

# Canadian Opinions on Refractive Surgery and Approaches to Presbyopia Correction

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## Abstract

**Purpose:** To explore the opinions of Canadian ophthalmologists on refractive and presbyopia-correcting surgeries.

**Methods:** We distributed an online survey to the Canadian Ophthalmological Society members, covering laser refractive surgery (LRS), femtosecond laser-assisted cataract surgery (FLACS), lenticular refractive surgery (lenRS) that includes cataract refractive surgery (CRS) with premium intraocular lens (IOL) implantation, and presbyopia correction.

**Results:** There were 68 (7.6%) total respondents. Most respondents would not consider LRS (62.5%) nor FLACS (73.9%) for themselves. Male sex and performance of LRS or FLACS was significantly associated with consideration of these procedures for self. Most respondents (59.3%) would consider lenRS for themselves. The top method of personal presbyopia correction was spectacles, chosen by 52.5%.

**Conclusions:** When surveying the wide body of Canadian ophthalmologists, most respondents preferred spectacle correction of presbyopia and would consider lenRS, but not LRS or FLACS for themselves. Surgeons performing these procedures were more likely to consider them for self.

**Keywords:** Femtosecond laser-assisted cataract surgery, Intraocular lens, Presbyopia, Refractive surgery

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**Submitted:** 05-Aug-2019; **Revised:** 16-Oct-2019; **Accepted:** 23-Oct-2019; **Published:** 23-Mar-2020

## INTRODUCTION

Laser refractive surgery (LRS) is a common and successful surgical option<sup>1</sup> for refractive error, a leading cause of visual impairment.<sup>2</sup> Lenticular refractive surgery (lenRS), defined as refractive lens exchange (RLE), phakic intraocular lens (IOL) implantation, and cataract refractive surgery (CRS) with premium IOL implantation (i.e. toric and multifocal, etc.), is another approach. These topics and more were explored among the American Society of Cataract and Refractive Surgery (ASCRS) membership.<sup>3</sup> Here, we present a Canadian perspective.

## METHODS

Ethics approval was granted through the Conjoint Health Research Ethics Board at the University of Calgary.

Online survey distribution through the Canadian Ophthalmological Society (COS) e-mail list of approximately 900 ophthalmologists ran from November 2017 to January 2018. The survey was subdivided into demographics, LRS, femtosecond laser-assisted cataract surgery (FLACS), lenRS, and presbyopia approaches, with participants able to skip sections as desired. A summary of survey questions is given in Supplemental File 1.

Pearson's Chi-square analysis was performed using IBM SPSS Statistics for Windows (Version 19.0. Armonk, NY, USA: IBM Corp.; 2010). Variables included age (divided into quartiles), gender, stage of practice (5 years or fewer, 6–15 years, and >15 years of practice), location of training (Canada vs. not), and subspecialty (cornea and/or refractive vs. not).

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**How to cite this article:** Chung H, Sanders E, Rocha G, Bhamra J. Canadian opinions on refractive surgery and approaches to presbyopia correction. *J Curr Ophthalmol* 2020;32:99-102.

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**DOI:**  
10.4103/JOCO.JOCO\_50\_20

## RESULTS

There were 68 (7.6%) total responses. Demographics are summarized in Table 1.

### Laser refractive surgery

Of 48 respondents to this section of questions, 20 (41.7%) performed LRS and 18 (37.5%) would consider LRS for themselves, with 3 (16.7%) having already undergone LRS. In total, 19 (39.6%) respondents would consider LRS for themselves if refractive error existed. The top reason given against considering LRS for self was worry over complications, though this was significantly less among those who performed LRS compared to those who did not ( $n = 1$  out of 16; 6.3% vs.  $n = 15$  out of 27; 55.6%) ( $\chi^2[1] = 10.453, P = 0.001$ ). A summary of reasons given for not undergoing LRS is given in Supplemental Table 1.

Surgeon performing LRS ( $\chi^2[1] = 10.505, P = 0.001$ ) and male gender ( $\chi^2[1] = 7.771, P = 0.005$ ) were associated with considering LRS for self. No association was found with age, stage of practice, location of training, nor identifying as a cornea or refractive subspecialist.

### Femtosecond laser-assisted cataract surgery

Of 46 (5.1%) respondents, 10 (21.7%) performed FLACS and 2 (4.3%) had plans to start performing FLACS within the next year. Thirty-four (73.9%) respondents would not personally undergo FLACS over conventional phacoemulsification. The top reasons given were unacceptable cost-benefit ratio, not enough evidence for efficacy, and not enough evidence for safety.

Surgeon performing FLACS ( $\chi^2[1] = 15.795, P = 0.000$ ) and male gender ( $\chi^2[1] = 5.730, P = 0.017$ ) were associated with consideration of FLACS for self. There was no association with age, stage, location, consideration of LRS, nor identifying as a cornea or refractive subspecialist.

### Lenticular refractive surgery

Of 54 (6.0%) respondents, 49 (90.7%) performed lenRS. Thirty-two (59.3%) respondents would consider lenRS for themselves, with 1 (1.9%) having already had this completed.

Consideration of LRS for self was associated with consideration of lenRS for self ( $\chi^2[1] = 8.975, P = 0.003$ ); therefore, those who would consider undergoing LRS were more willing to undergo lenRS. There was no association with age, gender, stage, location, identifying as a cornea or refractive subspecialist, nor surgeon performing lenRS.

IOLs offered and considered for self are summarized in Table 2. Quality of vision and high patient satisfaction were the top reasons given by those who selected monofocal IOLs for self. Offering presbyopia-correcting IOLs was not associated with increased selection of these for self.

### Presbyopia correction

There were 61 (6.8%) respondents. Presbyopia-correcting approaches offered and considered for self by respondents are summarized in Table 3. The top reason for personally selecting a non-surgical approach was lower risk involved.

**Table 1: Demographic features of survey respondents**

	Number of respondents (percentage of respondents)
Total	68
Age group (years)	
30 and younger	2 (2.9)
31-40	20 (29.4)
41-50	7 (10.3)
51-60	19 (27.9)
61 and older	16 (23.5)
Missing	4 (5.9)
Total	68 (100)
Gender	
Male	51 (75.0)
Female	17 (25.0)
Total	68 (100)
Years in practice (years)	
5 and under	15 (22.1)
6-15	15 (22.1)
16 and over	38 (55.9)
Total	68 (100)
Location of training	
Canada only	45 (66.2)
Canada and US	13 (19.1)
Canada and non-US location	4 (5.9)
US only	3 (4.4)
Non-Canada or US location	2 (2.9)
Missing	1 (1.5)
Total	68 (100)
Location of practice	
Canada	66 (97.1)
US	1 (1.5)
Non-North American location	1 (1.5)
Total	68 (100)
Specialties*	
Comprehensive	36 (52.9)
Anterior segment	20 (29.4)
Glaucoma	12 (17.6)
Cornea	8 (11.8)
Oculoplastics	7 (10.3)
Medical retina	6 (8.8)
Vitreoretinal surgery	4 (5.9)
Refractive	3 (4.4)
Neuro-ophthalmology	2 (2.9)
Uveitis	2 (2.9)
Ocular oncology	2 (2.9)
Pediatrics	1 (1.5)
Total	68 (100)

\*Respondents were able to select more than one option

Self-identifying as a cornea or refractive subspecialist ( $\chi^2[1] = 4.665, P = 0.031$ ) and consideration of LRS for self ( $\chi^2[1] = 5.403, P = 0.020$ ) were associated with consideration of intraocular presbyopia-correcting surgical approaches for self. There was no association with age, gender, stage of practice, location of training, nor with the surgeon performing any intraocular presbyopia-correcting procedure.

## DISCUSSION

We aimed to compare the broad Canadian perspective on refractive surgery against the ASCRS cohort.<sup>3</sup> Notably, our demographics were different compared to the previous surveys that were directed primarily toward refractive surgeons.<sup>3-5</sup>

Previous LRS among Canadian ophthalmologists ( $n=3, 6.3\%$ ) was lower than the reported rates of 21.0%–63.6%.<sup>3-5</sup> Consideration of LRS for self was also lower at 36.9% compared to 51.5%.<sup>3</sup> As surgeon performance of LRS was associated with consideration of LRS for self, this may reflect the overall lower proportion of our respondents who perform LRS ( $n = 20, 41.7\%$ ).

The US Trends in Refractive Surgery Survey reported a penetrance of LRS among respondents of 30–33%.<sup>4</sup> The authors then noted that this is 3–4 times the rate of LRS among the general population.<sup>4</sup> Thus the rate of LRS among Canadian ophthalmologist that we report of 6.3% is roughly similar to that of the American public.

**Table 2: Intraocular lenses offered to patients and preferred for self by respondents**

	Percentage of respondents		
	IOL(s) offered to patients*	IOL(s) considered for self*	Top IOL choice for self
Monofocal	51 (94.4)	45 (83.3)	22 (40.7)
Toric	48 (88.9)	34 (63.0)	18 (33.3)
Multifocal	27 (50.0)	8 (14.8)	2 (3.7)
Multifocal/toric	25 (46.3)	6 (11.1)	4 (7.4)
Trifocal	16 (29.6)	10 (18.5)	3 (5.6)
EDOF	24 (44.4)	11 (20.4)	5 (9.3)
Light-adjusted	0 (0)	2 (3.7)	0 (0)
Total	54 (100)	54 (100)	54 (100)

\*Respondents were able to select more than one option. IOL: Intraocular lens; EDOF: Extended depth of focus

Thirty-four (73.9%) respondents would not consider FLACS for themselves compared to 53.4% of the ASCRS cohort.<sup>3</sup> As with LRS, a surgeon performing FLACS increased consideration of FLACS for self. Given our low rate of performance of FLACS ( $n = 10, 27.7\%$ ), this may explain the discrepancy.

Thirty-two (59.3%) respondents would consider lenRS for themselves, which is higher than the 45.3% of the ASCRS cohort.<sup>3</sup> LenRS includes CRS and RLE, both similar procedures to standard phacoemulsification in terms of technique and risks. This may explain why a surgeon currently performing lenRS was not associated with increased willingness to undergo lenRS. The increased consideration of lenRS for self does not appear to be related to the lower rates of LRS, as only 3 (10%) respondents who have not undergone LRS stated that they preferred an intraocular approach. Although location of training was not statistically significantly associated, most respondents ( $n = 62, 91.2\%$ ) did some training in Canada, and thus, the robustness of the analysis may be challenged, given the large difference in group size. There is a difference between US and Canadian residency programs in terms of cataract surgery cases. A survey of US ophthalmology program directors reported a mean of 155 phacoemulsification surgeries as primary surgeon among graduates.<sup>6</sup> Another survey of the ASCRS Young Physicians and Residents Membership found that 60% and 78% of the respondents had no experience implanting a toric or presbyopia-correcting IOL, respectively.<sup>7</sup> Comparatively, a survey sent to Canadian ophthalmology residents in 2016 reported an average of 328 phacoemulsification surgeries among graduates (author’s own data not yet published). A sampling of 2018 ophthalmology graduates across Canada, one from each program, found 13/15 and 8/15 implanted at least one toric or presbyopia-correcting IOL during residency, respectively (author’s personal

**Table 3: Approaches to presbyopia offered to patients and preferred for self by respondents**

Approaches	Percentage of respondents		
	Offered to patients*	Considered for self*	Top choice for self
Natural monovision	N/A (N/A)	4 (6.6)	1 (1.6)
Natural mild myopia	N/A (N/A)	20 (32.8)	11 (18.0)
Glasses (readers, etc.)	56 (91.8)	45 (73.8)	32 (52.5)
Bi/multifocal CL	36 (59.0)	12 (19.7)	3 (4.9)
Monovision via CL	36 (59.0)	6 (9.8)	0 (0)
Bi/multifocal cornea via LRS	5 (8.2)	1 (1.6)	0 (0)
Monovision via LRS	22 (36.1)	3 (4.9)	1 (1.6)
Corneal inlays	2 (3.3)	0 (0)	0 (0)
Multifocal IOL	23 (37.7)	4 (6.6)	1 (1.6)
Trifocal IOL	16 (26.2)	4 (6.6)	4 (6.6)
EDOF IOL	28 (45.9)	5 (8.2)	2 (3.3)
Accommodative IOL	1 (1.6)	0 (0)	0 (0)
Light-adjustable IOL	0 (0)	1 (1.6)	0 (0)
Monovision via LenRS	41 (67.2)	12 (19.7)	6 (9.8)
Total	61 (100)	61 (100)	61 (100)

\*Respondents were able to select more than one option. CL: Contact lens, LRS: Laser refractive surgery, IOL: Intraocular lens, EDOF: Extended depth of focus, LenRS: Lenticular refractive surgery, N/A: Not available

communication, June 9, 2019). This may contribute to higher consideration of lenRS among the COS group, given overall increased exposure to intraocular surgery during training.

Monofocal and toric IOLs have been reported as most popular among ophthalmologists for personal use due to patients' satisfaction with these lenses.<sup>3</sup> Our survey concurs with 40.7% and 33.3% of respondents choosing these lenses for themselves, respectively.

Thirty-two (52.5%) respondents personally preferred spectacles for presbyopia correction. Identifying as a corneal or refractive subspecialist was associated with increased likelihood of preferring an intraocular approach to presbyopia correction for self, though the performance of these procedures was not.

Limitations included having an online survey format with primarily close-ended questions. Our low response rate may contribute to response bias, yet online surveys among physicians often have low uptake.<sup>8</sup> In online surveys, response representativeness may be more important,<sup>9</sup> and we feel we were able to collect responses from a range of ophthalmologists with different practices. Sensitivity analyses were also completed to determine impact of different demographic factors on main survey responses.

In summary, our survey reports on the views on refractive surgery and presbyopia correction of the broader Canadian ophthalmology community. This makes it difficult to compare results against previous surveys that were primarily sent to refractive surgeons.<sup>3-5</sup> Canadian ophthalmologists were less likely to consider LRS or FLACS, yet more likely to consider lenRS for self. Spectacle correction for presbyopia was also preferred over more invasive procedures for self. This may reflect exposure to these procedures during training, as well as the rate of performance of these procedures among respondents. Regarding whether we are truly 'practicing what we preach,' it is difficult to conclude without more

information on the penetrance of these procedures among the Canadian public. However, those actively practicing LRS or FLACS and those identifying as cornea or refractive subspecialists were more likely to undergo these procedures among our respondents, which is supported in other similar surveys.<sup>4,5</sup>

### **Acknowledgments**

This research received a grant from the Calgary Eye Foundation, which had no input into study design or data interpretation.

### **Conflicts of interest**

There are no conflicts of interest.

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## SUPPLEMENTAL FILE

### **Supplemental File 1: Summary of survey questions**

#### *Canadian Opinions on Refractive Surgery and Approaches to Presbyopia Correction*

##### **Section 1: Demographics**

1. What is your gender?
  - Male
  - Female
  - Other
2. What is your age? \_\_\_\_\_
3. How many years into practice are you? \_\_\_\_\_
4. In what country did you complete residency? \_\_\_\_\_
5. In what country did you complete your fellowship(s)? \_\_\_\_\_
6. What is your area of subspecialty? Please check all that apply.
  - General ophthalmology
  - Anterior segment surgery
  - Cornea
  - Glaucoma
  - Medical retina
  - Neuro-ophthalmology
  - Ocular oncology
  - Oculoplastics
  - Ophthalmic pathology
  - Pediatrics
  - Uveitis
  - Vitreo-retinal
  - Other: \_\_\_\_\_

##### **Section 2: Laser refractive surgery**

1. Do you or have you performed laser refractive surgery?
  - Yes
  - No
2. Would you personally have laser refractive surgery performed?
  - Yes and I have had it performed → skip to Section 3
  - Yes but I have not had it performed yet
  - No
3. What is/are your reason(s) for not having laser refractive surgery performed, either yet or at all? Please check all that apply.
  - Visual acuity does not require correction but if it did I WOULD undergo laser refractive surgery
  - Visual acuity does not require correction but if it did I WOULD NOT undergo laser refractive surgery
  - Have not had an opportunity to have it performed yet
  - Do not trust the current refractive surgery technology
  - Waiting for better refractive surgery technology to emerge
  - Prefer intraocular techniques such as phakic intraocular lens (IOL) or refractive lens exchange
  - Contraindication - abnormal curvature of cornea
  - Contraindication - corneal ectasia
  - Contraindication - concomitant eye disease, such as glaucoma
  - Contraindication - cornea too thin
  - Contraindication - corneal scarring
  - Contraindication - dry eyes
  - Contraindication - high refractive error and/or astigmatism
  - Contraindication - physical limitations against the procedure, such as deep-set eyes
  - Contraindication - underlying systemic disorder
  - Contraindication - recurrent corneal erosion

- Contraindication - other
- Intolerable Side Effect - dry eyes
- Intolerable Side Effect - glare/halo/starbursts
- Intolerable Side Effect - irregular astigmatism
- Intolerable Side Effect - over- or under-corrected vision
- Intolerable Side Effect - poor night vision
- Intolerable Side Effect - other
- Complication Risk - cataract formation
- Complication Risk - corneal inflammation and scarring
- Complication Risk - infection
- Complication Risk - retinal detachment
- Complication Risk - other
- Other: \_\_\_\_\_

### Section 3: Femtosecond laser-assisted cataract surgery

1. Do you perform femtosecond laser-assisted cataract surgery (FLACS)?
  - Yes
  - Not yet but I plan to within the next year
  - No and I have no plans to pursue this within the next year
2. If you needed cataract surgery, would you have FLACS done over conventional phacoemulsification cataract surgery?
  - Yes → skip to Section 4
  - No
3. Why not FLACS over conventional phacoemulsification cataract surgery? Please check all that apply.
  - Cost for level of benefit is not acceptable
  - Not enough evidence for safety
  - Not enough evidence for efficacy
  - Ophthalmologists need time to transcend the steep learning curve
  - Prefer conventional phacoemulsification cataract surgery
  - Other: \_\_\_\_\_

### Section 4: Lenticular refractive surgery

1. Do you perform lenticular refractive surgery (i.e., cataract refractive surgery which includes toric IOL and presbyopia-correcting IOL implantation; phakic IOL; or refractive lens exchange)?
  - Yes
  - No
2. Would you personally undergo lenticular refractive surgery (i.e. cataract refractive surgery which includes toric IOL and presbyopia-correcting IOL implantation; phakic IOL; or refractive lens exchange)?
  - Yes and I already have
  - Yes but not yet
  - No
3. What IOL options do you offer your patients? Please check all that apply.
  - Monofocal
  - Toric
  - Multifocal
  - Multifocal/Toric Combination
  - Trifocal
  - Extended range-of-focus
  - Accommodative
  - Light-adjustable lens
  - Other: \_\_\_\_\_
4. Which IOL option(s) would you consider for yourself? Please check all that apply.
  - Monofocal
  - Toric
  - Multifocal

- Multifocal/Toric Combination
  - Trifocal
  - Extended range-of-focus
  - Accommodative
  - Light-adjustable lens
  - Other: \_\_\_\_\_
5. If you had to select a single IOL option for yourself, which IOL would you choose?
- Monofocal
  - Toric
  - Multifocal
  - Multifocal/Toric Combination
  - Trifocal
  - Extended range-of-focus
  - Accommodative
  - Light-adjustable lens
  - Other: \_\_\_\_\_
6. Why this IOL? Please check all that apply.
- I desire both near/intermediate/distance vision with less dependence on glasses
  - Monovision with this lens results in better near/intermediate/distance vision than presbyopia-correcting IOLs
  - This lens offers better near/intermediate/distance vision than other presbyopia-correcting IOLs
  - Evidence-based efficacy
  - Quality of vision is best with this lens
  - My patients report high satisfaction with this lens
  - Cost-effective option for my needs
  - Familiarity with lens
  - I have amblyopia
  - I have other ocular pathology that precludes insertion of a premium IOL
  - Recommended to me by my ophthalmologist
  - Recommended to me by a friend/family member
  - Other: \_\_\_\_\_

### Section 5: Presbyopia correction options

1. Which presbyopia treatment options do you recommend and/or offer to your patients?
- Glasses (reading glasses, bifocals, progressives, etc.)
  - Contact lenses (bifocal, multifocal, etc.)
  - Achieving monovision or mini-monovision via contact lenses
  - Laser blended vision or presbyLASIK
  - Achieving monovision or mini-monovision via laser refractive surgery
  - Refractive corneal inlays (e.g., Flexivue)
  - Corneal reshaping inlays (e.g., Raindrop)
  - Small aperture corneal inlays (e.g., KAMRA)
  - Lenticular surgery with multifocal IOL
  - Lenticular surgery with trifocal IOL
  - Lenticular surgery with extended range-of-focus IOL
  - Lenticular surgery with accommodative IOL
  - Lenticular surgery with light-adjustable IOL
  - Achieving monovision or mini-monovision via lenticular refractive surgery
  - Other: \_\_\_\_\_
2. Which presbyopia treatment option(s) would you choose for yourself? Please check all that apply.
- I already have monovision or mini-monovision based on my original refraction
  - I have mild myopia and can take my glasses off for near work
  - Glasses (reading glasses, bifocals, progressives, etc.)
  - Contact lenses (bifocal, multifocal, etc.)
  - Achieving monovision or mini-monovision via contact lenses
  - Laser blended vision or presbyLASIK

- Achieving monovision or mini-monovision via laser refractive surgery
  - Refractive corneal inlays (e.g., Flexivue)
  - Corneal reshaping inlays (e.g., Raindrop)
  - Small aperture corneal inlays (e.g., KAMRA)
  - Lenticular surgery with multifocal IOL
  - Lenticular surgery with trifocal IOL
  - Lenticular surgery with extended range-of-focus IOL
  - Lenticular surgery with accommodative IOL
  - Lenticular surgery with light-adjustable IOL
  - Achieving monovision or mini-monovision via lenticular refractive surgery
  - Other: \_\_\_\_\_
3. If forced to select a single presbyopia treatment option for yourself, which of the following would you choose or have you already chosen?
- I already have monovision or mini-monovision based on my original refraction
  - I have mild myopia and can take my glasses off for near work
  - Glasses (reading glasses, bifocals, progressives, etc.)
  - Contact lenses (bifocal, multifocal, etc.)
  - Achieving monovision or mini-monovision via contact lenses
  - Laser blended vision or presbyLASIK
  - Achieving monovision or mini-monovision via laser refractive surgery
  - Refractive corneal inlays (e.g., Flexivue)
  - Corneal Reshaping inlays (e.g., Raindrop)
  - Small aperture corneal inlays (e.g., KAMRA)
  - Lenticular surgery with multifocal IOL
  - Lenticular surgery with trifocal IOL
  - Lenticular surgery with extended range-of-focus IOL
  - Lenticular surgery with accommodative IOL
  - Lenticular surgery with light-adjustable IOL
  - Achieving monovision or mini-monovision via lenticular refractive surgery
  - Other: \_\_\_\_\_
4. Why did you select this presbyopia treatment option? \_\_\_\_\_

**Supplemental Table 1: Summary of reasons for unwillingness to undergo laser refractive surgery (LRS) given by respondents**

Reasons for not undergoing LRS*	Number of respondents (percentage of respondents)
Worry over complications	13 (43.3)
Corneal inflammation	7 (23.3)
Infection	6 (20.0)
Cataract formation	3 (10.0)
Retinal detachment	3 (10.0)
Other (nonspecified)	7 (23.3)
Worry over intolerable side effect(s)	6 (20.0)
Dry eyes	5 (16.7)
Glare/halo	2 (6.7)
Other (non-specified)	2 (6.7)
Contraindication(s) exist	4 (13.3)
Dry eyes	3 (10.0)
Concomitant eye disease, such as glaucoma	1 (3.3)
Visual acuity does not require correction (but if it did, not willing to undergo LRS)	5 (16.7)
Visual acuity does not require correction (but if it did, willing to undergo LRS)	1 (3.3)
Distrust current technology	3 (10.0)
Waiting for better technology	3 (10.0)
Happy with glasses/contact lenses	5 (16.7)
Prefer intraocular approach	2 (6.7)
Total	30 (100)

\*Respondents were able to select more than one option. LRS: Laser refractive surgery