Comparative effectiveness of multifocal, accommodative, and monofocal intraocular lenses for cataract surgery and lens replacement

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Disclosure

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Evidence-based Synthesis Program (ESP)

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VA Evidence-based Synthesis Program (ESP) Overview

Sponsored by the Quality Enhancement Research Initiative (QUERI)

Four centers: Los Angeles, CA; Portland, OR; Durham, NC; Minneapolis, MN

Reports help provide timely and accurate syntheses/reviews to support:

- Development of clinical policies informed by evidence;
- Implementation of effective services to improve patient outcomes and to support VA clinical practice guidelines and performance measures;
- The direction of future research to address gaps in clinical knowledge.

Topics identified by VA clinicians, managers, and policy-makers using online topic nomination process:

http://www.hsrd.research.va.gov/publications/esp/TopicNominationForm.pdf

Evidence-based Synthesis Program (ESP)

Our Team

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Background

- A cataract is clouding of the natural lens in the eye which performs focusing

- Cataract extraction is one of the most commonly performed ophthalmic surgeries, with 18 million surgeries occurring annually and estimated to reach 24 million in the next few years.

- Phacoemulsification is the standard of care, involving removal of the cloudy cataract and replacement with a prosthetic intraocular lens implant (IOL)

- Intraocular lens implants differ from the natural lens in a patient under 40 years old in that it cannot change shape to focus on multiple planes

- Multiple IOL options are available

Types of intraocular lens implants (IOL)

- Monofocal
    - "Gold standard"
    - Fixed focal length
    - Usually set at far distance
    - Need glasses for near/reading

- Multifocal
    - Newer, "advanced"
    - Multiple focal points
    - Able to focus at far and near
    - May decrease need for glasses
    - Possible unwanted side effects
    - Contraindications for use

- Accommodative
    - Another "advanced" lens design
    - IOL is "hinged"
    - Movement within the eye produces multiple focal points
    - May not be as predictable as Multifocal lens

4 Key Questions

1. What is the effectiveness of multifocal or accommodative versus monofocal lenses with spectacle correction for distance vision in the setting of cataract surgery?

2. What is the effectiveness of multifocal or accommodative versus monofocal lenses with spectacle correction for near vision in the setting of cataract surgery?

3. What are the harms associated with multifocal or accommodative lenses versus monofocal replacement in the setting of cataract surgery?

4. If feasible, what resources are required to best care for patients who choose multifocal or accommodative lens implants in the setting of cataract surgery?

RESULTS

Selection of Studies

760 References

93 Publications

667 References

Excluded by stakeholders:
- Not available in the United States
- Not currently available in the VA
- ?older technology

81 Publications

No monofocal comparison group: 21
Not intervention of interest: 9
Not lens of interest: 30
Not outcome of interest: 2
Not RCT: 16
Commentary: 1
Background: 1
Duplicate: 1

12 Includes

- Study design
- Sample size
- Number of sites
- Country of origin
- Patient characteristics
- Intervention lenses
- Comparison monofocal lens
- Duration of follow-up
- Outcomes reported

Key Question 1

What is the effectiveness of multifocal or accommodative versus monofocal lenses with spectacle correction for distance vision in the setting of cataract surgery?

Main outcome measures

- Distance visual acuity
    - Uncorrected
        - 7 studies, 17 comparisons, 899 patients
    - Corrected
        - 6 studies, 15 comparisons, 899 patients

Key Question 1 – *Distance Vision*

No difference between Monofocal and Multifocal IOL in regards to uncorrected or corrected distance VA

Corrected Distance VA (logMAR)

Author, Year	Multifocal Group	Multifocal Sample Size	Monofocal Sample Size	Mean Difference [95% CI]
Alio, 2011.1	AcrySof ReSTOR SN6AD3	78	72	0.02 [−0.01, 0.05]
Alio, 2011.2	Acri.LISA 366D	84	72	0.02 [−0.01, 0.05]
Alio, 2011.3	Rezoom NXG1	70	72	0.02 [−0.01, 0.05]
Cillino, 2008.1	Array SA40N	16	15	0.01 [−0.05, 0.07]
Cillino, 2008.2	ReZoom NXG1	15	15	0.01 [−0.10, 0.11]
Cillino, 2008.3	Tecnis ZM900	16	15	0.00 [−0.11, 0.12]
Ji, 2012	Acrysof ReSTOR	24	27	0.02 [−0.08, 0.12]
Palmer, 2008.1	Tecnis MFIOL ZM900	26	24	−0.03 [−0.06, −0.00]
Palmer, 2008.2	ReZoom (zonal refractive)	32	24	−0.02 [−0.05, 0.01]
Palmer, 2008.3	TwinSet	32	24	−0.06 [−0.09, −0.03]
Peng, 2012	ReSTOR Sn6AD1	50	51	0.02 [−0.01, 0.05]
Rasp, 2012.1	AT.LISA 366d	28	29	0.02 [−0.03, 0.07]
Rasp, 2012.2	Acrysof ReStor SN6AD3	30	29	0.08 [0.02, 0.14]
Rasp, 2012.3	Rezoom NXG1	30	29	0.04 [−0.01, 0.09]
Rasp, 2012.4	TecnisMF ZMA00	26	29	0.02 [−0.03, 0.07]
Zeng, 2007.1	Tecnis Z9001 Aspheric	40	45	−0.01 [−0.02, −0.00]
Zeng, 2007.2	Array SA40N	39	45	0.00 [−0.01, 0.01]

$I^2 = 79.2\%$
RE Model
Total Sample Size = 899

0.01 [−0.01, 0.03]

Favors Multifocal   Favors Monofocal

−0.1   −0.05   0   0.05   0.1

Key Question 1 – *Other Comparisons*

Multifocal vs. monovision

- 2 studies identified
- No significant difference in uncorrected distance VA

Accommodative vs. monofocal

- 1 study identified
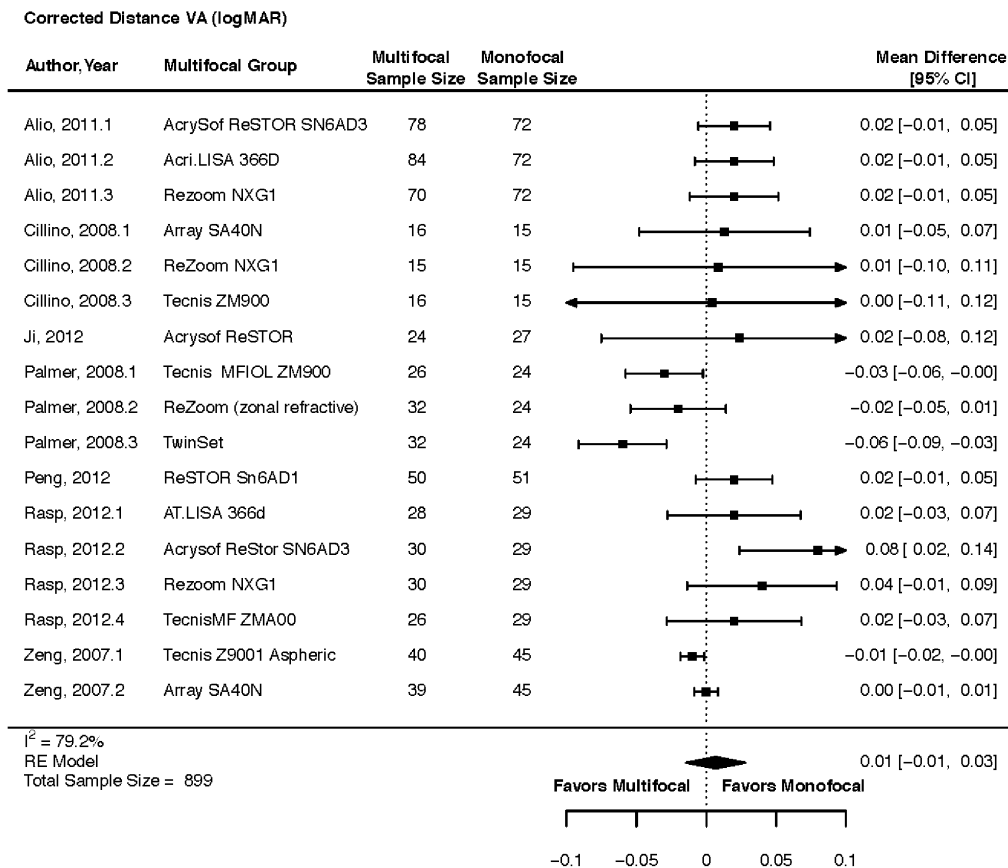- No significant difference in corrected distance VA

Key Question 2

What is the effectiveness of multifocal or accommodative versus monofocal lenses with spectacle correction for near vision in the setting of cataract surgery?
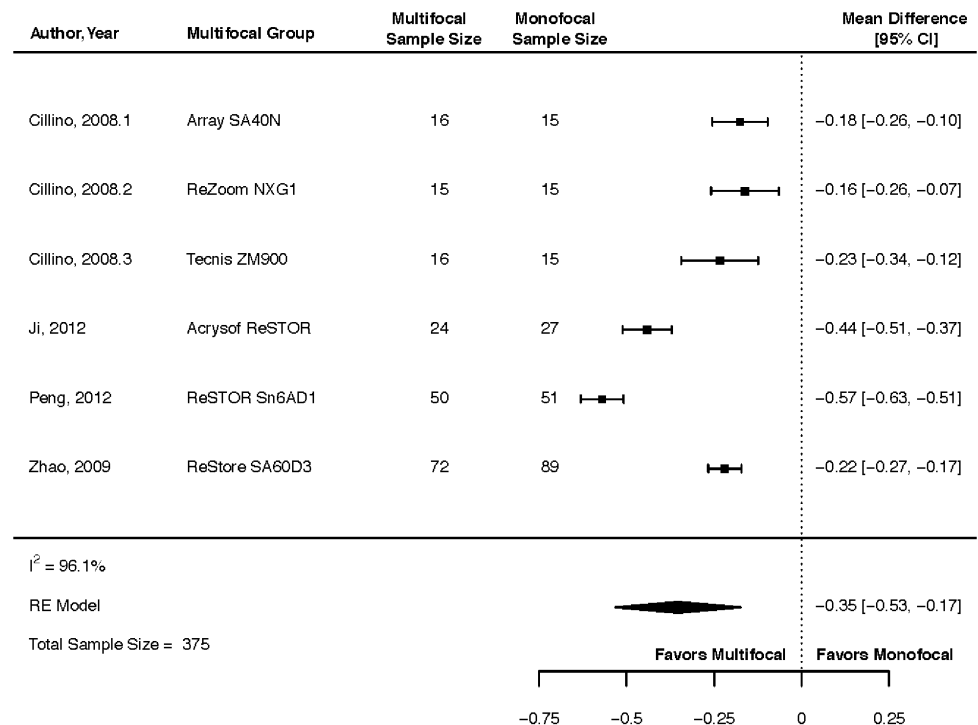
Main outcome measures

- Uncorrected near vision

- Spectacle independence

- Visual function/quality of life
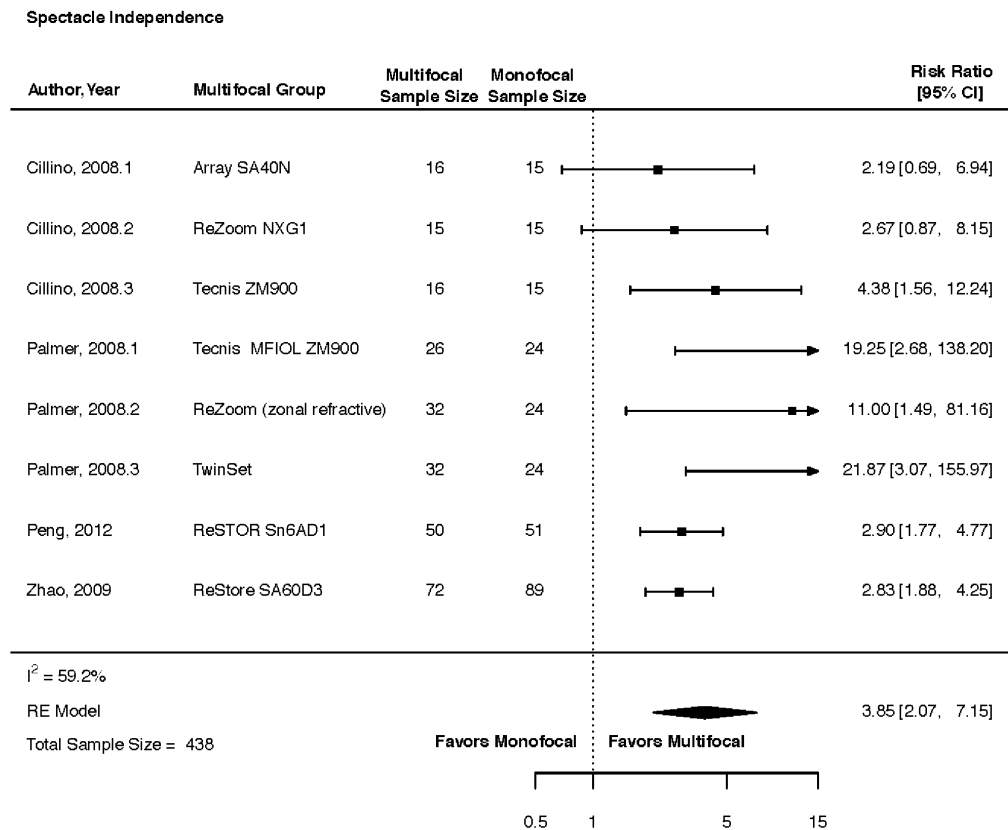
Key Question 2 – *Uncorrected Near Vision*

- 4 RCT's
  - 6 comparisons
  - 375 patients
- Multifocal *favored* over monofocal

Uncorrected Near VA (logMAR)

Author, Year	Multifocal Group	Multifocal Sample Size	Monofocal Sample Size		Mean Difference [95% CI]
Cillino, 2008.1	Array SA40N	16	15		−0.18 [−0.26, −0.10]
Cillino, 2008.2	ReZoom NXG1	15	15		−0.16 [−0.26, −0.07]
Cillino, 2008.3	Tecnis ZM900	16	15		−0.23 [−0.34, −0.12]
Ji, 2012	Acrysof ReSTOR	24	27		−0.44 [−0.51, −0.37]
Peng, 2012	ReSTOR Sn6AD1	50	51		−0.57 [−0.63, −0.51]
Zhao, 2009	ReStore SA60D3	72	89		−0.22 [−0.27, −0.17]

I^2 = 96.1%

RE Model −0.35 [−0.53, −0.17]

Total Sample Size = 375

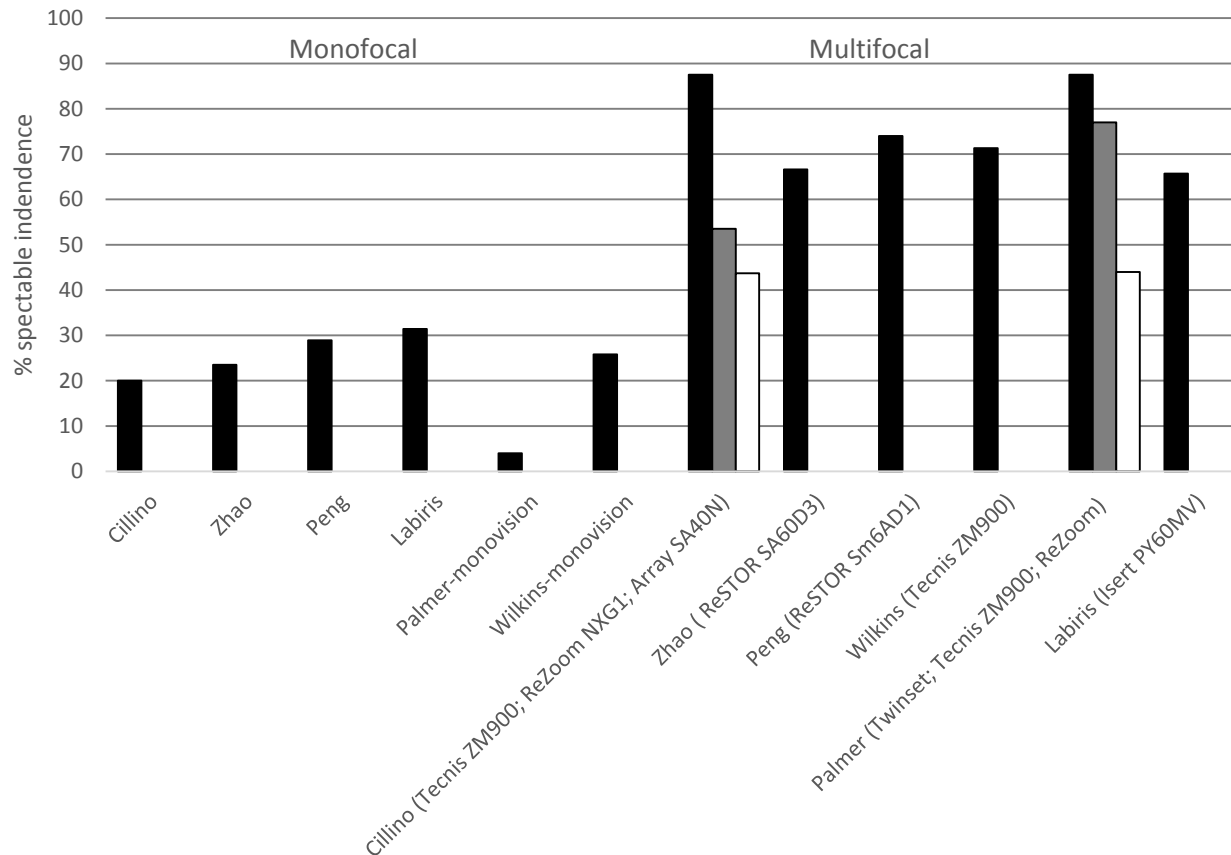Favors Multifocal | Favors Monofocal

−0.75 −0.5 −0.25 0 0.25

Key Question 2 – *Spectacle Independence*

- 4 RCT's
  - 8 comparisons
  - 438 patients
- Multifocal favored over monofocal

Spectacle Independence

Author, Year	Multifocal Group	Multifocal Sample Size	Monofocal Sample Size	Risk Ratio [95% CI]
Cillino, 2008.1	Array SA40N	16	15	2.19 [0.69, 6.94]
Cillino, 2008.2	ReZoom NXG1	15	15	2.67 [0.87, 8.15]
Cillino, 2008.3	Tecnis ZM900	16	15	4.38 [1.56, 12.24]
Palmer, 2008.1	Tecnis MFIOL ZM900	26	24	19.25 [2.68, 138.20]
Palmer, 2008.2	ReZoom (zonal refractive)	32	24	11.00 [1.49, 81.16]
Palmer, 2008.3	TwinSet	32	24	21.87 [3.07, 155.97]
Peng, 2012	ReSTOR Sn6AD1	50	51	2.90 [1.77, 4.77]
Zhao, 2009	ReStore SA60D3	72	89	2.83 [1.88, 4.25]

I^2 = 59.2%

RE Model — 3.85 [2.07, 7.15]

Total Sample Size = 438

Favors Monofocal | Favors Multifocal

0.5　1　5　15

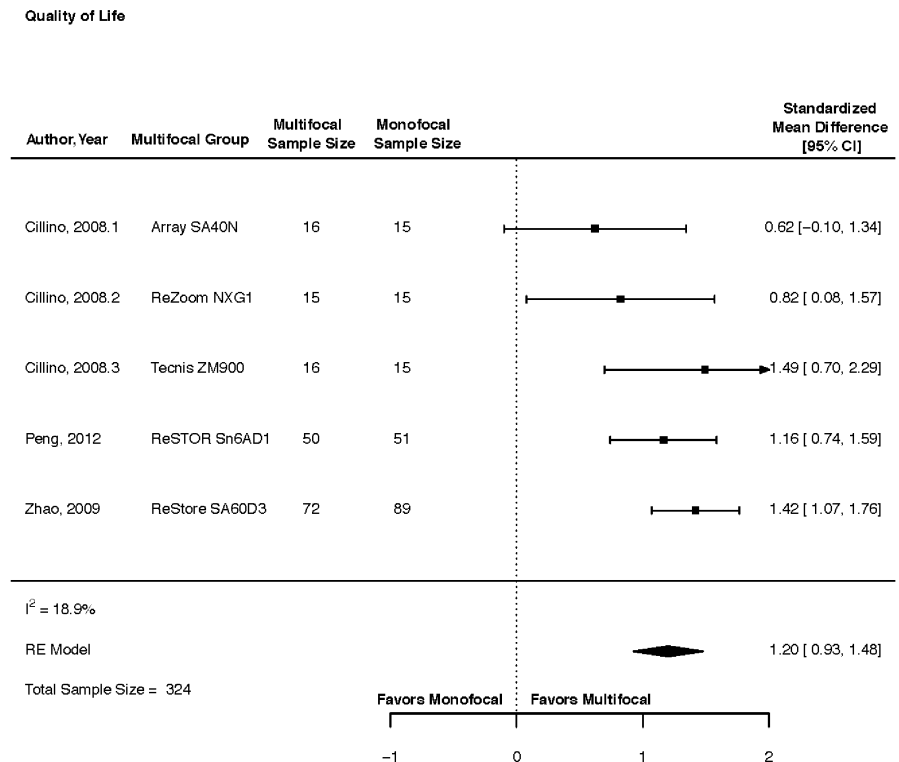# Key Question 2 – *Spectacle Independence*

2-3x higher proportion of multifocal patients achieved spectacle independence

Key Question 2 – *Quality of Life*

Multifocal vs. monofocal

- 3 RCT's identified
  - 5 comparisons
  - 324 patients
- Multifocal favored over monofocal

Quality of Life

Author, Year	Multifocal Group	Multifocal Sample Size	Monofocal Sample Size	Standardized Mean Difference [95% CI]
Cillino, 2008.1	Array SA40N	16	15	0.62 [−0.10, 1.34]
Cillino, 2008.2	ReZoom NXG1	15	15	0.82 [0.08, 1.57]
Cillino, 2008.3	Tecnis ZM900	16	15	1.49 [0.70, 2.29]
Peng, 2012	ReSTOR Sn6AD1	50	51	1.16 [0.74, 1.59]
Zhao, 2009	ReStore SA60D3	72	89	1.42 [1.07, 1.76]

$I^2 = 18.9\%$

RE Model — 1.20 [0.93, 1.48]

Total Sample Size = 324

Favors Monofocal | Favors Multifocal

−1 0 1 2

Key Question 2 – *Other comparisons*

Multifocal vs. monovision

- 2 RCT's identified
- Multifocal favored for both uncorrected near vision and spectacle independence

- Accommodative vs. monofocal
- 1 RCT identified
- Distance-corrected near vision significantly better in accommodative group

Key Question 3

What are the harms associated with multifocal or accommodative lenses versus monofocal replacement in the setting of cataract surgery?

Main outcome measures

- Surgical complications

- Contrast sensitivity

- Glare

- Halo

- Need for IOL exchange

Key Question 3 – *Surgical Complications*

Surgical complications

- 6 studies reported on surgical complications
- Minimal complications noted

Key Question 3 – *Contrast Sensitivity*

Contrast sensitivity

- 8 studies reported

- Monofocal IOL's favored

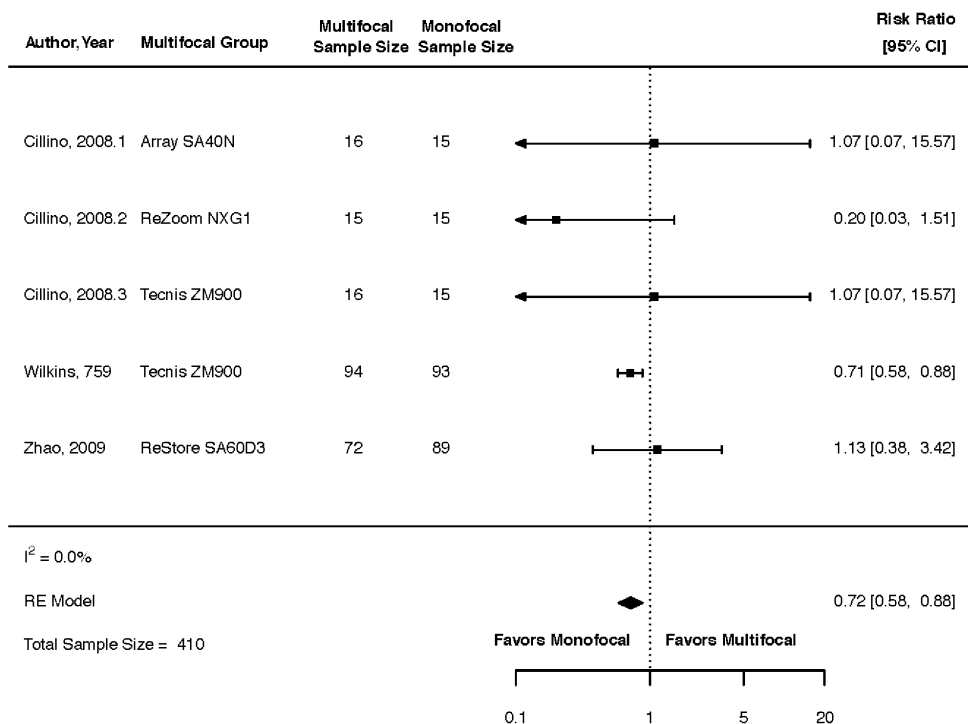   - Multifocal associated with worse contrast sensitivity

Studies	Favors Multifocal IOLs	No difference	Favors Monofocal IOLs
Zeng, 2007			x
Cillino, 2008			x
Palmer, 2008			x
Zhao, 2009		x	
Ji, 2012			x
Peng, 2012			x
Wilkins, 2013			x
Labiris, 2015		x	

Key Question 3 - *Glare*

Glare

- 8 studies
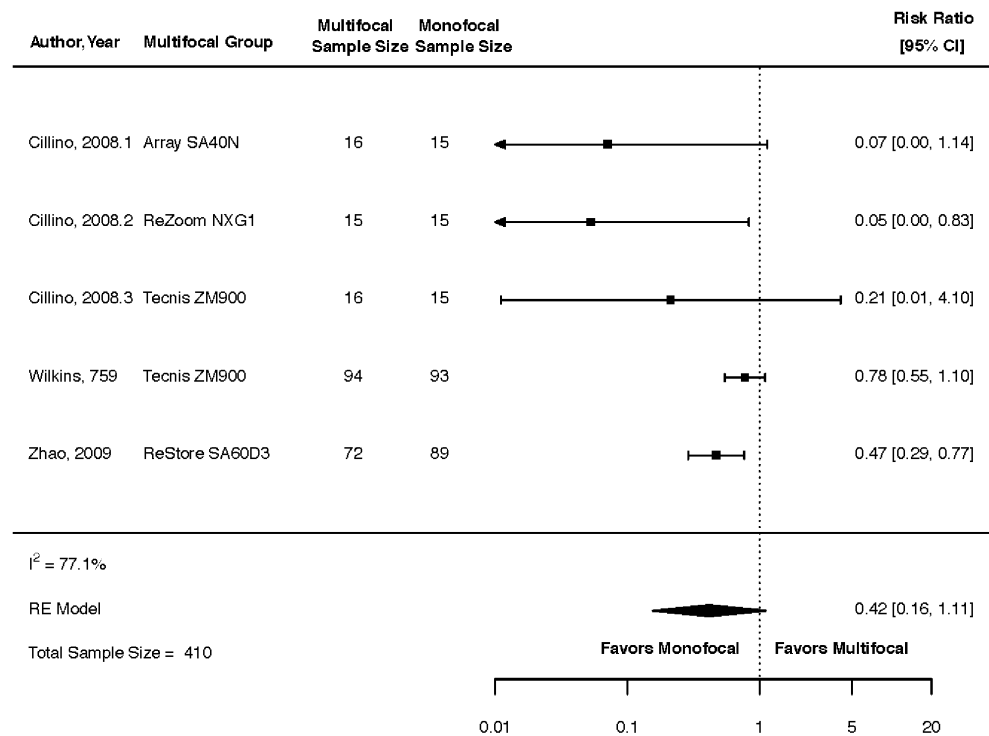- 410 patients
- Monofocal favored over multifocal

AE: Glare

Author, Year	Multifocal Group	Multifocal Sample Size	Monofocal Sample Size		Risk Ratio [95% CI]
Cillino, 2008.1	Array SA40N	16	15		1.07 [0.07, 15.57]
Cillino, 2008.2	ReZoom NXG1	15	15		0.20 [0.03, 1.51]
Cillino, 2008.3	Tecnis ZM900	16	15		1.07 [0.07, 15.57]
Wilkins, 759	Tecnis ZM900	94	93		0.71 [0.58, 0.88]
Zhao, 2009	ReStore SA60D3	72	89		1.13 [0.38, 3.42]

$I^2 = 0.0\%$

RE Model — 0.72 [0.58, 0.88]

Total Sample Size = 410

Favors Monofocal | Favors Multifocal

0.1   1   5   20

Key Question 3 – *Halo*

Halo

- 3 studies
- 410 patients
- Monofocal favored over multifocal

AE: Halo

Author, Year	Multifocal Group	Multifocal Sample Size	Monofocal Sample Size		Risk Ratio [95% CI]
Cillino, 2008.1	Array SA40N	16	15		0.07 [0.00, 1.14]
Cillino, 2008.2	ReZoom NXG1	15	15		0.05 [0.00, 0.83]
Cillino, 2008.3	Tecnis ZM900	16	15		0.21 [0.01, 4.10]
Wilkins, 759	Tecnis ZM900	94	93		0.78 [0.55, 1.10]
Zhao, 2009	ReStore SA60D3	72	89		0.47 [0.29, 0.77]

$I^2 = 77.1\%$

RE Model — 0.42 [0.16, 1.11]

Total Sample Size = 410

Favors Monofocal — Favors Multifocal

0.01   0.1   1   5   20

Key Question 3 – *IOL Exchange*

IOL exchange

- Wilkins, et al.
  - 6 patients underwent 2nd surgery to exchange multifocal with monofocal IOL due to dissatisfaction with the multifocal IOL

Key Question 4

If feasible, what resources are required to best care for patients who choose multifocal or accommodative lens implants in the setting of cataract surgery?

- No study specifically addressed this question
- Several studies identified specific exclusion criteria that may require additional testing
    - High corneal astigmatism
    - Age-related macular degeneration
- One study indicated the need for LASIK after multifocal IOL to correct residual refractive error

Summary

Compared to Monofocal IOLs (quality of evidence):

- Multifocal IOLs achieve better outcomes on spectacle independence and uncorrected near visual acuity, without sacrificing uncorrected or corrected distance vision. (Moderate)

- Multifocal IOLs result in better visual function/quality of life. (Low)

- Multifocal IOLs result in worse contrast sensitivity and a greater risk of glare (Moderate)

- Multifocal IOLs result in a greater risk of halos. (Low)

- Multifocal IOLs result in greater IOL exchange due to dissatisfaction. (Low)

Limitations

Study Quality

- The principal limitation to this review is the quality of the original RCTs.
- Most studies had methodologic limitations and were of small size.

Heterogeneity

- Heterogeneity was in general not large in most of the pooled analyses.

Applicability of Findings to the VA Population

- No studies were performed in VA populations, or even US populations, therefore the applicability of these results to VA patients with cataracts is uncertain.

Rapidly evolving IOL technology

- IOL technology is rapidly changing, and therefore newer lenses may have differences in the benefits and harms we report here for older lenses.

Evidence into Action

- Final report now available on VA intranet

Questions?

If you have further questions, please feel free to contact:

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