

1 ORIGINAL RESEARCH

2 Rocher et al

3 **Intraocular lens unfurling time exponentially decays**
4 **with increased solution temperature**

5 Erick E Rocher¹, Rishima Mukherjee¹, James Pitingolo¹, Eli Levenshus¹, Gwyneth Alexander¹,
6 Minyoung Park¹, Rupsa Acharya¹, Sarah Khan¹, Jordan Shuff¹, Andres Aguirre¹, Shababa Matin²,
7 Keith Walter³, Allen Eghrari⁴

8

9 ¹Center for Bioengineering Innovation and Design, Department of Biomedical Engineering, Johns
10 Hopkins University, Baltimore, MD, United States; ²Rice 360 Institute for Global Health
11 Technologies, Rice University, Houston, TX, United States; ³Department of Ophthalmology,
12 Wake Forest Baptist Health, Winston-Salem, NC, United States; ⁴Department of Ophthalmology,
13 Wilmer Eye Institute, Johns Hopkins University School of Medicine, Baltimore, MD, United States

14

15 Correspondence: Allen Eghrari

16 Department of Ophthalmology, Wilmer Eye Institute, Johns Hopkins University School of
17 Medicine, 400 N Broadway, Smith 5013, Baltimore, MD, United States, 21231

18 Email allen@jhmi.edu

19

20 **Supplementary Materials**

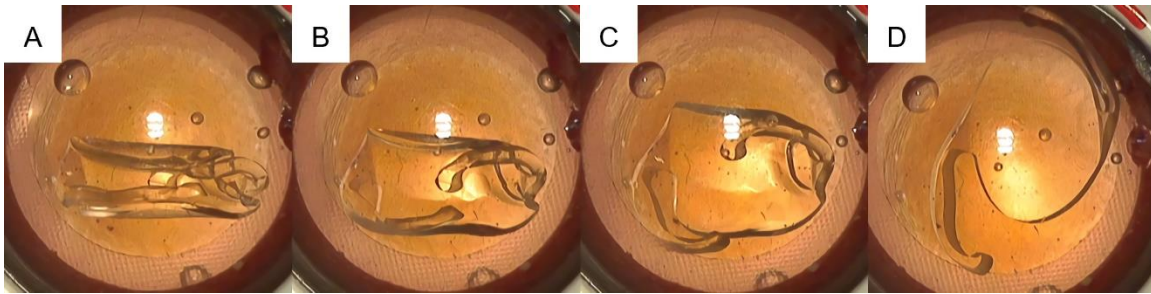
21

22

23

24

25



26

27 **Figure S1** IOL unfurling stages over time. This standardization allowed for consistent and
 28 unambiguous assessment of IOL unfurling following injection. **(A)** IOLs initially were fully furled
 29 with both haptics stuck to the optic. **(B)** Often, one haptic became free of the optic prior to the
 30 other haptic. **(C)** Eventually, both haptics were free of the optic. **(D)** IOLs were determined to be
 31 fully unfurled when the optic was round and planar. IOL = intraocular lens.

32

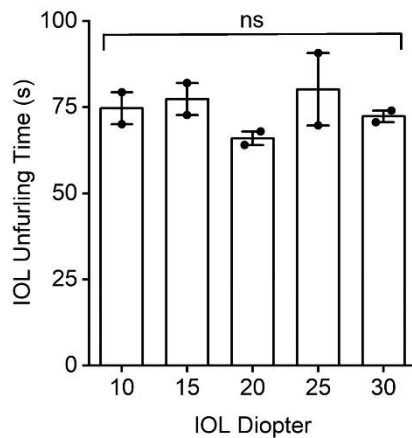
33 **Table S1** Descriptive statistics of IOL diopter used in each study. Multifocal IOLs are +3.0D and
 34 toric IOLs are 1.50-3.00 CYL.

Environment	Solution	Optic Type	Mean	SD	Minimum	Maximum
6-well plate	BSS	Toric	29.69	0.36	29.0	30.0
6-well plate	BSS	Monofocal	23.94	1.25	23.0	25.5
6-well plate	BSS	Multifocal	25.31	0.36	25.0	26.0
6-well plate	Dispersive OVD	Toric	28.88	0.34	28.5	29.5
6-well plate	Cohesive OVD	Toric	28.94	0.57	28.0	30.0
6-well plate	Dispersive OVD	Monofocal	21.69	0.96	20.0	23.0
6-well plate	Cohesive OVD	Monofocal	20.88	1.26	19.5	23.0
Plastic Eye	Dispersive OVD	Toric	26.67	0.65	26.0	27.5
Plastic Eye	Cohesive OVD	Toric	26.67	0.65	26.0	27.5

35

IOL = intraocular lens, BSS = balanced salt solution, OVD = ophthalmic viscoelastic device.

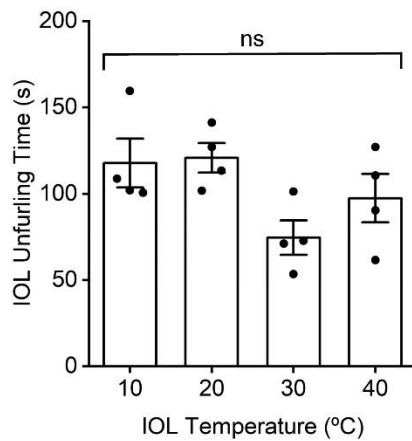
36



37

38 **Figure S2** IOL unfurling time is not affected by diopter *in vitro*. Toric IOLs (AcrySof SA6AT3,
 39 Alcon, Geneva, Switzerland) of diopters ranging from 10 to 30 were injected into a 6-well plate
 40 filled with BSS. The entirety of the experiment was conducted at room temperature (22°C). IOL =
 41 intraocular lens, BSS = balanced salt solution.

42



43

44 **Figure S3** Modulating the temperature of the IOL prior to injection did not significantly affect
 45 unfurling time *in vitro*. IOL diopters used in this study ranged from 24.5 to 25. IOL = intraocular
 46 lens.

47

48 **Table S2** Fitted functions for each model, determined from trials ranging from 20°C to 40°C. All
 49 models are two-parameter exponential functions (shown below). Significance was determined at
 50 the 0.05 level by comparing the fitted function against a function of constant IOL unfurling time.

51
$$y = ae^{bx}$$

52 y = intraocular lens unfurling time (s), x = solution temperature of respective model (°C)

Environment	Solution	Optic Type	$a \pm SE$	$b \pm SE$	R^2	Significance
6-well plate	BSS	Toric	17989 ± 53409	-0.23244 ± 0.14756	0.731	$P < 0.001$
6-well plate	BSS	Monofocal	72877 ± 85615	-0.29821 ± 0.05864	0.986	$P < 0.0001$
6-well plate	BSS	Multifocal	30383 ± 38086	-0.26368 ± 0.06248	0.967	$P < 0.0001$
6-well plate	Dispersive OVD	Toric	30644 ± 85980	-0.23304 ± 0.13945	0.738	$P < 0.0001$
6-well plate	Cohesive OVD	Toric	3879.9 ± 1739.5	-0.16192 ± 0.02186	0.961	$P < 0.0001$
6-well plate	Dispersive OVD	Monofocal	14476 ± 22317	-0.21515 ± 0.07643	0.866	$P < 0.0001$
6-well plate	Cohesive OVD	Monofocal	7306.2 ± 4068.7	-0.1823 ± 0.02739	0.962	$P < 0.0001$

53 IOL = intraocular lens, BSS = balanced salt solution, OVD = ophthalmic viscoelastic device.