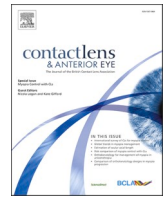




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Short communication

Decreased effectiveness of 0.01% atropine treatment for myopia control during prolonged COVID-19 lockdowns

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ABSTRACT

The COVID-19 pandemic of 2020 and its' accompanied lockdowns impacted the entire globe in ways the world is only beginning to comprehend. In Israel, children age 9–15 had not been in a frontal classroom and been socially restricted from March 2020 till March 2021. Fourteen of these children that had been under myopia control treatment which had been effective prior to the pandemic were included in this retrospective study to learn if their myopia continued to stay under control, or if the unique environmental modifications affected their progression. The results showed that average increase in spherical equivalent refraction and axial length, measured with optical biometer OA-2000 (Tomey GmbH, Nagoya, Japan), during the year of lockdowns was $-0.73 \pm 0.46\text{D}/0.46 \pm 0.31$ mm respectively, while the average increase in the year prior was $-0.33 \pm 0.27\text{D}/0.24 \pm 0.21$ mm. Though several articles have indicated the pandemic environment has influenced myopia progression in children, this communication indicates a possible significant impact of the environment on myopia increase even in individuals under effective atropine treatment. These children's' progression suggests practitioners consider and address multiple aspects simultaneously when attempting myopia control.

1. Introduction

The COVID-19 pandemic of 2020 impacted the entire globe in ways the world is only beginning to comprehend. In order to minimize the spread of infection and the stress on the healthcare systems, governments around the world imposed lockdowns in various stringencies for weeks and months at a time [1]. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), over 160 countries have closed schools, most classes held on digital platforms in front of computer screens [1]. Israel implemented its' first lockdown in March 2020 and while various restrictions have been eased, children age 9–15 had not been in a frontal classroom and been socially restricted for a full year, until March 2021. They were educated either via digital screen or application platforms, some via listening to a cellphone and looking at reading material. This alternative school day would last between 4.5 and 7 h per day, with additional time dedicated to assignments. The nature of spending months socially distanced indoors led to added extended use of gadgets and increased cellphone use. Even before the pandemic, device use was an average of 4–5 h per day in this age

group in the western society [2], now use increased to an all-time peak, as this was the primary outlet for socializing. Quarantine myopia has circulated in discussions in the literature and in addition to the associated intensity of near work activities discussed, fewer outdoor activities is an independent known risk factor for myopia [1]. Data can now be collected to understand how this year may have impacted this population.

This short communication compares the refractive and axial length changes in children treated with 0.01% atropine for myopia control during a year when they were home-educated and socially-distanced due to COVID-19 related lockdowns, with those occurring in the previous (normal) year.

2. Methods

At the end of the COVID-19 lockdowns (March 2021), a clinic retrospectively reviewed the charts of fourteen children who began treatment for myopia control at age 10.5 ± 2.1 , 38% of them female. They instilled 0.01% atropine daily and wore single vision distance

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Table 1

Demographic data and binocular status at the beginning of treatment in March 2019, the refractive and axial length measurements of each child and the increase during year one (March 2019–March 2020) and year two, a year of lockdown and social distancing (March 2020–March 2021).

#	M/F	Age March 2019	Binocular March 2019		SE 2019		AL 2019		SE 2020		AL 2020
			Far	Near	L	R	L	R	L	R	L
1	M	9	Ortho	Ortho	3	4	23.22	23.2	3.25	4.5	23.41
2	F	9.5	Ortho	Ortho	2.75	3.25			2.75	3.25	23.87
3	F	14	Ortho	Ortho	2.75	4.25	25.54		3	4.25	25.73
4	F	10	20XP	8XP	7	5.25	25.07	24.42	6.75	5.75	24.87
5	F	15	Ortho	Ortho	7.75	7.5	25.95	25.45	8	8.25	26.14
6	M	9	Ortho	Ortho	6.62	6.62	26.09	25.5	7.25	7	26.58
7	M	9	Ortho	ET8	1.25	1.5	23.15	23.17	1.75	2.25	23.54
8	F	9.5	Ortho	Ortho	2.75	2	23.76	23.9	3.25	2.25	24.15
9	M	9	Ortho	Ortho	4.5	4.5	25.99	26.05	5.25	5.12	26.57
10	M	11.5	Ortho	4EP	2.75	2.75			2.75	2.75	24.76
11	M	9	Ortho	Ortho	3.25	3	22.8	22.65	3.75	3.75	23.19
12	M	9	Ortho	Ortho	0.75	0.75	23.14	23.41	1	1	23.3
13	M	10.5	Ortho	Ortho	2.75	3.5	25.19	25.53	3	3.75	25.34
14	M	13	Ortho	Ortho	8.5	8.25	25.46	25.34	8.75	8.5	25.6
AVG ± SD		10.50 ± 2.07			4.03 ± 2.45	4.08 ± 2.20	24.61 ± 1.29	24.42 ± 1.20	4.32 ± 2.44	4.46 ± 2.26	24.79 ± 1.23
R+L AVG ± SD					4.05 ± 2.29		24.52 ± 1.22		4.46 ± 2.26		24.76 ± 1.14

Abbreviations: M/F: male/female, XP: exophoria, ET: esotropia, EP: esophoria, SER: spherical equivalent refraction (diopter), AL: axial length (mm).

spectacles for two years (March 2019 until March 2021). These children had been home-schooled and socially restricted for a full year because of the COVID-19 pandemic (March 2020 to March 2021). A precondition to implementing atropine treatment in this clinic is a minimum of -0.75D increase in SER during the previous year, which was met by this group.

The cycloplegic subjective spherical equivalent refraction (SER) of these children at the beginning of treatment was between -0.75 and -8.50D and the axial length (AL) measurements obtained using the optical biometer OA-2000 (Tomey GmbH, Nagoya, Japan) were between 22.65 and 26.10 mm. Cycloplegic SER and AL was measured annually a year before lockdowns at the beginning of treatment (March 2019), at the beginning of the lockdowns (March 2020) and then at the end of the COVID-19 lockdowns (March 2021). The average SER and AL of the right and left eyes was statistically analyzed from the beginning of treatment to the beginning of lockdowns and from the beginning of lockdowns to the end of lockdowns. The average increase in SER and AL from the COVID-19 lockdown year was then compared to the average increase that occurred the year before. This group all exhibited orthophoria at distance and near except one child with a near esophoria, one child with a divergence excess basic exophoria and one child exhibited an esotropia (Table 1).

The Medical Center Institutional Review Board (IRB) approval was obtained for this study and all of the procedures were carried out in accordance with their guidelines. This study followed the tenets of the Helsinki Declaration. The parents were aware their children’s data were included in this study but as per IRB guidelines, signed consent of the children or their guardians was unnecessary.

2.1. Statistical analysis

The primary analysis was to compare the increase in SER and AL during the COVID-19 year of lockdowns to the previous year of treatment. Statistical analysis was performed with Analysis of covariance (ANCOVA) using the IBM Statistical Package for Social Sciences software Version 25.0 (IBM SPSS Statistics for Windows, Armonk, NY). In addition, ANCOVA was used to analyze the spherical equivalent and axial lengths a year before the lockdowns at the beginning of treatment, at the beginning of the lockdowns and the end of the lockdowns.

3. Results

Fourteen children were included in this study, all of whom underwent 0.01% atropine treatment for two years, the second a year of

lockdowns and social distancing. The binocular status did not change in any of the children throughout.

At the end of the year of COVID-19 lockdowns the average SER and AL in the right eye measured at 5.16 ± 2.23 D and 25.20 ± 1.19 mm respectively and in the left eye 5.09 ± 2.18 D and 25.26 ± 1.14 mm respectively. There was a statistically significant difference in SER and AL both the right ($P < 0.01$ and $P < 0.001$ respectively) and the left eye ($P < 0.001$) at the end of the lockdowns compared to the beginning of that year (Table 1).

The average SER increase during the year of COVID-19 lockdowns was 0.74 ± 0.46 D while the average increase the year prior was 0.33 ± 0.27 D. There was a statistically significant increase in SER during the year of the lockdowns compared to pre-lockdowns year treatment (the previous year, $P < 0.001$). There was likewise a statistically significant increase in the AL growth during the year of the lockdowns compared to pre-lockdowns year treatment. The average increase during that year was 0.47 ± 0.30 mm while the average growth during the previous year was 0.24 ± 0.21 mm ($P < 0.001$, Table 1).

4. Discussion

Myopia progression increased significantly during the COVID-19 lockdown year in home-schooled and socially distanced children treated with 0.01% atropine for myopia control compared with the year prior.

Low dose 0.01% atropine has been shown to be even more effective at arresting myopia progression in the second year compared to the first [3,4], therefore this study which included children treated for one year prior to the pandemic further amplifies the increase in myopia exhibited during the second year.

A limitation to this study is the wide range of myopia in this group, as baseline SER can influence the amount of progression [5]. This range was derived from the desire to include all children that had begun atropine treatment exactly one year before the first lockdown and to measure the influence of the year of COVID-19 lockdowns and social distancing. An additional limitation is the absence of a control group.

While myopia increase may not be exclusively a result of digital screen use, it seems possible that the extended time indoors has influenced the children’s myopia progression. It has been suggested that extended school closures, social distancing and increased screen time with associated lack of physical activity may have additional negative consequences. Eyestrain and musculoskeletal issues are part of the computer vision syndrome which has been discussed extensively in the

AL 2020	March 2019–March2020				SER 2021		AL 2021		March 2020–March 2021			
	R	ΔAL (L)	ΔAL (R)	ΔSER (L)	ΔSER (R)	L	R	L	R	ΔAL (L)	ΔAL (R)	ΔSER (L)
23.59	0.19	0.38	0.25	0.5	4.37	5.5	24.11	24.21	0.7	0.63	1.125	1
24.18			0	0	3.75	3.75	24.49	24.49	0.63	0.31	1	0.5
25.08	0.19		0.25	0	4.5	5.6	26.67	25.92	0.94	0.84	1.5	1.35
24.8	-0.19	0.38	-0.25	0.5	8.25	6	25.81	24.96	0.94	0.16	1.5	0.25
26.14	0.19	0.68	0.25	0.75	8	8.25	26.22	26.45	0.08	0.31	0	0
25.82	0.48	0.31	0.62	0.37	7.75	8.5	26.84	27.07	0.26	1.25	0.5	1.5
23.75	0.38	0.58	0.5	0.75	2.75	3.1	24.16	24.28	0.63	0.53	1	0.85
24.09	0.38	0.19	0.5	0.25	4	2.75	24.52	24.37	0.38	0.28	0.75	0.5
26.53	0.58	0.48	0.75	0.62	5.6	5.5	26.76	26.74	0.19	0.21	0.35	0.37
24.57			0	0	3.75	3.75	25.38	25.19	0.63	0.63	1	1
23.02	0.38	0.37	0.5	0.75	4.1	4.12	23.36	23.21	0.18	0.19	0.35	0.37
23.54	0.16	0.13	0.25	0.25	2.25	1.5	24.08	23.85	0.78	0.31	1.25	0.5
25.67	0.15	0.14	0.25	0.25	3.5	4.25	25.59	25.92	0.25	0.25	0.5	0.5
25.49	0.14	0.15	0.25	0.25	8.75	9.6	25.65	26.18	0.06	0.69	0	1.1
24.73 ± 1.09	0.25 ± 0.20	0.34 ± 0.18	0.29 ± 0.27	0.38 ± 0.28	5.09 ± 2.18	5.16 ± 2.33	25.26 ± 1.14	25.20 ± 1.19	0.47 ± 0.31	0.47 ± 0.31	0.77 ± 0.50	0.70 ± 0.44
	0.29 ± 0.2		0.33 ± 0.27		5.13 ± 2.22		25.23 ± 1.14		0.47 ± 0.30		0.74 ± 0.46	

literature, irregular sleep pattern, alterations in diets resulting in weight gain and decline in cardiorespiratory fitness [6]. Even with end of this pandemic in sight, the emergence of vaccinations and the opening of society, children are going to be committed to significant amounts of screen time, daily, for the foreseeable future [6]. While the use of digital devices and staying indoors may not be the exclusive reasons for myopia progression, it would be prudent to educate parents and give ergonomic guidelines appropriate to these study environments and to advise more time spent outdoors [7], as this environment seems beneficial in terms of myopia progression.

Declaration of competing interest

No conflicts of interest to be declared.

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