

Research Assessment Exercise 2020

Impact Case Study

University: The Hong Kong Polytechnic University

Unit of Assessment (UoA): 05 Nursing, Optometry, Rehabilitation Sciences and Other Health Care Professions

Title of case study: Improving treatment and delaying progression of myopia: a successful research journey addressing a worldwide problem

(1) Summary of the impact

Myopia requiring visual correction affects >30% people worldwide and 70-90% of school-age children in Hong Kong. The Hong Kong Polytechnic University team developed novel contact and spectacle lenses and evaluated their efficacy in controlling myopia progression in schoolchildren. These innovative spectacles and contact lens designs are highly effective (~60%) in slowing myopia progression. Our research and innovation are changing clinical practice in myopia control for children. The patented lenses have been licensed and are now commercially available in Hong Kong and elsewhere.

(2) Underpinning research

The Hong Kong Polytechnic University team comprised the following researchers:

Prof Carly Lam (Professor 2008 – present)

Prof Chi-ho To (Chair Professor 2019 – present)

Dr Dennis Tse (Assistant Professor 2016 – present)

Dr Wing Chun Tang (post doc and research optometrists since 2012)

Since 2003, myopia has been a central thematic research area in the UoA's School of Optometry (SO). Our myopia research platform has included biochemical, physiological, molecular and animal model studies to determine the underlying causes of myopia and ways of delaying its progression, epidemiological studies of local prevalence, and randomized controlled clinical trials (RCCT) designed to evaluate innovative, non-invasive and non-pharmacological lens-based strategies to delay the progression of myopia in school-age children. The three key underpinning stages of this successful research journey are outlined below.

Using dual-power lenses and animal models for proof of concept, we found that early eye growth responds to simultaneously imposed myopic and hyperopic defocus. This led us to develop dual-power lenses, engineered to provide visual correction and myopic defocus concurrently. Our research between 2007-2014 confirmed that this form of myopic defocus, induced by the positive powered area of these dual-power lenses, effectively inhibits axial elongation in several animal species including chicks, guinea pigs, and monkeys [R1-R4].

A soft contact lens incorporating myopic defocus was designed and patented by The Hong Kong Polytechnic University. This novel lens (the Defocus Incorporated Soft Contact [DISC] lens) was manufactured and, beginning in 2007, was tested for effectiveness against myopia progression in schoolchildren in an RCCT led by Prof Carly Lam (then Professor and Head, currently Professor in SO). Myopia progression was retarded significantly (by up to 60%) in children wearing the novel contact lens compared to the retardation seen for children in the control group wearing the single-vision contact lens (the usual type) [R5]. Our results published in BJO 2014 demonstrated that the DISC lens could be successfully applied to children eight years of age or above, for daily visual

correction, and it also controlled myopia progression. The DISC lens is now licensed to a local company in Hong Kong and available as a daily disposal contact lens.

Prof Chi-ho To and Prof Carly Lam, together with the Hoya Corporation, designed a novel spectacle lens called a Defocused Incorporated Multi-Segment (DIMS) lens, which incorporated myopic defocus into a conventional visual correction lens. This was evaluated for effectiveness against myopia progression in an RCCT commencing in 2014 (led by Prof Carly Lam). Results from the first two years of the trial revealed a 52% delay in myopia progression in schoolchildren, compared to the control children wearing single-vision lens [R6]. This effectiveness meant that the novel lens design is among the most effective optical designs in the market, and is cosmetically superior to older bifocal lens designs. Because it is a spectacle lens, no limitations are imposed on the age of wearers, thus markedly increasing the number of myopia sufferers benefitting from its novel design. The invention won the grand prize at the 46th International Exhibition of Inventions in Geneva. It is now licensed to the Hoya Vision Care and has been in distribution from July 2018.

(3) References to the research

Publications

[R1] Tse DY, Lam CS, Guggenheim JA, Lam C, Li KK, Liu Q, et al. Simultaneous defocus integration during refractive development. *Invest Ophthalmol Vis Sci.* 2007;48(12):5352-9.

[R2] Tse DY, To CH. Graded competing regional myopic and hyperopic defocus produce summated emmetropization set points in chick. *Invest Ophthalmol Vis Sci.* 2011;52(11):8056-62.

[R3] Arumugam B, Hung LF, To CH, Holden B, Smith EL, 3rd. The effects of simultaneous dual focus lenses on refractive development in infant monkeys. *Invest Ophthalmol Vis Sci.* 2014;55(11):7423-32.

[R4] McFadden SA, Tse DY, Bowrey HE, Leotta AJ, Lam CS, Wildsoet CF, et al. Integration of defocus by dual power Fresnel lenses inhibits myopia in the mammalian eye. *Invest Ophthalmol Vis Sci.* 2014;55(2):908-17.

[R5] Lam CS, Tang WC, Tse DY, Tang YY, To CH. Defocus Incorporated Soft Contact (DISC) lens slows myopia progression in Hong Kong Chinese schoolchildren: a 2-year randomised clinical trial. *Br J Ophthalmol.* 2014;98(1):40-5.

[R6] Lam CS, Tang WC, Tse DY, Lee RPK, Chun RKM, Hasegawa K, et al. Defocus Incorporated Multiple Segments (DIMS) spectacle lenses slow myopia progression: a 2-year randomised clinical trial. *Br J Ophthalmol.* 2019, doi: 10.1136/bjophthalmol-2018-313739.

Details of key research grants

1. RGC GRF (B-Q04G) Control of myopia progression in myopic children using simultaneous vision approach (PI: Prof. Carly Lam), 1/2007 to 6/2010, HKD\$893,500
2. The Hong Kong Polytechnic University, Niche Area Fund (J-BB7P) Myopia Control: Freeing the world from sight-threatening myopia, (Coordinating PI: Prof. Carly Lam), 3/2008 to 3/2013, HKD\$10,000,000
3. RGC GRF (B-Q29M) Modulation of mammalian ocular growth with competing defocus (PI: Prof Carly Lam) 1/2012 to 6/2015 HKD\$925,000
4. Industrial fund from HOYA Lens Thailand Ltd. Myopia Control for Young Children with Myopic Defocus Incorporated Spectacles Lens (PI: Prof. Carly Lam), 5/2014 to ongoing, HKD3,120,400
5. Industrial fund from Johnson & Johnson Vision Care Inc. Myopia Control Using Optimized Optical Defocus in Schoolchildren—a 12 Months Randomized Double Masked Control Trial (PI: Prof. Carly Lam), 1/2019 to 11/2020, HK\$4,680,000

6. RGC RIF (3-RC2C) Effectiveness of Bright Light Therapy, Myopic Defocus, Atropine and the Combinations for Controlling Myopic Eye Growth in Schoolchildren: A Randomized Control Trial (PI: Prof. Chi Ho To), 6/ 2019 to 6/ 2023, HKD\$11,500,000
7. HMRP (K-ZC1N) Does Blue-Light Filtering Spectacle Lens Promote Myopia Progression in Schoolchildren? (PI: Dr Rachel Chun), 6/2018 to 5/2021, HKD\$1,199,600

(4) Details of the impact

Hong Kong and Mainland Population: Experimental results were successfully translated from the myopia research platform into innovative clinical applications. The successful control of myopia at an early age benefits individuals over their lifetime, preventing severe visual impairment and ocular complications due to high myopia development.

DIMS and DISC lenses are highly effective for controlling myopia progression and are non-invasive. The DIMS lens is also the treatment of choice for children under eight years of age and for those who cannot or do not wish to wear contact lens. Given the scale of the myopia problem, the potential benefit and market share for these therapeutic technologies are expected to be enormous. As of August 2019, the number of DIMS lenses sold in the market was ~130,000 (approx. HK\$ ■ million) in Hong Kong and the Mainland.

Underprivileged Population: Based on the belief that the benefit of controlling myopia using DIMS lenses should not be restricted by one's socioeconomic status, the Hong Kong Innovation Foundation (HKIF) teamed up with SO to launch a two-year "The Hong Kong Polytechnic University-HKIF Children Eye Care Project" in 2019 [S1]. The objective is to help 200 underprivileged families to prevent the development of myopia at an early age. The prevention of myopia at an early age can significantly reduce the risk of high myopia at later ages. The development of ocular complications due to high myopia becomes a long-term financial and eye health burden to the underprivileged population. The Project received positive feedback from the participants and their parents [S2]. Excerpts (translated) of the feedback include, "*the project provided the opportunity to use this novel myopia control device*", "*it enhanced eye health awareness and the understanding to eyewear care*", and "*it facilitated the understanding of the cause and consequences of myopia.*"

Industry: The developed technologies have been licensed to industrial partners for commercial use. Since the launch of the DIMS spectacle lens in the summer of 2018, Hoya has organized 3,787 seminars in Hong Kong and the Mainland, and attracted 75,569 practitioners to the workshops, seminars and talks [S3]. The company received positive feedback on the effectiveness of the lens for myopia control, and it foresees significant demand for the lens in Asian countries including Singapore, Malaysia and Korea.

Vision Science and Technology Co. Ltd. (VST), one of the licensed partners since 2017, reported that over 1,400 pairs of DISC lenses were prescribed in Hong Kong from June 2018 to June 2019. VST launched the DISC lens in China in April 2019, and ~3,000 pairs of lenses were prescribed by the end of June 2019. The total business generated was more than HK\$ ■ million by September 2019 [S4].

Public Sectors: The DIMS lens is available to all eye care practitioners for prescription to the general public in both Hong Kong and the Mainland. At our optometry clinic at The Hong Kong Polytechnic University, ~1,000 pairs of DIMS lenses were prescribed from June 2018 to January 2019, representing ~25% of all the lenses prescribed during that period. To assist in the use and extend the

impact of our research, we have offered 25 training workshops/seminars since September 2017, in which there have been a total of 13,400 participants.

Government: The innovation of spectacle intervention to retard myopia has been recognized by the Hong Kong government. In her public speech to congratulate the winners of the 46th International Exhibition of Inventions Geneva, the Chief Executive of Hong Kong cited the DIMS lens as a good example of government funding [S5]. The citation of this lens, to attract IT talent, also appeared in the “Innovation” booklet distributed by the Hong Kong Government Innovation and Technology Bureau [S6].

Global: SO has continued to play an active role in developing general guidelines for clinical use. Two faculty members from SO served on the international experts’ panels for two white papers published in February 2019, in a renowned ophthalmology and vision research journal [S7, S8].

(5) Sources to corroborate the impact

[S1] Report posted in South China Morning Post, 14 Sep 2019, on the project to support disadvantaged children in Hong Kong with the myopia control lens.

<https://www.scmp.com/news/hong-kong/health-environment/article/3027181/cutting-edge-glasses-short-sighted-children-under>

[S2] Letter of appreciation: Participants of The Hong Kong Polytechnic University-HKIF 2019 project. (appended)

[S3] Letter of supports by the managing director of Hoya Lens Hong Kong Ltd. 23 Sep 2019. (appended)

[S4] Letter of supports by the director of Vision Science and Technology Co. Ltd. 9 Aug 2019. (appended)

[S5] Chief Executive's speech at the 46th Geneva International Invention Exhibition winners' reception. The HKSAR Government. 4 June 2018.

<https://www.info.gov.hk/gia/general/201806/04/P2018060400779.htm>

[S6] “Innovation” booklet distributed by Innovation and Technology Bureau. The HKSAR Government. July 2018.

<https://goo.gl/xHrprA>

[S7] White paper published by international myopia institute on clinical guidelines for managing myopia where our research is cited. Gifford KL, Richdale K, Kang P, Aller T A, **Lam CS**, Liu YM, Michaud L, Mulder J, Orr JB, Rose KA, Saunders KJ, Seidel D, Tideman JWL & Sankaridurg P. IMI - Clinical Management Guidelines Report. *Invest Ophthalmol Vis Sci* 2019; 60, M184-M203, doi:10.1167/iovs.18-25977.

<https://www.ncbi.nlm.nih.gov/pubmed/30817832>

[S8] White paper published by International Myopia Institute on interventions available for controlling myopia where our research is cited. Wildsoet CF, Chia A, **Cho P**, Guggenheim JA, Polling JR, Read S, Sankaridurg P, Saw SM, Trier K, Walline JJ, Wu PC & Wolffsohn JS. IMI - Interventions Myopia Institute: Interventions for Controlling Myopia Onset and Progression Report. *Invest Ophthalmol Vis Sci* 2019; 60, M106-M131, doi:10.1167/iovs.18-25958.

<https://www.ncbi.nlm.nih.gov/pubmed/30817829>