%, see further details in Table 2.

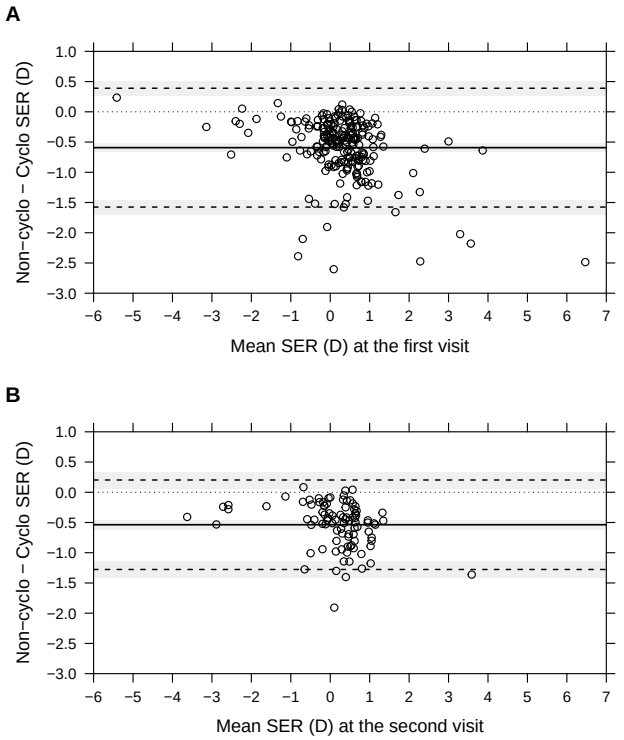

Figure 1: *Bland-Altman plots for comparisons between non-cycloplegic (Non-cyclo) and cycloplegic (Cyclo) autorefraction SER for the participants (A) at the first visit (n = 215; 16–17 years of age) and (B) at the second visit two years later (n = 93). The mean difference is shown as a solid line, while the 95% limits of agreement with the corresponding confidence intervals are shown as dashed lines with grey areas, respectively.*

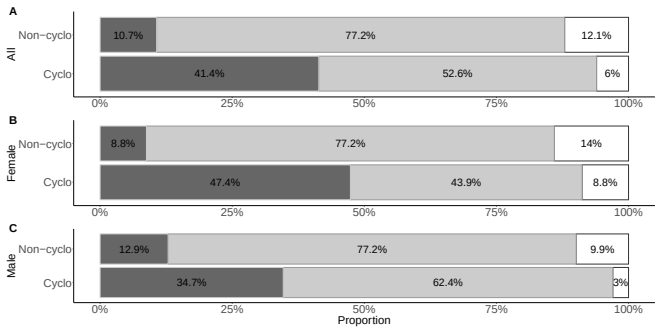

Figure 2: *Frequency of refractive errors based on non-cycloplegic (Non-cyclo) versus cycloplegic (Cyclo) autorefraction SER for (A) all, (B) females, and (C) males at the first visit (16–17 years of age). Bars in dark grey, light grey, and white illustrate hyperopia (SER ≥ +0.75 D), emmetropia (-0.75 D < SER < +0.75 D), and myopia (SER ≤ -0.75 D), respectively.*

There were significant differences between non-cycloplegic and cycloplegic SER in the hyperopes, ΔSER = 0.86 D, $t(212) = 18.2$, $p < 0.001$, $n = 89$, and the emmetropes, ΔSER = 0.43 D, $t(212) = 10.4$, $p < 0.001$, $n = 113$, but the difference did not reach significance in the myopes, ΔSER = 0.14 D, $t(212) = 1.2$, $p = 0.24$, $n = 13$. Note that the refractive errors of the participants were here categorised by cycloplegic SER. As illustrated in Figure 3, the differences between non-cycloplegic and cycloplegic SER were

larger in the hyperopes compared with the emmetropes, $t(212)$ = -6.7, $p < 0.001$, and the myopes, $t(212)$ = -5.4, $p < 0.001$.

Table 2: *The frequency of hyperopia (SER ≥ +0.75 D) based on non-cycloplegic and cycloplegic data. Sensitivity, specificity, positive (PPV) and negative (NPV) predictive values for identifying hyperopia from non-cycloplegic autorefraction are presented.*

		Cycloplegic data		
		Hyperopia	No hyperopia	Total
Non-cycloplegic data	Hyperopia	23	0	PPV 100.0%
	No hyperopia	66	126	NPV 65.6%
		Sensitivity 25.8%	Specificity 100%	

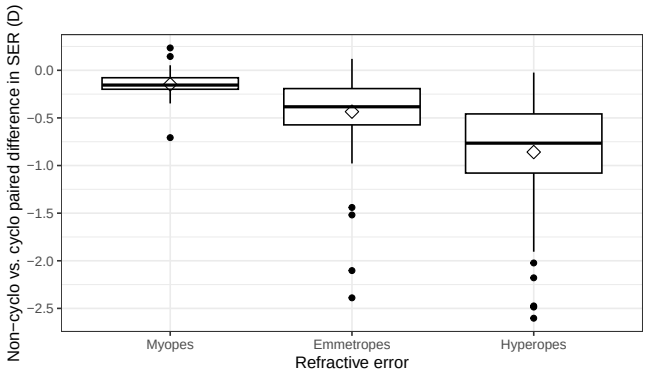

Figure 3: *Paired differences between non-cycloplegic and cycloplegic SER in myopes (n = 13), emmetropes (n = 113) and hyperopes (n = 89) at the first visit (16–17 years of age). Refractive errors were based on cycloplegic data. Horizontal line and diamond denote the median and the mean values, respectively.*

Ocular biometry was undertaken before and after administration of cycloplegia in 93 participants (34 males) at the second visit (18–19 years of age). Figure 4 illustrates the differences in SER, crystalline lens thickness (LT) and anterior chamber depth (ACD) as measured with and without cycloplegia grouped by cycloplegic refractive error. Mean LT decreased significantly with cycloplegia, $t(92)$ = -17.7, $p < 0.001$. The decrease in mean LT with cycloplegia was larger in the hyperopes, ΔLT = -0.10 mm, $t(90)$ = -16.2, $p < 0.001$, compared with the emmetropes, ΔLT = -0.07 mm, $t(90)$ = -12.3, $p < 0.001$, and the myopes, ΔLT = -0.03 mm, $t(90)$ = -2.1, $p = 0.04$. Mean ACD increased significantly with cycloplegia, $t(92)$ = 26.4, $p < 0.001$. The increase in mean ACD with cycloplegia was larger in the hyperopes, ΔACD = 0.14 mm, $t(90)$ = 23.1, $p < 0.001$, compared with the emmetropes, ΔACD = 0.10 mm, $t(90)$ = 18.9, $p < 0.001$, and the myopes, ΔACD = 0.08 mm, $t(90)$ = 5.3, $p < 0.001$. Overall, cycloplegic ocular biometry showed shallower vitreous chamber and thicker central cornea compared with non-cycloplegic measurements, ΔVCD = -0.03 mm, $t(92)$ = -12.8, $p < 0.001$; ΔCCT = 0.002, $t(92)$ = 4.2, $p < 0.001$, with no significant interaction effect between cycloplegia and the category of refractive error. The data showed no significant difference between non-cycloplegic and cycloplegic measurements of mean corneal radius, $t(92)$ = 0.46, $p = 0.65$.

Figure 1B presents data on non-cycloplegic and cycloplegic SER for the 93 participants at the second visit (18–19 years of age). The mean ±*SD* difference in SER was -0.54 ±0.44 D, whereas the 95% limit of agreement (LoA) was -1.33 – 0.25 D. The paired differences between non-cycloplegic and cycloplegic SER at the first visit were compared with the same results at the second visit for the 93 participants who were re-measured after 2 years (mean ±*SD* age at the first visit: 16.2 ±0.4 years). Figure 5 shows that the individual differences between non-cycloplegic and cycloplegic SER varied by more than ±0.25 D between the first and second visits for 31% of the 93 participants (data points outside the grey shaded area). The individual differences between non-cycloplegic and cycloplegic SER varied by more than ±0.5 D in 11%. The data points within the grey shaded area in Figure 5 represent the 69% of the participants in which the individual differences between non-cycloplegic and cycloplegic SER varied by less than ±0.25 D between the first and second visits.

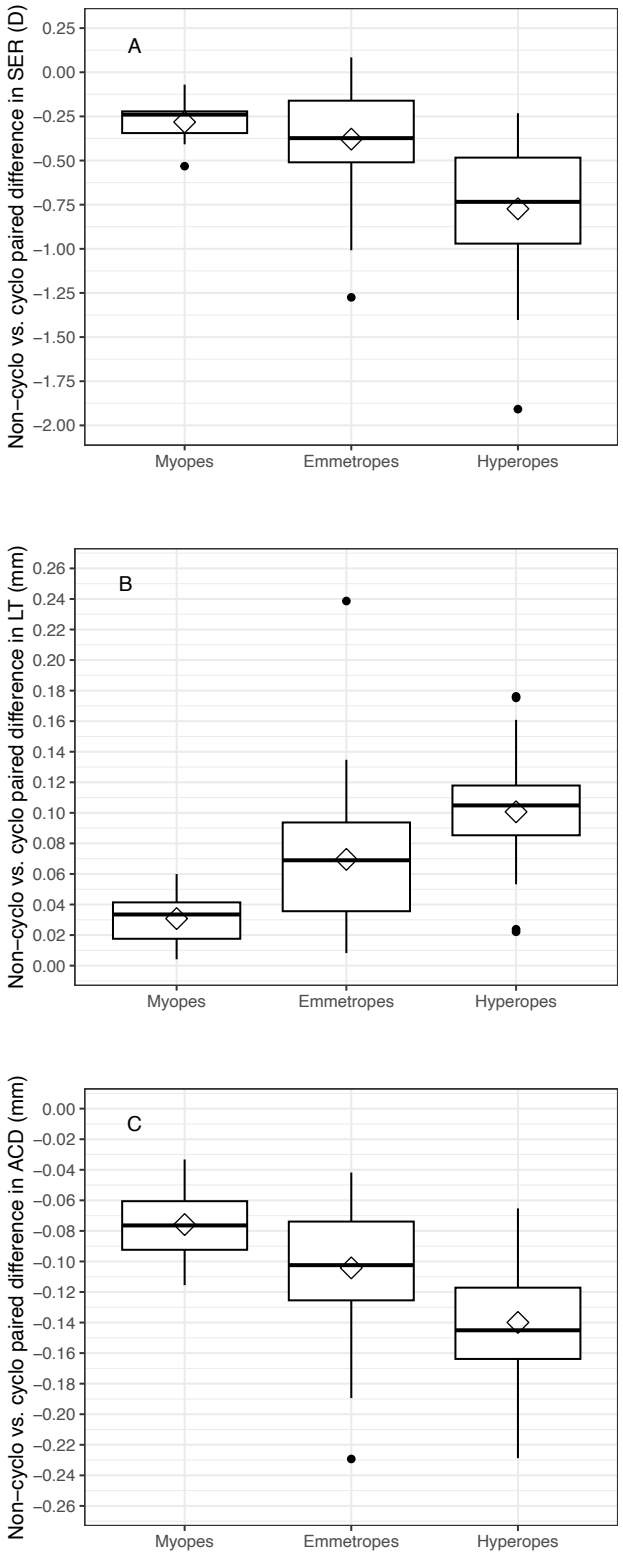

Figure 4: *Paired differences between non-cycloplegic and cycloplegic (A) SER, (B) LT, and (C) ACD in myopes (n = 7), emmetropes (n = 47) and hyperopes (n = 39) at the second visit (18–19 years of age). Refractive errors were based on cycloplegic data. Horizontal line and diamond denote the median and the mean values, respectively.*

Table 3: *Data from studies on differences between pre- and post-cycloplegic SER in myopic, emmetropic, and hyperopic adolescents and young adults. Classification of refractive errors was based on cycloplegic data except Sanfilippo et al. (2014), in which classification of refractive errors was based on pre-cycloplegic data.*

	Mean ±*SD* difference in SER (D)					
Age (yrs)	Myopes	Emmetropes	Hyperopes	Eye drop procedure	Autorefractor	Country
13–19	0.23 ±0.48		0.31 ±0.54	Cyclopentolate 1% (one drop). From 15 years of age: tropicamide 1% (one drop)	Humphrey-598 (Zeiss Meditech)	Australia (Sanfilippo et al., 2014)
16–17	0.15 ±0.23	0.57 ±0.43	1.48 ±0.74	Cyclopentolate 1% (blue-green iris: one drop; brown iris: two drops)	Huvitz HRK-8000A	Norway (present study)
18–19	0.28 ±0.15	0.37 ±0.29	0.77 ±0.37			
19–21	0.69 ±0.69	1.26 ±0.93	1.80 ±1.11	Cyclopentolate 1% (two or three drops) and tropicamide 0.5% (one drop)	Huvitz HRK-7000A	China (Sun et al., 2018)
17–22	0.35 ±0.31	0.73*	1.08 ±0.70	Cyclopentolate 1% (two drops)	Topcon KR-800	China (Pei et al., 2021)
18–21	0.46 ±0.68		1.30 ±0.90	Cyclopentolate 1% (two drops)	Speedy-K (Nikon Corp.)	Israel (Mimouni et al., 2016)
20–26	0.02 ±0.45		0.08 ±0.41	Tropicamide 1% (one drop)	Humphrey-598 (Zeiss Meditech)	Australia (Sanfilippo et al., 2014)

** SD not reported.*

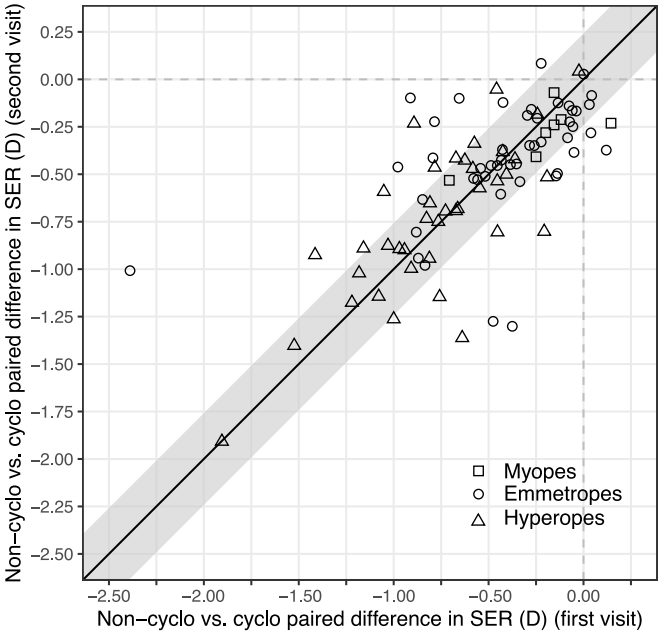

Figure 5: *Individual differences between non-cycloplegic and cycloplegic SER (D) at the first (x-axis) and the second visit (y-axis) for the 93 participants who were re-measured after two years. Mean ±SD age at the first visit was 16.2 ±0.4 years. The markers indicate the cycloplegic refractive error status for the participants at the first visit. The solid line represents the identity line (y = x), while the shaded grey area symbolises ±0.25 D from the identity line.*

Discussion

The results of this study emphasise the importance of pharmacologically inducing cycloplegia for the assessment of refractive error in adolescents and young adults, i.e. beyond the age range recommended by existing guidelines (Pei et al., 2021; Sankaridurg et al., 2017; Yoo et al., 2017). Several recent studies have reported that it is crucial to ensure that the eyes are sufficiently relaxed when measuring refractive error and deciding what to prescribe, also for patients in young adulthood (Mimouni et al., 2016; Sun et al., 2018). Studies claiming that cycloplegia is not needed for refraction have, in general, not used the recommended dosage of cyclopentolate 1%; some of those studies have used a pharmacological agent known to have a weaker cycloplegic effect, such as tropicamide 1% (Sanfilippo et al., 2014). Table 3 shows reported data on differences between pre- and post-cycloplegic SER in myopes, emmetropes, and hyperopes.

It is evident from Table 3 that the choice of pharmacological agent and number of drops play an important role in the cycloplegic depth attained. This is important when comparing the effect of the administered drops on the change in measured refractive error. Studies reporting refractive error with tropicamide or just one drop of cyclopentolate irrespective of iris pigmentation, show a considerably smaller difference between non-cycloplegic and cycloplegic refraction than studies that used the recommended dosage of cyclopentolate 1% (Table 3).

The data show differences in pre- and post-cycloplegic measurements of anterior chamber depth and lens thickness, as reported by others (Hashemi et al., 2020). There is clinical value in knowing which emmetropes have the thinnest crystalline lens as these are assumed to have a higher risk of developing myopia (Hagen et al., 2019; Mutti et al., 2012; Rozema et al., 2019). In Norwegian adolescents, it is expected that several emmetropes are at risk of developing myopia when they move into higher education (Fledelius, 2000; Jacobsen et al., 2008; Kinge & Midelfart, 1999). Indeed, there is a group of emmetropes who have a crystalline lens that is as thin as that observed in the myopes (Hagen et al., 2019).

The expected increase in myopia incidence in late adolescence and young adulthood indicates that there is a need to consider myopia control in this age group in Scandinavia and Europe – and cycloplegic refraction should be carried out at first time eye exam in adolescents and young adults who are in higher education. The measurement of cycloplegic refractive error is important information from which to assess the best treatment option. Treatment options other than standard single-vision spectacles or contact lenses carry an added burden on the patient, in terms of increased cost, compliance and sometimes side effects (Ha et al., 2022; Jonas et al., 2021; Liu & Xie, 2016; Polling et al., 2020; Sha et al., 2018). This challenges optometrists and ophthalmologists to ascertain the best solution for the patient, from among the many myopia control options available. Furthermore, to be able to assess the effect of the prescribed myopia control solutions, both ocular biometry and cycloplegic refraction are needed as baseline. Current standard of care for myopia management set out by the World Council of Optometry (World Council of Optometry, 2021) includes "regular comprehensive vision and eye health exams". Both cycloplegic refraction and ocular biometry results are recommended for baseline and as a means of follow-up to assess the effect of a given myopia control regime on the individual child and adolescent. Current advice for follow-up is that cycloplegic refraction is carried out at least once a year (Morton et al., 2019; Spillmann, 2020; Weng, 2020).

Clinicians may think that the degree of relaxation of the eyes is not important when measuring refractive errors and deciding what to prescribe in adolescents. This and other studies indicate the contrary (Mimouni et al., 2016; Sun et al., 2018), which is expected since average accommodation amplitude typically declines from 15 ±2 D in a 6-year-old to 12 ±2 D in a 16-year-old (Duane, 1922). The average 3 D decline in accommodation amplitude, combined with considerable between-individual varia-

tion, is not large enough to make cycloplegic refraction redundant. Another aspect to consider is that adolescents and young adults who have remained hyperopic from childhood, and who may have coped without correction, may, to a larger degree, need a corrective prescription to sustain the amount of near work required in higher education. The difference in SER between cycloplegic and non-cycloplegic data was larger in the hyperopes than in the emmetropes and myopes (see Figure 3), indicating that hyperopes accommodate more than emmetropes and myopes. It is clear from the data that without cycloplegia, hyperopes are prone to be misclassified and remain undetected. Thus, assessment of cycloplegic refraction is needed in adolescents to ensure that the clinician knows the correct baseline – with no influence from individual variation in accommodation – and uses this when assessing the type of solution for both myopes and hyperopes.

Limitations

It is possible that the depth of cycloplegia was not at maximum in this study as measurements were obtained as early as 15–20 minutes post administration of cyclopentolate 1%. A majority of the participants, however, had blue iris pigmentation, and there are indications that a sufficient cycloplegic depth was attained within this time (Manny et al., 1993). If sufficient cycloplegic depth was not reached, the difference between non-cycloplegic and cycloplegic refraction may be even larger than what we have reported here.

Conclusion

The results of this study underline the soundness of the recommendation by the Norwegian Optometry Association of pharmacologically inducing cycloplegia at the first visit in all patients aged 18 years and younger (Norges Optikerforbund, 2021), but the recommendation should also include young adults older than 18 years of age (AOA Evidence-Based Optometry Guideline Development Group, 2017) and follow-up measurements. Cycloplegic refraction is not only important for precise prescriptions, but also for proper myopia control treatment, in which the current advice for follow-up is at least annual cycloplegic refraction (Morton et al., 2019; Spillmann, 2020). This supports that good clinical practice is to perform cycloplegic refraction both at the first visit and in follow-up measurements in young adults as well as those aged 18 years and younger.

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Supplementary information

An informal online questionnaire on use of pharmacological agents for assessing refractive error on the first visit of patients aged 16–20 years was answered by 136 optometrists and 5 ophthalmologists in May 2022. Supplementary Table S1 shows responses from the 123 optometrists and one ophthalmologist who all reported to examine patients aged 16–20 years on a daily or weekly basis in Norway.

Table S1: *Frequency of use of pharmacological agents for assessing refractive error at the first visit of patients aged 16–20 years, as assessed from an informal online questionnaire. Data are the responses from 123 optometrists and one ophthalmologist, all of whom reported to examine patients aged 16–20 years on a daily or weekly basis in Norway.*

	Pharmacological agent		
Frequency	Cyclopentolate 1%	Tropicamide 0.5%	No eye drops
Always	2 (1.6%)	0 (0.0%)	
In more than half	16 (12.9%)	1 (0.8%)	
In fewer than half	78 (62.9%)	5 (4.0%)	
Never			22 (17.7%)

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Behovet for cykloplegisk refraksjon hos ungdommer og unge voksne

Sammendrag

Cykloplegisk refraksjon regnes som gullstandard-metoden ved undersøkelse av barn og for å sikre en nøyaktig utmåling av brytningsfeil i epidemiologiske studier. Nyere studier viser at cykloplegi er like viktig for å sikre nøyaktig utmåling av brytningsfeil hos kinesiske ungdommer og unge voksne (Sun et al., 2018). Målet med denne studien var å vurdere betydningen av cykloplegi for utmåling av brytningsfeil hos norske ungdommer og unge voksne.

Autorefraktor (Huvitz HRK-8000A) ble målt før og under cykloplegi, og okulær biometri (IOLMaster 700) ble målt under cykloplegi, hos 215 norske ungdommer (101 menn) i alderen 16–17 år. Cyklopentolathydroklorid 1% ble brukt for å oppnå cykloplegi. To år senere ble autorefraktor og okulær biometri målt på nytt hos 93 av deltakerne (34 menn), både før og under cykloplegi.

Sfærisk ekvivalent refraktiv feil (SER = sfære + ½ sylinder) målt før cykloplegi var mer myop (mindre hypermetrop) enn SER målt under cykloplegi hos 93,6% av deltakerne, samlet gjennomsnittlig ±*SD* forskjell i SER: -0,59 ±0,50 D, 95% grenseverdier (limits of agreement): -1,58–0,39 D. Klassifisering av brytningsfeil basert på SER målt uten cykloplegi underestimerte frekvensen av hypermetropi (10,4% vs. 41,4%; SER ≥ +0,75 D) og overestimerte frekvensen av myopi (12,1% vs. 10,7%; SER ≤ -0,75 D), sammenlignet med klassifisering av brytningsfeil basert på SER målt under cykloplegi. Ved cykloplegi ble gjennomsnittlig linsetykkelse tynnere og gjennomsnittlig fremre kammerdybde økte, de største endringene var hos de hypermetrope sammenliknet med de emmetrope og myope ($p \leq 0{,}04$). Individuelle forskjeller mellom SER målt før og under cykloplegi varierte mer enn ±0,25 D mellom første og andre besøk for 31% av deltakerne.

Nøyaktige førstegangsmålinger — så vel som oppfølgingsmålinger — er vesentlige for å avgjøre når og hva som skal foreskrives til myope og hypermetrope barn, ungdommer og unge voksne. Resultatene i denne studien bekrefter at cykloplegi er nødvendig for å sikre nøyaktig utmåling av brytningsfeil hos norske ungdommer og unge voksne.

Nøkkelord: Cykloplegi, refraktive feil, hypermetropi, myopi, ungdommer

La necessita' di refrazione cicloplegica in adolescenti e giovani adulti

Riassunto

La refrazione cicloplegica e' considerata un metodo "gold standard" quando si esaminano bambini e per assicurarsi che la rilevazione del difetto refrattivo all'interno degli studi epidemiologici. Comunicati recenti sottolineano come la cycloplegia sia ugualmente importante per assicurarsi che la rilevazione del difetto refrattivo in adolescenti e giovani adulti cinesi (Sun et al., 2018). Lo scopo di questo studio e' stato quello di verificare che la cicloplegia sia ugualmente importante per la rilevazione dell'errore refrattivo in adolescenti e giovani adulti norvegesi.

L'auto-refrattometria non cicloplegica e cicloplegica (Huvitz HRK-8000A), e la biometria cicloplegica (IOLMaster 700), sono state misurate in 215 adolescenti norvegesi (101 maschi) di eta' compresa tra 16 e 17 anni. Il farmaco topico-oculare hydrochloride 1% e' stato utilizzato per la ciclopegia. Due anni dopo, l'autorefrazione e la biometria oculare sono state ripetute in 93 soggetti (34 maschi), sia in cicloplegia che senza cicloplegia.

Gli errori refrattivi secondo l'equivalente sferico (SER= sfera + ½ del cilindro) sono stati misurati in non-cicloplegia e sono stati rilevati piu' miopici (meno ipermetropici) che in cicloplegia SER in 93.6% dei partecipanti (media generale ±*SD* con differenza in SER: -0.59 ±0.50 D, 95% limite di accordo: -1.58–0.39 D). La classificazione dell'errore refrattivo attraverso la non cycloplegia SER ha sottostimato la frequenza dell'ipermetropia (0.4% vs. 41.4%; SER ≥ +0.75 D) e sovrastimato la frequenza della miopia (12.1% vs. 10.7%; SER ≤ -0.75 D), cosi come comparato con la classificazione dell'errore refrattivo con ciclopegia SER. La media dello spessore del cristallino e' diminuita e la media della profondita' della camera anteriore e' aumentata in cicloplegia, con il piu' grande cambiamento negli ipermetropi in confronto agli emmetropi e ai miopi ($p \leq 0.04$). La differenza individuale tra i valori di SER non cicloplegici e quelli di SER cicloplegici e' cambiata di piu' di ±0.25 D tra la prima e la seconda visita tra il 31% dei partecipanti.

Misure accurate nella prima visita di base, cosiccome nelle misure di follow-up, sono perentorie per decidere quando e cosa prescrivere per bambini miopi ed ipermetropi, adolescenti e giovani adulti. I risultati di seguito confermano che la cicloplegia e' necessaria per assicurarsi che le misure degli errori refrattivi siano accurati in adolescenti e giovani adulti norvegesi.

Parole chiave: cicloplegia, errore refrattivo, ipermetropia, miopia, adolescenti