

# Meta-analysis comparing same-day versus delayed vitrectomy clinical outcomes for intravitreal retained lens fragments after age-related cataract surgery

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**Purpose/design:** We aimed to perform a systematic review and meta-analysis comparing the risk difference of clinical outcomes for same-day (SD) vs delayed (DEL) pars plana vitrectomy (PPV).

**Methods:** We searched MEDLINE (English; January 1, 1985 to July 16, 2013) and article reference lists, for patients with crystalline retained lens fragments and discussion of SD-PPV vs DEL-PPV. For the meta-analysis, articles needed the number of patients receiving SD-PPV and DEL-PPV, and the number, in each group, who experienced one or more of the outcomes: not good visual acuity (VA) (<20/40), bad VA (≤20/200), retinal detachment, increased intraocular pressure/glaucoma, intraocular infection/inflammation, cystoid macular edema, and corneal edema.

**Results:** Of 304 articles identified, 23 provided data for the meta-analysis. Results were mixed, indicating 1) neither vitrectomy time produced better outcomes in all studies (not good VA risk difference =10.3% [positive numbers favored SD-PPV; negative numbers favored DEL-PPV], 95% confidence interval [CI] = [-0.4% to 21.0%], *P*=0.059; and bad VA risk difference =-0.3%, 95% CI = [-10.7% to 10.1%], *P*=0.953); 2) better outcomes with immediate SD-PPV compared with all DEL-PPV (not good VA risk difference =16.2%, 95% CI = [0.8% to 31.5%], *P*=0.039; and bad VA risk difference =8.5%; 95% CI = [0.8% to 16.2%], *P*=0.030); and 3) immediate SD-PPV and prompt DEL-PPV (3 to 14 days after cataract surgery) had no significant differences and so may produce similar outcomes (not good VA risk differences range = [-19.9% to 6.5%], 95% CI = [-59.9% to 36.4%]; and bad VA risk differences range = [-6.9% to 7.4%], 95% CI = [-33.1% to 31.8%]).

**Conclusion:** Perhaps SD-PPV should be limited to facilities at which a vitreoretinal surgeon is immediately available. Otherwise, these results support referring a patient with retained lens fragments promptly to a vitreoretinal surgeon but do not support interfacility transport for SD-PPV.

**Keywords:** retained lens fragments, vitrectomy, time factors, visual acuity, meta-analysis, systematic review

## Introduction

Phacoemulsification lensectomy<sup>1</sup> occasionally results in retained lens fragments or the entire crystalline lens dislocating into the vitreous, which increases the risk of postoperative complications and vision loss.<sup>2,3</sup> With an estimated 10 million cataract surgeries performed per year worldwide,<sup>4</sup> the estimated annual incidence of retained lens fragments is between 10,000–160,000 (mean =85,000). The timing of pars plana vitrectomy (PPV) to remove retained lens fragments is controversial, especially

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concerning whether, and under what circumstances, a “same day” (SD) (as the cataract surgery) vitrectomy (SD-PPV) might be performed. Optimal management of retained lens fragments has not been determined, but cataract surgeons have been urged to avoid attempting to retrieve retained lens fragments by manipulating the vitreous,<sup>5,6</sup> to prevent complications such as retinal detachment,<sup>7</sup> and to refer patients to a vitreoretinal surgeon promptly.<sup>8–13</sup>

Some vitreoretinal surgeons suggest performing an SD-PPV, as they believe this to be the optimal time to remove retained lens fragments.<sup>14,15</sup> However, the logistics of arranging an SD-PPV can be daunting.<sup>16,17</sup> Others feel that SD-PPV is unnecessary, complicates the informed consent process, and may increase the risk of complications.<sup>18,19</sup> A survey of cataract surgeons indicated they believed that 58% of patients had retained lens fragments removed immediately,<sup>20</sup> far higher than reported by vitreoretinal surgeons, who indicated only 13% (536 of 4,150) of eyes received an SD-PPV.<sup>21</sup>

Policies for performing SD-PPV differ among facilities. Lack of the necessary equipment and/or the immediate availability of an experienced vitreoretinal surgeon may preclude an SD-PPV.<sup>22</sup> Preliminary examination of the SD-PPV results in the literature<sup>23</sup> found that some facilities had good visual acuity (VA) results,<sup>22,24,25</sup> while other facilities’ results were not as good<sup>26–28</sup> (data not shown). Reasons for this dichotomy were not clear, but lower rates of increased intraocular pressure (IOP) and cystoid macular edema (CME) with SD-PPV may be related to reduced intraocular inflammation/infection.<sup>24</sup> Several authors reported better VA and lower rates of complications (including retinal detachment, increased IOP, corneal edema, CME, and intraocular inflammation/infection) among patients who had SD-PPV compared with delayed vitrectomy (DEL-PPV), but these differences were not always statistically significant.<sup>25,29–31</sup> Other authors reported little or no differences in these and other outcomes when comparing SD-PPV and DEL-PPV.<sup>32–34</sup>

This is our second meta-analysis about vitrectomy timing for retained lens fragments. The first, which included no SD-PPV patients, indicated that prompt DEL-PPV (3 to 7 or possibly 3 to 14 days after cataract surgery) was associated with better VA and fewer cases of previtrectomy and postvitrectomy retinal detachment, increased IOP, and intraocular inflammation/infection compared with later (nonprompt) DEL-PPV.<sup>13</sup> As in our previous study, the primary outcomes for this meta-analysis were not good VA (<20/40) and bad VA ( $\leq 20/200$ ). Secondary outcomes included retinal detachment, increased IOP, intraocular inflammation/infection, CME, and corneal edema. All outcome data were

postvitrectomy, preferably at final examination. The aim of this research was to explore 1) differences in clinical outcomes between SD-PPV and DEL-PPV, 2) the observed heterogeneity in SD-PPV results, and 3) the effect of policy differences on SD-PPV results. Complete citations and greater detail may be found in the first author’s doctoral dissertation,<sup>21</sup> which is available upon request. All references to our previous research are to this dissertation and the authors’ previous meta-analysis.<sup>13</sup>

## Materials and methods

### Search strategy

Details of the article search for the systematic review and meta-analyses of the literature on retained lens fragments timing were described previously<sup>13,21</sup> and are summarized in Figure S1. The publication date range for the MEDLINE search was January 1, 1985 to July 16, 2013. All study designs were considered, and no previous meta-analysis comparing SD-PPV and DEL-PPV outcomes was found. Internal review board approval and informed consent are not required for a meta-analysis.

### Inclusion criteria

A study was included in the meta-analysis if it contained at least ten patients who received a vitrectomy for intravitreal retained lens fragments after surgery for an age-related cataract; had mean follow-up of at least 3 months; and had results for both SD-PPV and DEL-PPV patients, including the number receiving each treatment (SD-PPV and DEL-PPV), and the number in each treatment group who experienced at least one of the outcomes.

### Data extraction

For each study/outcome combination, the number of patients was recorded, separately for those who did and did not experience that outcome, for SD-PPV and DEL-PPV. Our previous research indicated that when an SD-PPV was not performed, a vitreoretinal surgeon should wait at least 3 days after cataract surgery before attempting a vitrectomy unless severe complications preclude a delay. Therefore, whenever possible, DEL-PPVs were limited to those performed at least 3 days after cataract surgery. Additional details of the data extraction were described previously.<sup>13,21</sup>

### Study classification

The Mayo Clinic Florida (MCF) SD-PPV policy permits an SD-PPV under a “no move, no wait” policy only if a vitreoretinal surgeon begins the vitrectomy within 15 minutes of

cataract surgery and the patient is not moved from the original operating room. In addition, the policy precludes cataract surgeons from attempting to remove intravitreal retained lens fragments.<sup>35</sup> Based on the information available, articles were classified as MCF+ if their SD-PPVs met criteria similar to those at the MCF and as MCF- if their SD-PPVs did not meet these criteria.

The three criteria were SD-PPVs performed 1) at the same facility as the cataract surgery, 2) with only a short time between cataract surgery and vitrectomy, and 3) without any cataract surgeons attempting to remove the intravitreal retained lens fragments. SD-PPV was coded as “same facility” if the authors indicated immediate vitrectomy, vitrectomy at the time of cataract surgery, or that SD-PPV was possible only if cataract surgery was done in a facility where a vitreoretinal surgeon was available. SD-PPV was coded as “a short time between cataract surgery and vitrectomy” if the authors indicated this explicitly or implied this, for example: immediate, converted to vitrectomy, or same operating room. SD-PPV was coded as “different facility” and/or “not a short time between cataract surgery and vitrectomy” if the above conditions were not met and/or if the authors indicated that some or all of the SD-PPV patients were “referred to our facility”. All facilities were coded based on whether the authors indicated that any cataract surgeons attempted to remove intravitreal retained lens fragments for SD-PPV patients during cataract surgery.

### Estimating the effect for each study

The summary effect for the meta-analysis was the risk difference of patients experiencing each outcome between the SD-PPV and DEL-PPV treatment groups. To estimate the risk difference in the population, using sample data from each study, the observed risk was determined by dividing the number of events (occurrence of the adverse outcome, such as retinal detachment) in each treatment group (SD-PPV and DEL-PPV) by the number of patients in that group. The risk difference for each study was the proportion of DEL-PPV patients minus the proportion of SD-PPV patients, so positive numbers “favored” (indicated superior outcomes with) SD-PPV, while negative numbers favored DEL-PPV.

When possible, the variance for each risk difference was estimated using the standard formula for estimating the variance of a risk difference.<sup>36</sup> However, when there were no events (or no nonevents) in a study treatment group (SD-PPV and/or DEL-PPV), the variance was estimated using the observed proportion of events in the total sample (SD-PPV plus DEL-PPV groups) for that study or

the overall proportion of events (in that treatment group) in all studies.<sup>21</sup> The effect of including studies whose variance was not estimated using the standard formula for estimating the variance of a risk difference was assessed with a sensitivity analysis.

### Statistical analyses

Meta-analyses were performed using Comprehensive Meta-Analysis, version 2.2 (Biostat Inc., Englewood, NJ, USA). As in our previous research, random-effects models were used in the main meta-analyses. All additional meta-analyses, which compared subgroups of studies, used mixed-effect models, combining studies within subgroups using random-effects models but combined subgroups using fixed-effects models. These mixed-effect models did not assume a common variance across subgroups (no pooling of variance), but rather, the variance in each subgroup was estimated separately. These additional analyses assessed how results differed between MCF+ and MCF- studies and, for MCF+ studies only, by the timing of the DEL-PPV. We also assessed effects of reporting and publication biases, including studies whose variance was not estimated using the standard formula (discussed above), and assessed whether the results were robust with sensitivity analyses.<sup>37,38</sup> Results were statistically significant with  $P$ -value  $\leq 0.05$  and marginally significant with  $0.05 < P \leq 0.15$ .<sup>35,39</sup>

## Results

### Search results

A total of 304 articles were identified (230 through PubMed and 74 from other sources, including articles' reference lists), with 128 excluded based on reading the title and abstract. Full text of the remaining 176 articles was retrieved and reviewed. A total of 76 articles were included in the systematic review of the retained lens fragments literature. However, only 23 articles with 21 unique study cohorts had the data necessary for the SD-PPV vs DEL-PPV meta-analysis.

In one article,<sup>40</sup> there were data for only the study (not the control) group, so only these patients were included. All the patients in Kim et al<sup>22</sup> and Moore et al<sup>7</sup> were also in Modi et al<sup>32</sup> but no patients were double-counted. Modi et al<sup>32</sup> was used for VA, CME, and corneal edema; Moore et al<sup>7</sup> was used for retinal detachment; and Kim et al<sup>22</sup> was used for increased IOP and intraocular inflammation/infection. This was done to preferentially use data for final outcomes rather than for outcomes any time after the vitrectomy. Nine (39%) articles were MCF- and 14 (61%) were MCF+ (see the “Study classification” section). A summary of the initial search results

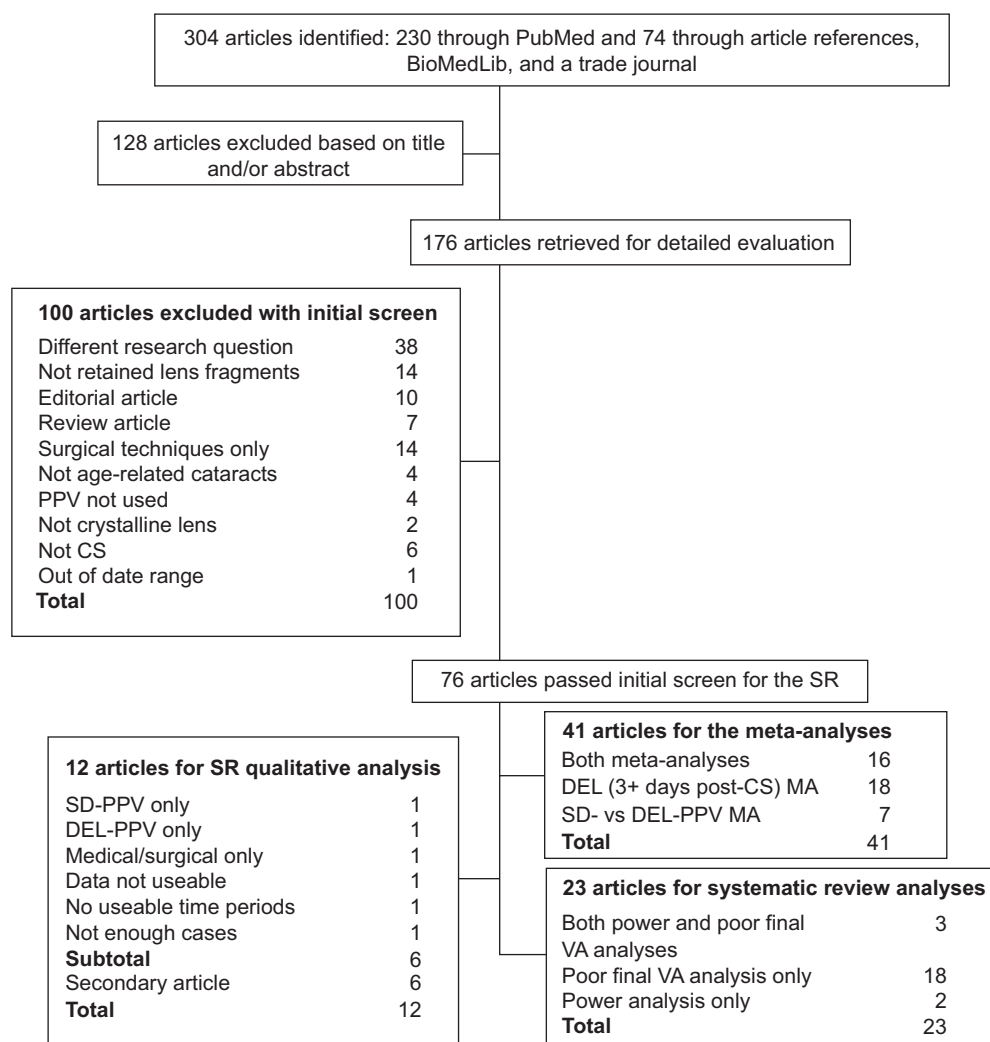
of the “retained lens fragments timing” literature appeared previously.<sup>13</sup> Figure 1 contains a summary, in the standard format,<sup>41</sup> of the updated search results.

Table 1 contains details for the 23 articles (21 studies). The studies’ locations were: six of 21 from the USA/Canada (29%), nine from Europe (43%), five from Asia (24%), and one from Australia (5%). Patients were treated from 1988 to 2011, so overall, there were 24 years of service for all the studies collectively, with an average of 6.6 years of service per study (range 1 to 22 years of service). The studies tended to be small, with 17 (81%) including fewer than 100 patients. Collectively, studies included in the meta-analysis had data for 1,606 eyes, with a mean of 76.5 eyes per study (median =25; range 12 to 569 eyes). Of these, 1,596 (99.4%) eyes received a vitrectomy (article range 83% to 100%), and ten eyes (0.6%) received medical management. Of the eyes that received a

vitrectomy, 337 (21%) received an SD-PPV and 1,259 (78%) received a DEL-PPV. Approximately 52% of the patients were female, with an average age of 74.2 years (study means range from 54 to 78 years). Including the SD-PPV patients, the average time between cataract surgery and vitrectomy was 13.8 days (study mean range 1.7 to 41 days), and mean follow-up time was approximately 13.6 months (study mean range 3 to 63 months).

## Quality analysis

Overall quality issues were similar to those in our previous meta-analysis.<sup>13</sup> In 18 (78%) of 23 articles, patients were a consecutive series (a representative sample of the population), but only one (4%) article was a prospective study. In 21 (91%) articles, the years of service were stated, all patients were accounted for, and patients’ characteristics



**Figure 1** Flowchart of the updated articles search for the systematic review and meta-analyses of the retained lens fragment timing literature with publication dates January 1, 1985 through July 16, 2013.

**Notes:** Secondary articles contained data for patients who were also in another article.

**Abbreviations:** CS, cataract surgery; DEL, delayed; MA, meta-analysis; PPV, pars plana vitrectomy; SD, same day; SR, systematic review; VA, visual acuity; vs, versus.

**Table 1** Description of the 23 articles for the same-day versus delayed vitrectomy meta-analysis

Article number	Article ID	Location (N)	Years of participation	Number of eyes	PPV, N (%)	Patients' ages (years) M/Md/Min/Max	Days CS to PPV* M/Md/Min/Max	Follow-up (months) M/Md/Min/Max
1	Ross 1993 <sup>6</sup>	BC, Canada (1)	---	12	10 (83)	77/76/53/94	20/12/0/93	16/16/6/26
2	Kim et al 1994 <sup>22</sup>	FL, USA (1)	1990–1992	62	62 (100)	75/---/51/91	---/---/0/365	---/---/---/---
3	Tommila and Immonen 1995 <sup>27</sup>	Finland (1)	1991–1994	23	23 (100)	75/---/56/89	---/7/0/53	11/---/3/20
4	Borne et al 1996 <sup>18</sup>	PA, USA (1)	1991–1994	121	121 (100)	75/---/43/92	19/30/0/120	17/---/3/---
5	Stilma et al 1997 <sup>26</sup>	The Netherlands (11)	1988–1994	70	63 (90)	75/---/47/88	---/---/0/---	---/---/3/---
6	Stenkula et al 1998 <sup>19</sup>	Sweden (2)	1994–1994	19	19 (100)	76/79/58/89	21/20/0/60	11/8/0/24
7	Watts et al 2000 <sup>29</sup>	Wales (1)	1995–1998	18	18 (100)	74/76/62/87	10/5/0/77	14/12/6/34
8	Verma et al 2001 <sup>40</sup>	India (1)	1997–1999	12	12 (100)	52/---/40/76	27/---/0/99	3/3/3/3
9	Hansson and Larsson 2002 <sup>11</sup>	Sweden (1)	1997–2000	66	66 (100)	---/80/41/94	---/3/0/255	---/8/0/30
10	Yang et al 2002 <sup>12</sup>	Taiwan (2)	1992–1998	25	24 (96)	70/72/40/90	25/17/0/97	10/6/3/44
11	Moore et al 2003 <sup>7</sup>	Florida (1)	1990–2001	343	343 (100)	---/76/24/100	---/13/0/167	---/8/1/96
12	Stefaniotou et al 2003 <sup>14</sup>	Greece (1)	---	26	26 (100)	67/---/59/90	---/---/---/---	---/---/3/9
13	Kaynak et al 2006 <sup>2</sup>	Turkey (1)	2002–2003	12	12 (100)	78/---/72/85	4/---/0/7	11/---/9/15
14	Ruiz-Moreno et al 2006 <sup>17</sup>	Spain (1)	---	18	18 (100)	71/71/58/87	8/7/0/24	34/45/6/53
15	Merani et al 2007 <sup>31</sup>	Australia (1)	1998–2003	223	223 (100)	76/78/53/93	10/4/0/132	21/15/0/66
16	Romero-Aroca et al 2007 <sup>25</sup>	Spain (1)	1997–2005	47	47 (100)	73/---/57/86	---/---/---/---	63/---/12/106
17	Tajunisah and Reddy 2007 <sup>15</sup>	Malaya (1)	2001–2005	22	22 (100)	69/68/52/84	11/5/0/60	9/---/1/24
18	Chen et al 2008 <sup>24</sup>	Taiwan (1)	2000–2006	78	78 (100)	70/---/24/92	---/---/---/---	14/---/5/47
19	Konstantopoulos et al 2009 <sup>30</sup>	England (1)	2000–2005	17	17 (100)	---/---/---/---	---/---/---/---	---/3.35/---/---
20	Colyer et al 2011 <sup>34</sup>	MD, USA (1)	2005–2008	172	172 (100)	75/---/---/---	15/7/---/---	---/---/6/---
21	Chiang et al 2012 <sup>3</sup>	PA/CA, USA (2)	2006–2011	21	21 (100)	75.5/76/53/97	1.7/1/0/7	3.3/3/2/6
22	Vanner et al 2012 <sup>35</sup>	FL, USA (1)	1999–2010	35	35 (100)	---/---/---/---	41/30/1/166	48/41/3/124
23	Modi et al 2013 <sup>32</sup>	FL, USA (1)	1990–2011	569	569 (100)	74.6/---/---/---	---/13.6/0/5.475	---/8/0.25/100

**Notes:** \*Days between cataract surgery and vitrectomy are for delayed (not same-day) PPV patients only. ---Represents missing data.

**Abbreviations:** CS, cataract surgery; ID, identification; M, mean; Max, maximum; Md, median; Min, minimum; PPV, pars plana vitrectomy.

at presentation were reported. Reasons were given for all lost/excluded patients in 20 (87%) articles, but in only 17 (74%) articles was information reported on all patients excluded for missing data or loss to follow-up. In 14 (61%) articles, the authors specified standardized assessments of outcomes, and in 13 (57%) articles, the authors indicated their criteria for treatment choice (vitrectomy timing). Only eleven (48%) articles reported preexisting ocular comorbidities and actual *P*-values.

Also, using the Minckler<sup>42</sup> evidence-based rating system, for clinical importance, 19 (83%) articles were rated A, one (4%) article was rated B, and three articles were rated C (13%). For Minckler's other criterion, strength of evidence, all articles were rated III (weak), mainly because the research was retrospective. Two (9%) articles reported data for all seven outcomes, two (9%) articles for six outcomes, five (22%) articles for five outcomes, three (13%) articles for four outcomes, three (13%) articles for three outcomes, four articles (17%) for two outcomes, and four (17%) articles for one outcome. Five (22%) articles had average follow-up time between 3 and 6 months, nine (39%) articles between 6 and 12 months, six (26%) articles

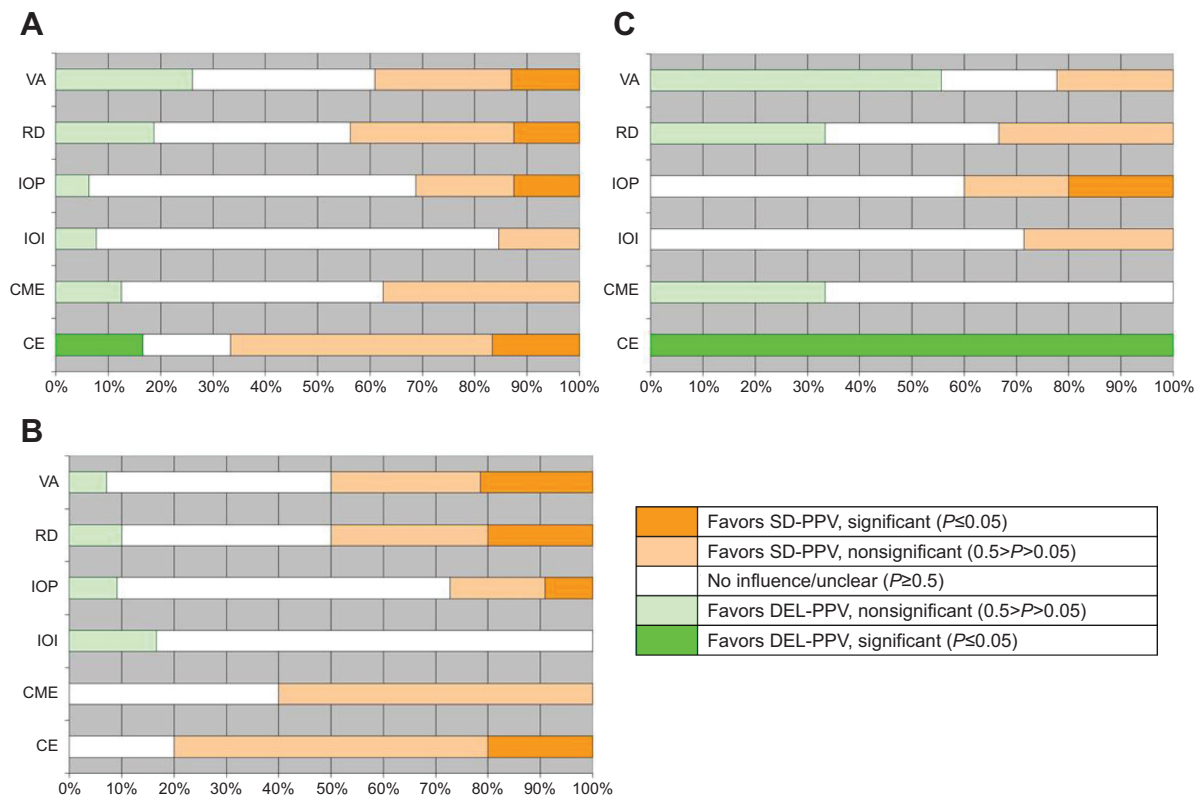
between 12 and 24 months, and three (13%) articles for more than 24 months.

### Statistical significance analysis

Our previous research discussed low statistical power in the retained lens fragments timing literature. The analysis estimating each study's power for comparing outcomes was updated, and the results (mean =24%, median =14%) again indicated that many studies had low power. Figure 2A shows whether SD-PPV or DEL-PPV seemed better for each outcome, for all articles with these data.<sup>2,3,6,7,11,12,14,15,17-19,22,24-27,29-31,34,35,40,43-45</sup> These SD-PPV vs DEL-PPV results appear mixed and do not obviously favor either vitrectomy time.

### Main SD-PPV vs DEL-PPV meta-analysis

These results (Table 2) favored SD-PPV for all outcomes except bad VA, remembering that a positive risk difference "favored" (indicated superior outcomes with) SD-PPV, while a negative risk difference favored DEL-PPV. However, only one of the results among the outcomes that favored SD-PPV (not good VA, retinal detachment, increased IOP, intraocular inflammation/infection, CME, and corneal edema) was



**Figure 2** Indication of which PPV timing, SD-PPV or DEL-PPV had better outcomes, for all studies (all SD- vs DEL-PPV articles) (A), MCF+ studies (B), and MCF- studies (C). **Abbreviations:** CE, corneal edema; CME, cystoid macular edema; DEL-PPV, delayed PPV; IOI, intraocular inflammation/infection; IOP, increased intraocular pressure; MCF, Mayo Clinic Florida; MCF-, studies not adhering to MCF SD-PPV policies; MCF+, studies adhering to MCF SD-PPV policies; PPV, pars plana vitrectomy; RD, retinal detachment; SD-PPV, same-day PPV; VA, visual acuity; vs, versus.

**Table 2** Main same-day versus delayed vitrectomy meta-analysis results (random effects models) estimated summary risk differences for all studies that had data for that outcome

Outcome	Studies N	RiskDiff	95% CI	Z-score**	P-value	I <sup>2</sup> ***	SD better <sup>§</sup> N	DEL better <sup>‡</sup> N	No difference <sup>#</sup> N
VA not good	20	10.3%	(-0.4%, 21%)	1.886	0.059 <sup>†</sup>	46.191	12	8	0
VA bad	15	-0.3%	(-10.7%, 10.1%)	-0.059	0.953	52.025	7	7	1
Retinal detachment	12	3.1%	(-3.0%, 9.3%)	0.995	0.320	32.317	7	3	2
IOP/glaucoma	13	7.0%	(0.2%, 13.8%)	2.031	0.042*	24.282	8	4	1
IOI	11	1.0%	(-1.6%, 3.7%)	0.755	0.450	0.000	5	2	4
CME	7	1.8%	(-3.1%, 6.7%)	0.732	0.464	0.000	5	2	0
Corneal edema	5	2.6%	(-7.3%, 12.5%)	0.518	0.605	68.588	4	1	0

**Notes:** \* $P \leq 0.05$ ,  $^{\dagger}P \leq 0.15$  (marginally significant). \*\*Statistic for comparing the risk difference of SD-PPV and DEL-PPV patients. \*\*\*Indication of heterogeneity among individual study risk difference estimates in the fixed effects model. <sup>§</sup>Number of studies in which the SD-PPV patients experienced better clinical outcomes; <sup>‡</sup>number of studies in which DEL-PPV patients experienced better clinical outcomes; <sup>#</sup>number of studies in which there was no difference between the SD-PPV and DEL-PPV clinical outcomes. Risk difference was the risk (of an adverse clinical outcome, such as RD) for DEL-PPV patients minus the risk for SD-PPV patients. Positive numbers favor SD-PPV. Negative numbers favor DEL-PPV. The null hypothesis for the z-tests was that the risk difference was equal to zero.

**Abbreviations:** CI, confidence interval; CME, cystoid macular edema; DEL, delayed; IOI, intraocular inflammation/infection; IOP, increased intraocular pressure; PPV, pars plana vitrectomy; RD, retinal detachment; RiskDiff, risk difference; SD, same day; VA, visual acuity.

statistically significant. The IOP results indicated a significant risk difference of 7.0% between SD-PPV and DEL-PPV ( $P=0.042$  [z-test], 95% confidence interval = [0.2% to 13.8%]). Also, the corneal edema results were heavily influenced by a single case, which was the only SD-PPV patient in one study.<sup>6</sup> These results do not provide enough evidence to indicate a consistent association between clinical outcomes and vitrectomy timing (SD-PPV or DEL-PPV) and agree with the statistical significance analysis in Figure 2A.

### Separate MCF+ and MCF- meta-analyses

Another statistical significance analysis, with studies separated into MCF+ (Figure 2B) and MCF- (Figure 2C), indicated that SD-PPV might have produced better outcomes in MCF+ studies<sup>2,7,11,17-19,22,24,25,27,30,32,35,40,44,45</sup> but not in MCF- studies.<sup>3,6,12,14,15,26,29,31,34,43</sup> Table 3 compares the percent of SD-PPV and DEL-PPV patients with each outcome, by MCF policy status. Figures 2B and 2C, along with the data in Table 3, support a hypothesis that the risk differences between immediate SD-PPV and DEL-PPV (in MCF+ studies) more consistently favor SD-PPV than the risk differences between nonimmediate SD-PPV and DEL-PPV (in MCF- studies).

Therefore, meta-analyses were done separately for the MCF+ and MCF- studies, and these results differed from those done with all the studies combined (compare Tables 2 and 4). For the MCF+ studies, all results favored SD-PPV (except intraocular inflammation/infection, which was essentially neutral). For five of seven outcomes (not good VA, bad VA, retinal detachment, increased IOP, and corneal edema), the effect favoring SD-PPV was statistically significant. In the MCF+ studies, the number needed to treat, with

immediate SD-PPV rather than DEL-PPV, to avoid all five statistically significant outcomes, was four.<sup>36</sup> This provided some evidence that immediate SD-PPVs (performed according to policies similar to the MCF SD-PPV policies) produced better outcomes than DEL-PPVs.

For the MCF- studies, three outcomes favored SD-PPV (not good VA, increased IOP, and intraocular inflammation/infection) and four favored DEL-PPV (bad VA, retinal detachment, CME, and corneal edema). The only significant (corneal edema) or marginally significant (bad VA) effects favored DEL-PPV. Based on these mixed, mostly nonsignificant results, there was little evidence to favor either vitrectomy timing (SD-PPV or DEL-PPV) for the MCF- studies, so further analyses were limited to the MCF+ studies only.

An examination of the forest plot from the not good VA meta-analysis (Figure 3) visually supported a conclusion that the estimated summary risk difference did not indicate better outcomes with either SD-PPV or DEL-PPV for the MCF- studies (top) but did indicate better outcomes with immediate SD-PPV for the MCF+ studies (bottom). The forest plots for the remaining outcomes (not shown) were similar.

### Subgroup analysis: DEL-PPV time after cataract surgery (MCF+ only)

The results of our previous meta-analysis indicated, for vitrectomies performed 3 or more days after cataract surgery, that prompt (earlier) vitrectomies (3 to 7 or 3 to 14 days after cataract surgery) provided better outcomes (for not good VA, bad VA, retinal detachment, increased IOP, and intraocular inflammation/infection).<sup>13</sup> Based on these results, we investigated whether superior outcomes for immediate SD-PPV (in MCF+ studies) were sensitive to the time until

**Table 3** Same-day vitrectomy and delayed vitrectomy risk and risk difference for each clinical outcome, separated for MCF- and MCF+ articles

Article	MCF status		Patients, N		Not good visual acuity (<20/40)		Bad visual acuity (≤20/200)		Retinal detachment		IOP/ glaucoma		Intraocular inflammation/ infection		Cystoid macular edema		Corneal edema						
	SD	DEL	SD	DEL	SD	DEL	Risk diff	Risk diff	SD	DEL	Risk diff	SD	DEL	Risk diff	SD	DEL	Risk diff	SD	DEL	Risk diff			
Ross <sup>6</sup>	1	9	0	56	0	56	22	22	0	11	11	0	22	0	0	0	22	100	0	(100)			
Stilma et al <sup>26</sup>	6	57	67	40	(26)	17	16	(1)	Not reported	Not reported	Not reported	Not reported	Not reported	0	0	0	Not reported	Not reported	Not reported	Not reported			
Watts et al <sup>29</sup>	5	13	20	15	(5)	20	0	(20)	Not reported	Not reported	0	15	15	20	8	(12)	20	0	(20)	Not reported			
Yang et al <sup>12</sup>	1	23	100	43	(57)	100	30	(70)	Not reported	Not reported	Not reported	Not reported	Not reported	0	4	4	Not reported	Not reported	Not reported	Not reported			
Stefaniotou et al <sup>14</sup>	8	18	13	44	32	0	28	28	0	17	17	0	44	0	11	11	Not reported	Not reported	Not reported	Not reported			
Merani et al <sup>31</sup>	14	209	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	0	4	4	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported			
Tajunisah and Reddy <sup>5</sup>	8	14	63	50	(13)	50	7	(43)	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported			
Colyer et al <sup>34</sup>	59	113	29	35	7	20	11	(10)	7	1	(6)	5	4	(1)	2	2	14	13	(0)	Not reported			
Chiang et al <sup>3</sup>	7	14	71	64	(7)	57	14	(43)	14	0	(14)	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported			
<b>All MCF- articles</b>	<b>n=9</b>	<b>470</b>	<b>36</b>	<b>40</b>	<b>4</b>	<b>24</b>	<b>15</b>	<b>(10)</b>	<b>6</b>	<b>4</b>	<b>(2)</b>	<b>4</b>	<b>11</b>	<b>7</b>	<b>1</b>	<b>3</b>	<b>1</b>	<b>14</b>	<b>13</b>	<b>(1)</b>	<b>100</b>	<b>0</b>	<b>(100)</b>
Kim et al <sup>22</sup>	8	54	Not used*	Not used*	Not used*	Not used*	Not used*	Not used*	Not used**	Not used**	Not used**	0	15	15	0	2	2	Not used*	Not used*	Not used*	Not used*	Not used*	Not used*
Tommila and Immonen <sup>27</sup>	7	16	43	38	(5)	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	0	6	6	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Borne et al <sup>18</sup>	6	115	50	31	(19)	Not reported	Not reported	Not reported	33	8	(26)	0	2	2	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	0	1	1
Stenkula et al <sup>19</sup>	2	17	50	53	3	50	29	(21)	0	0	0	50	41	(9)	0	6	6	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Verma et al <sup>40</sup>	3	9	0	100	100	0	0	0	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Hansson and Larsson <sup>11</sup>	7	59	43	47	5	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Moore et al <sup>7</sup>	36	307	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	0	6	6	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Kaynak et al <sup>2</sup>	1	11	0	9	9	0	9	9	0	0	0	0	0	0	0	0	0	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Ruiz-Moreno et al <sup>17</sup>	2	16	100	63	(38)	0	6	6	0	6	6	50	19	(31)	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Romero-Aroca et al <sup>25</sup>	9	38	22	58	36	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	0	32	32	0	0	0	11	13	2	0	5	5
Chen et al <sup>24</sup>	45	33	24	61	36	2	24	22	0	18	18	0	21	21	0	0	0	0	9	9	Not reported	Not reported	Not reported
Konstantopoulos et al <sup>30</sup>	6	11	33	64	30	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported
Vanner et al <sup>35</sup>	23	12	22	42	20	4	25	21	4	17	12	9	8	(0)	9	0	(9)	13	25	12	0	8	8
Modi et al <sup>32</sup>	117	452	39	42	3	16	19	3	Not reported***	Not reported***	Not reported***	Not reported***	Not reported***	Not reported***	Not reported***	Not reported***	13	13	0	9	17	7	7
<b>All MCF+ articles</b>	<b>n=14</b>	<b>228</b>	<b>34</b>	<b>44</b>	<b>9</b>	<b>11</b>	<b>19</b>	<b>8</b>	<b>3</b>	<b>7</b>	<b>5</b>	<b>4</b>	<b>13</b>	<b>9</b>	<b>2</b>	<b>1</b>	<b>(1)</b>	<b>10</b>	<b>13</b>	<b>3</b>	<b>7</b>	<b>13</b>	<b>6</b>
<b>Difference (MCF- minus MCF+)</b>			<b>2</b>	<b>(4)</b>	<b>(5)</b>	<b>13</b>	<b>(5)</b>	<b>(17)</b>	<b>3</b>	<b>(3)</b>	<b>(6)</b>	<b>0</b>	<b>(2)</b>	<b>(2)</b>	<b>1</b>	<b>2</b>	<b>(4)</b>	<b>0</b>	<b>(0)</b>	<b>(4)</b>	<b>93</b>	<b>(13)</b>	<b>(106)</b>

**Notes:** All risks are expressed as percent. ( ) signifies a negative number. Risk difference was the risk (of an adverse clinical outcome, such as RD) for DEL-PPV patients minus the risk for SD-PPV patients. Positive numbers favor SD-PPV. Negative numbers favor DEL-PPV. \*Used data from Modi et al 2013;<sup>32</sup> \*\*used data from Moore et al 2003;<sup>7</sup> \*\*\*Final conditions not reported – used data from Kim et al 1994<sup>22</sup> or Moore et al 2003.<sup>7</sup>

**Abbreviations:** DEL, delayed; IOP, increased intraocular pressure; MCF, Mayo Clinic Florida; MCF-, articles not adhering to MCF SD-PPV policies; MCF+, articles adhering to MCF SD-PPV policies; PPV, pars plana vitrectomy; RD, retinal detachment; Risk diff, risk difference; SD, same day.



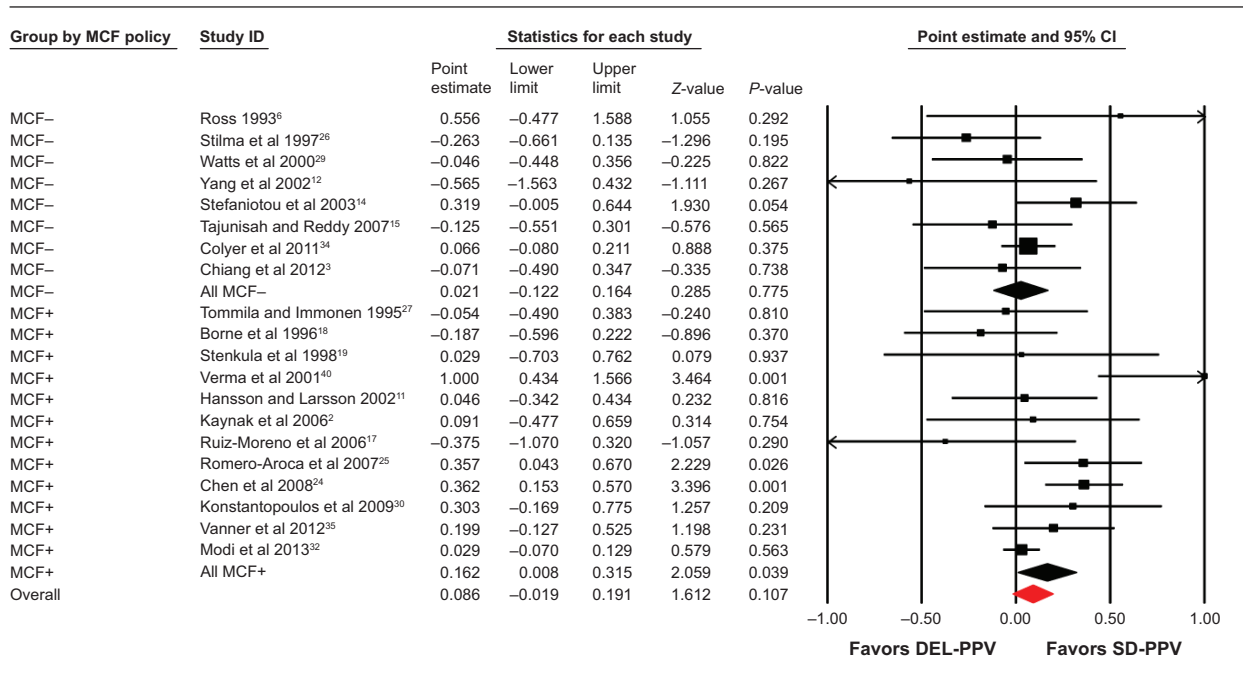
**Table 4** Same-day vs delayed vitrectomy meta-analysis results (mixed-effects models) estimated summary risk differences stratified by MCF+/MCF-

Outcome	Group	Articles N	RiskDiff	95% CI	Z-score <sup>o</sup>	P-value (z)	I <sup>2o</sup>	Test for BGD: MCF+ vs MCF-		SD better <sup>§</sup> N	DEL better <sup>‡</sup> N	No difference <sup>#</sup> N
								Q-value	df			
Not good VA	MCF-	8	2.1%	(-12.2%, 16.4%)	0.285	0.775	18.572	1	0.189	3	5	0
	MCF+	12	16.2%	(0.8%, 31.5%)	2.059	0.039*	56.864			9	3	0
Bad VA	MCF-	8	14.1%	= % advantage	-1.494	0.135†	45.439	1	0.024*	2	6	0
	MCF+	7	-12.9%	(-29.8%, 4%)	2.172	0.030*	7.572			5	1	1
RD	MCF-	5	8.5%	(0.8%, 16.2%)	2.172	0.030*						
	MCF+	7	21.4%	= % advantage	-0.333	0.739	23.255	1	0.088†	3	2	0
IOP	MCF-	4	7.3%	(-9.1%, 6.4%)	2.302	0.021*	0.000			4	1	2
	MCF+	9	8.7%	(1.1%, 13.6%)	2.056	0.040*	5.354			5	3	1
IOI	MCF-	4	13.4%	(-8.6%, 35.3%)	1.195	0.232	48.689	1	0.624	3	1	0
	MCF+	6	7.6%	(0.4%, 14.8%)	0.972	0.331	0.000			3	1	2
CME	MCF-	5	-5.8%	= % advantage	-0.020	0.984	0.000			2	1	2
	MCF+	3	1.7%	(-1.7%, 5.1%)	0.972	0.331	0.000			3	1	2
CE	MCF-	4	0.0%	(-4.4%, 4.3%)	-0.020	0.984	0.000			2	1	2
	MCF+	4	-1.7%	= % advantage	-0.275	0.783	0.000			1	2	0
CE	MCF-	4	-1.4%	(-11.7%, 8.8%)	0.981	0.327	0.000			4	0	0
	MCF+	4	2.8%	(-2.77%, 8.3%)	0.981	0.327	0.000			4	0	0
CE	MCF-	1	4.2%	= % advantage	-3.162	0.002**	0.000			0	1	0
	MCF+	4	-100.0%	(-162%, -38%)	2.157	0.031*	0.000			4	0	0
			4.9%	(0.4%, 9.3%)	2.157	0.031*	0.000			4	0	0
			104.9%	= % advantage								

**Notes:** \*p≤0.05; \*\*p≤0.01; \*\*\*p≤0.001; †p≤0.15 (marginally significant). <sup>o</sup>Statistic for comparing the RiskDiff of SD-PPV and DEL-PPV patients. <sup>o†</sup>Indication of heterogeneity among individual study risk difference estimates in the fixed effects models. <sup>§</sup>Number of articles in which SD-PPV patients experienced better clinical outcomes; <sup>‡</sup>number of articles in which DEL-PPV patients experienced better clinical outcomes; <sup>#</sup>number of articles in which there was no difference between SD-PPV and DEL-PPV clinical outcomes. Risk difference was the risk (of an adverse clinical outcome, such as RD) for DEL-PPV patients minus the risk for SD-PPV patients. Positive numbers favor SD-PPV. Negative numbers favor DEL-PPV. The null hypothesis for the z-tests was that this risk difference was equal to zero. The null hypothesis for tests of between groups differences (Q-value) was that the risk difference in the MCF+ studies was the same as the risk difference in the MCF- studies. The % advantage was the percent advantage of MCF+ articles' SD-PPVs relative to MCF- articles' SD-PPVs over those articles' DEL-PPVs.

**Abbreviations:** BGD, between-groups difference; CE, corneal edema; CI, confidence interval; CME, cystoid macular edema; DEL, delayed; df, degrees of freedom; IOI, intraocular inflammation/infection; IOP, increased intraocular pressure; MCF, Mayo Clinic Florida; MCF-, articles not adhering to MCF SD-PPV policies; MCF+, articles adhering to MCF SD-PPV policies; PPV, pars plana vitrectomy; RD, retinal detachment; RiskDiff, risk difference; SD, same day; VA, visual acuity; vs, versus.

Not good VA (<20/40) risk differences of SD- and DEL-PPV by MCF+/MCF-



**Figure 3** Forest plot of a not good VA (<20/40) mixed-effects model for risk differences comparing SD-PPV and DEL-PPV, separately for MCF+ and MCF- studies. **Notes:** Risk difference was the risk for DEL-PPV patients minus the risk for SD-PPV patients. Positive numbers favor SD-PPV. Negative numbers favor DEL-PPV. Squares (size proportional to study weight in the meta-analysis) indicate the estimated risk difference from each individual study, with lines indicating the 95% CI. The red diamond is centered at the overall (all studies) summary estimate of the risk difference. The upper black diamond is centered at the MCF- studies' summary estimate of the risk difference, and the lower black diamond is centered at the MCF+ studies' summary estimate. Each diamond spans its 95% CI.

**Abbreviations:** CI, confidence interval; DEL, delayed; ID, identification; MCF, Mayo Clinic Florida; MCF-, studies not adhering to MCF SD-PPV policies; MCF+, studies adhering to MCF SD-PPV policies; PPV, pars plana vitrectomy; SD, same day; VA, visual acuity.

the DEL-PPV. These analyses did not include CME and intraocular inflammation/infection because for these outcomes, there were no significant or marginally significant differences between SD-PPV and DEL-PPV in the MCF+ studies (Table 4).

**Delayed vitrectomy time periods and data issues**

Five DEL-PPV time periods (after cataract surgery) were analyzed. Three time periods were considered “prompt” DEL-PPV (3 to 7, 3 to 14, and 7 to 14 days after cataract surgery), and two time periods were considered “non-prompt” DEL-PPV (7 or more days and 15 or more days after cataract surgery). For studies that provided individual patient data (including the exact day postcataract surgery of the vitrectomy), the time periods were exact. However, for studies that provided data grouped into time intervals, the time periods were based on average (often estimated) times. For these studies, some vitrectomies done on days 1 and 2 after cataract surgery (previously determined to be time needed for the eye to “recover” from cataract surgery)<sup>13</sup> may have been included in the 3 to 7 and 3 to 14 days, data, and some vitrectomies done in weeks 3

and 4 after cataract surgery may have been included in the 3 to 14 and 7 to 14 days, data. This occurred as long as the average delay was within these time periods because it was impossible to separate the grouped results.

In addition, not every study provided data for each time period. For example, in some studies, no vitrectomies were performed 3 to 7 days after cataract surgery. For each outcome (not good VA, bad VA, retinal detachment, increased IOP, and corneal edema), an initial analysis was performed to estimate a summary effect (risk difference) comparing SD-PPV to various DEL-PPV time periods, including all MCF+ studies with data for any of the DEL-PPV time periods. Summaries of these results are found in the shaded areas of Table 5. Three subsequent analyses were performed, using only studies that had data for all the time periods being compared. One analysis compared SD-PPV to DEL-PPV performed 3 to 7, 7 to 14, and 15+ days after cataract surgery. The second analysis compared SD-PPV to DEL-PPV performed 3 to 7 and 7+ days after cataract surgery. The third analysis compared SD-PPV to DEL-PPV performed 3 to 14 and 15+ days after cataract surgery. Summaries of these results are found in the unshaded areas of

**Table 5** Same-day versus delayed vitrectomy meta-analysis results (mixed-effects models) summary ranges of risk differences by timing of delayed vitrectomy (prompt vs nonprompt) for MCF+ articles only

Outcome	Range in risk differences between SD- and DEL-PPV			
	Prompt DEL-PPV		Nonprompt DEL-PPV	
	Low	High	Low	High
Not good VA (<20/40)	1.90%	6.50%	11.90%	22.60%
	-19.90%	6.20%	8.20%	22.60%
Bad VA ( $\leq$ 20/200)	2.20%	7.40%	11.70%	13.10%
	-6.90%	2.80%	11.70%	13.10%
RD	-0.10%	7.40%	10.60%	12.90%
	-0.20%	3.90%	10.60%	12.90%
IOP/Glaucoma	-0.10%	22.20%	13.80%	20.80%
	-3.40%	1.40%	13.80%	18.30%
Corneal edema	2.80%	4.30%	8.50%	14.30%
	0.00%	2.80%	9.10%	14.30%

**Notes:** Risk difference was the risk (of an adverse clinical outcome, such as RD) for DEL-PPV patients minus the risk for SD-PPV patients. Positive numbers favor SD-PPV. Negative numbers favor DEL-PPV. Shaded areas have results for analyses using articles with data for any of the time periods, while unshaded areas have results for analyses using only articles that had data for all time periods. Nonprompt delayed vitrectomies occurred 7 or more or 15 or more days after cataract surgery. Prompt delayed vitrectomies occurred 3 to 7, 3 to 14, or 7 to 14 days after cataract surgery. All comparisons between same-day vitrectomies and nonprompt delayed vitrectomies favor same-day vitrectomies, while results of comparisons between same-day vitrectomies and prompt delayed vitrectomies were mixed.

**Abbreviations:** DEL, delayed; IOP, increased intraocular pressure; MCF, Mayo Clinic Florida; MCF+, articles adhering to MCF SD-PPV policies; PPV, pars plana vitrectomy; RD, retinal detachment; SD, same day; VA, visual acuity; vs, versus.

Table 5. These subsequent comparisons were done because there was a reasonable amount of heterogeneity (ie, between-study variability in effects [see the *I*-squared statistics in Table 4]) in some of the initial MCF+ analyses.

Because the above analyses compared the results for immediate SD-PPVs to only a subset of the DEL-PPVs for each study, the sample size and number of events was often quite small, and there were many studies with no events (or nonevents) in one or both treatment groups. In particular, some corneal edema results were based on only one or two MCF+ studies. Therefore, these results are preliminary and not conclusive.

Detailed results (discussed below) for these analyses are not shown but are available on request. Figure 4A shows the median and range of the estimated risk differences for immediate SD-PPV (MCF+) vs prompt DEL-PPV, and Figure 4B provides the same information for immediate SD-PPV vs nonprompt DEL-PPV.

### Same-day vs prompt delayed vitrectomies

Overall, these results (Figure 4A) show no consistent pattern of risk differences favoring either immediate SD-PPV or

prompt DEL-PPV (3 to 7, 3 to 14, or 7 to 14 days after cataract surgery). Of the 35 total comparisons of immediate SD-PPV and prompt DEL-PPV, only one (3%) (favoring immediate SD-PPV) was statistically significant, nine (26%) had *P*-values between 0.05 and 0.50 (eight [23%] favoring immediate SD-PPV and one favoring prompt DEL-PPV), and 25 (71%) had *P*-values greater than 0.50, providing little evidence of an association between clinical outcomes and immediate SD-PPV or prompt DEL-PPV. Based on this lack of a consistent pattern in comparisons of immediate SD-PPV and prompt DEL-PPV, there is a preliminary indication that prompt DEL-PPV produces outcomes that are similar to those produced by immediate SD-PPV (Figures 4A and 5).

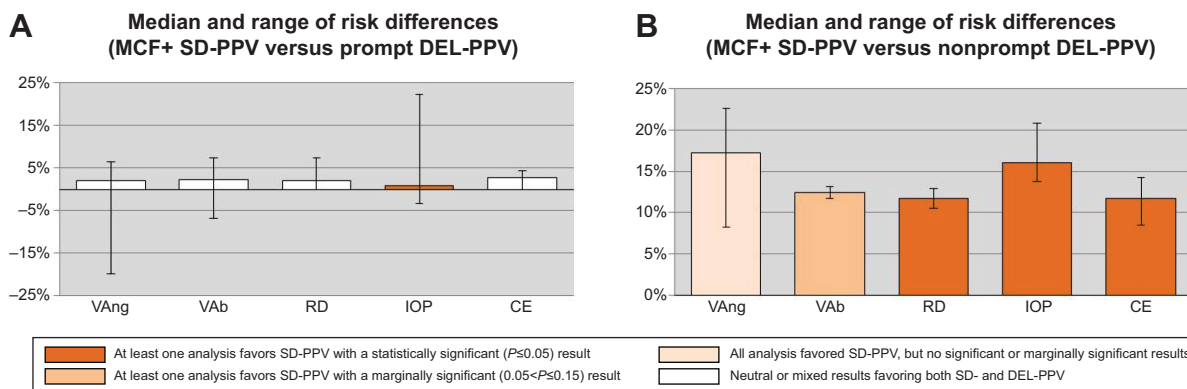
### Same-day vs nonprompt delayed vitrectomies

However, all 25 results comparing immediate SD-PPV to nonprompt DEL-PPV (7+ and 15+ days after cataract surgery) favored immediate SD-PPV with eight (32%) statistically significant, 14 (56%) with *P*-values between 0.05 and 0.50, and three (12%) with *P*-values greater than 0.50. None favored nonprompt DEL-PPV. This provides a preliminary indication that nonprompt DEL-PPV produces outcomes that may be inferior to those from immediate SD-PPV (Figures 4B and 5).

## Results summary

The SD-PPV vs DEL-PPV results are summarized in Figure 6, for all studies (Figure 6A) and separately for MCF+ (Figure 6B) and MCF- studies (Figure 6C). For all studies together and for the MCF- studies, the results did not indicate an association between clinical outcomes and whether the patient had an SD-PPV or DEL-PPV. However, there was evidence that immediate SD-PPV (MCF+ studies) may produce better outcomes than DEL-PPV. These results were robust in analyses for publication/reporting biases and all sensitivity analyses (results not shown).<sup>21</sup>

Comparisons of immediate SD-PPV with prompt or nonprompt DEL-PPV cannot be considered conclusive, due to small samples, but were congruent with results from our previous meta-analyses.<sup>13</sup> Comparisons of immediate SD-PPV and prompt DEL-PPV did not consistently favor either vitrectomy time. This supports a preliminary hypothesis that patients who receive a prompt DEL-PPV might enjoy outcomes that are comparable with those who receive an immediate SD-PPV. However, all comparisons of immediate SD-PPV and nonprompt DEL-PPV favored SD-PPV.



**Figure 4** Comparison of estimated risk differences for immediate SD (MCF+) vs prompt (3 to 7, 3 to 14, or 7 to 14 days after cataract surgery) DEL-PPV (A) and nonprompt (7+ or 15+ days after cataract surgery) DEL-PPV (B).

**Notes:** Risk difference is the risk for DEL-PPV patients minus the risk for SD-PPV patients. Positive numbers favor immediate SD-PPV. Negative numbers favor DEL-PPV. Column height indicates median estimated risk differences and error bars represent their range. (A) Nonsignificant, mixed results and large ranges support a preliminary hypothesis of similar outcomes for immediate SD- and prompt DEL-PPV. (B) Several significant results favoring SD-PPV support previous research that earlier DEL-PPV produces better outcomes.

**Abbreviations:** CE, corneal edema; DEL, delayed; IOP, increased intraocular pressure; MCF, Mayo Clinic Florida; MCF+, studies adhering to MCF SD-PPV policies; PPV, pars plana vitrectomy; RD, retinal detachment; SD, same day; VA, visual acuity; VAb, bad visual acuity (<20/200); VAng, not good VA (<20/40).

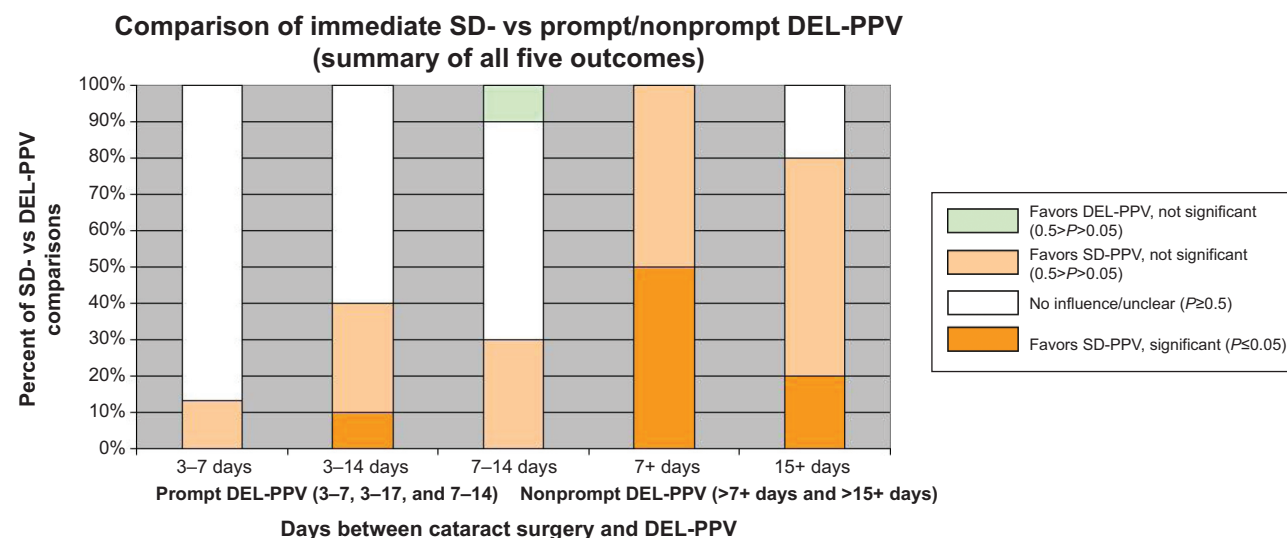
### Discussion

Patient displeasure is common following complicated cataract surgery<sup>46,47</sup> and tends not to improve if reduced VA persists.<sup>48</sup> One article reported that, “Most patients [with retained lens fragments], who had expected a rapid visual recovery after cataract surgery, were very dissatisfied with poor vision postoperatively.”<sup>27</sup> SD-PPV could help to mitigate this patient dissatisfaction.<sup>49</sup>

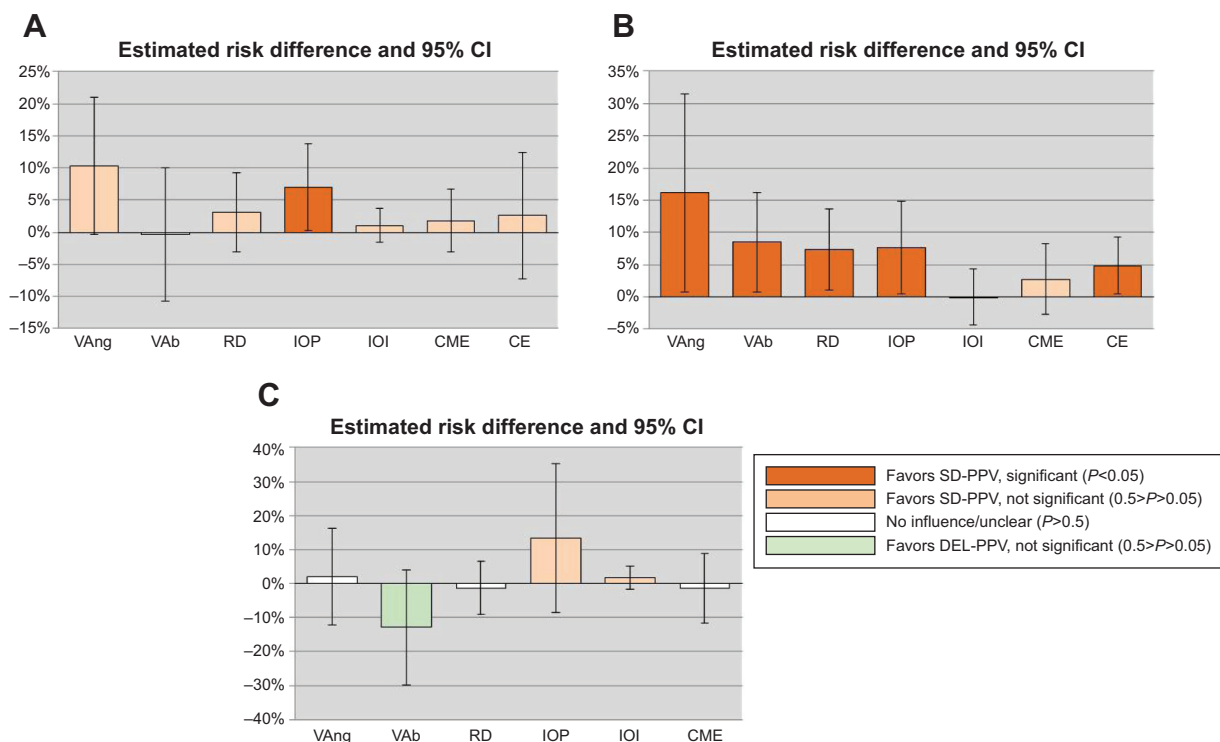
Some authors have suggested that cataract surgery on eyes with increased risk for retained lens fragments be performed at a facility where a vitreoretinal surgeon is available.<sup>28</sup> One author

extended this recommendation to any cataract surgeon learning phacoemulsification.<sup>50</sup> Our results do not support these suggestions for all cataract surgery patients (although future research may support these for patients with specific risk factors). As long as the cataract surgeon refers the patient to a vitreoretinal surgeon in time for a prompt DEL-PPV (3 to 7 or perhaps 14 days after cataract surgery), our results provide support for current cataract surgery practice patterns and locations.

Previously reported results for SD-PPV were mixed.<sup>23</sup> Some facilities had good VA results,<sup>22,24,25</sup> while other facilities’ results were not as good.<sup>26-28</sup> In one study, six SD-PPV



**Figure 5** Indications, from risk differences comparing SD-PPV to prompt and nonprompt DEL-PPV, of which PPV timing produced better clinical outcomes. **Notes:** 15+ = nonprompt DEL-PPV 15 or more days after cataract surgery; 3 to 14= prompt DEL-PPV 3 to 14 days after cataract surgery; 3 to 7= prompt DEL-PPV 3 to 7 days after cataract surgery; 7+ = nonprompt DEL-PPV more than 7 days after cataract surgery; 7 to 14= prompt DEL-PPV 7 to 14 days after cataract surgery. The five outcomes were corneal edema, increased intraocular pressure/glaucoma, retinal detachment, bad visual acuity ( $\leq 20/200$ ), and not good visual acuity ( $< 20/40$ ). **Abbreviations:** DEL, delayed; PPV, pars plana vitrectomy; SD, same day; vs, versus.



**Figure 6** Comparison of SD- vs DEL-PPV risk differences for all studies (A), MCF+ studies (B), and MCF- studies (C).

**Notes:** Risk difference is the risk for DEL-PPV patients minus the risk for SD-PPV patients. Positive numbers favor SD-PPV. Negative numbers favor DEL-PPV. Column height is the estimated risk difference; error bars span its 95% CI. CE results for MCF- studies (outlier not included).

**Abbreviations:** CE, corneal edema; CI, confidence interval; CME, cystoid macular edema; DEL, delayed; IOI, intraocular inflammation/infection; IOP, increased intraocular pressure; MCF, Mayo Clinic Florida; MCF-, studies not adhering to MCF SD-PPV policies; MCF+, studies adhering to MCF SD-PPV policies; PPV, pars plana vitrectomy; RD, retinal detachment; SD, same day; VAb, bad visual acuity ( $\leq 20/200$ ); VAng, not good VA ( $< 20/40$ ).

patients had cataract surgery done at a facility with a vitreo-retinal unit: one had a massive choroidal hemorrhage, and another had corneal decomposition, possibly “related to prolonged use of intraocular fluids”.<sup>26</sup> Elsewhere, excessive use of infusion fluid was contraindicated to prevent traction and retinal complications.<sup>6</sup> One study reported no retinal detachments among 38 patients who received an SD (or next-day) vitrectomy,<sup>31</sup> while, in another study, four of six SD-PPV patients had a retinal detachment.<sup>18</sup>

The reasons for inconsistent SD-PPV results are not clear, but based on our results, part of the explanation may be that policies and strategies for SD-PPV differ. It is possible that immediate SD-PPV, when cataract surgeons do not attempt retained lens fragment retrieval, produces superior results,<sup>35</sup> but other SD-PPV strategies may not be as good. Perhaps immediate SD-PPV removes the lens fragments before the onset of time-dependent inflammation and the accompanying choroidal congestion that occurs with same-day patient transfer between surgical facilities. Immediate SD-PPV for retained lens fragments closely resembles a planned pars plana lensectomy, something frequently performed, without complications, by vitreoretinal surgeons. Compared with waiting several hours

between surgeries, immediate SD-PPV may take advantage of a clear cornea and minimally inflamed eye to enable better removal of retained lens fragments, with fewer complications. Reasons for inconsistent SD-PPV results might also include characteristics of the eyes and/or surgeons, which could not be explored in a meta-analysis using study-level data.

These results support our previous research on vitrectomy timing. Our previous analysis of MCF SD-PPV vs DEL-PPV data<sup>35</sup> indicated that immediate SD-PPV was associated with superior clinical outcomes. Our previous meta-analysis, which assessed the effect of increasing vitrectomy delays (3 or more days after cataract surgery), indicated that prompt DEL-PPV outcomes were superior to later (nonprompt) DEL-PPV outcomes.<sup>13</sup> The current meta-analysis indicated that immediate SD-PPV was associated with superior clinical outcomes compared with all and nonprompt DEL-PPV but that prompt DEL-PPV was associated with outcomes comparable with immediate SD-PPV.

## Future research

This leads to a hypothesis that immediate SD-PPV and prompt DEL-PPV may produce equivalent outcomes.

A multicenter, randomized controlled trial would be needed to test a noninferiority hypothesis comparing immediate SD-PPV and prompt DEL-PPV outcomes. Although the MCF policy is one alternative, different facilities may have other successful SD-PPV policies. Further research should analyze how SD-PPV results differ based on various SD-PPV strategies, to determine the optimal circumstances for an SD-PPV.

## Study limitations

Major limitations include low power due to few patients with adverse events, especially in the SD-PPV group, which was generally much smaller than the DEL-PPV group, and especially in the MCF+ studies (Table 3). Another limitation was the classification of studies as MCF+ or MCF– based solely on information provided in each article (study-based). It is possible that some SD-PPV patients in the MCF– studies received an immediate SD-PPV, which would undermine the internal validity of MCF+/MCF– comparisons and understate any actual differences between these groups.<sup>51</sup> Another possible threat to internal validity was selection bias<sup>51</sup> because it was not possible to determine whether there were significant between-group (SD-PPV vs DEL-PPV) differences in baseline variables. Comparisons of immediate SD-PPV and prompt DEL-PPV (3 to 7, 3 to 14, or 7 to 14 days after cataract surgery) were affected by data grouped into time intervals, so data from DEL-PPV performed outside these time periods were included in some analyses.

Several additional limitations to meta-analysis of these data were discussed previously.<sup>13</sup> As with our previous meta-analysis, this one had little evidence of publication bias, but the studies did exhibit reporting bias, and it is possible that authors were more likely to report significant, rather than nonsignificant, results. However, sensitivity analyses indicated that the overall conclusions were not affected by reporting bias, the inclusion of small studies and those with no events (or nonevents) in a treatment group, or the removal of any one study from the analyses.<sup>21</sup>

## Clinical recommendations

The question of whether SD-PPV for retained lens fragments is appropriate has long been debated by vitreoretinal surgeons, with many firmly on one side (in favor of SD-PPV) and others just as firmly on the other. This research raises the possibility that this lack of consensus may have occurred because all SD-PPVs cannot be considered as the same clinical option. There appears to be at least two distinct variations of SD-PPV: immediate SD-PPV performed under strategies

such as the MCF “no move, no wait” policy<sup>35</sup> and SD-PPV performed under different strategies that permit longer waits and/or interfacility patient transport.

Some ophthalmologists who support SD-PPV may have had good clinical experience with immediate SD-PPV compared with DEL-PPV that occurred weeks, months, or even years after cataract surgery. On the other hand, it is possible that some ophthalmologists who do not support SD-PPV have had experiences with SD-PPV after long delays and/or interfacility patient transport that were not as positive. This meta-analysis may help inform the SD-PPV debate with the contribution that while SD-PPV may be appropriate under some policies (for example, immediately with no waiting or interfacility patient transport), SD-PPV may often be inappropriate under other policies.

## Conclusion

This research provides some preliminary evidence that SD-PPV may be unnecessary as long as prompt DEL-PPV would be performed. Some cataract surgery practice patterns can accommodate either immediate SD-PPV or prompt DEL-PPV because the cataract surgeons operate at the same facility as a vitreoretinal surgeon, but most operate where a vitreoretinal surgeon is not readily available. These results, coupled with the results of our previous meta-analysis, provide a preliminary indication that if an immediate SD-PPV cannot be performed, the cataract surgeon need not attempt to transfer the patient to another facility for an SD-PPV, but should refer the patient to a vitreoretinal surgeon so that a prompt DEL-PPV can be performed.

## Disclosure

The authors report no conflicts of interest in this work.

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## Supplementary materials

### First search

- |                   |                     |                                 |
|-------------------|---------------------|---------------------------------|
| 1 retained lens   | 3 dislocated lens   | 5 posterior dislocation of lens |
| 2 dropped nucleus | 4 intravitreal lens | 6 #1 or #2 or #3 or #4 or #5    |

Limits: English, January 1, 1985 (year of the initial journal article on this subject) to October 31, 2009, with updates weekly through the "My NCBI" service of PubMed. Outcomes were not included based on recommendations for search strategies in the *Cochrane Handbook for Systematic Review of Interventions*.<sup>1</sup>

### Second search

- |                                    |                                  |   |
|------------------------------------|----------------------------------|---|
| 1 lens fragments                   | 11 retina detachment             | 21 intraocular infection  |
| 2 dropped nuclei                   | 12 glaucoma                      | 22 intra-ocular infection   |
| 3 retained nuclei                  | 13 intraocular pressure          | 23 endophthalmitis  |
| 4 nuclear fragments                | 14 intra-ocular pressure         | 24 hypopyon   |
| 5 lens dislocation                 | 15 intra-ocular inflammation     | 25 corneal edema  |
| 6 lens material                    | 16 intraocular inflammation      | 26 cornea edema   |
| 7 #1 or #2 or #3 or #4 or #5 or #6 | 17 uveitis                       | 27 cystoid macular edema  |
| 8 visual acuity                    | 18 vitritis                      | 28 #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 |
| 9 visual outcome                   | 19 AC inflammation               | 29 #7 and #28   |
| 10 retinal detachment              | 20 anterior chamber inflammation |   |

Limits: English, January 1, 1985 to July 30, 2010, with updates weekly through the "My NCBI" service of PubMed. Outcomes included because the term "nuclear fragments" returned many studies about cell nuclei.

Updated search methods for identification of studies (MEDLINE/PubMed).

### Updated second search

- |                                    |                                  |   |
|------------------------------------|----------------------------------|---|
| 1 lens fragments                   | 11 retina detachment             | 21 intraocular infection  |
| 2 dropped nuclei                   | 12 glaucoma                      | 22 intra-ocular infection   |
| 3 retained nuclei                  | 13 intraocular pressure          | 23 endophthalmitis  |
| 4 nuclear fragments                | 14 intra-ocular pressure         | 24 hypopyon   |
| 5 lens dislocation                 | 15 intra-ocular inflammation     | 25 corneal edema  |
| 6 lens material                    | 16 intraocular inflammation      | 26 cornea edema   |
| 7 #1 or #2 or #3 or #4 or #5 or #6 | 17 uveitis                       | 27 cystoid macular edema  |
| 8 visual acuity                    | 18 vitritis                      | 28 #8 or #9 or #10 or #11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 |
| 9 visual outcome                   | 19 AC inflammation               | 29 #7 and #28   |
| 10 retinal detachment              | 20 anterior chamber inflammation |   |

Limits: English, July 1, 2010 to July 16, 2013, with updates weekly through the "My NCBI" service of PubMed. Outcomes included because the term "nuclear fragments" returned many studies about cell nuclei.

**Figure S1** Original search methods for identification of studies (MEDLINE/PubMed).

**Abbreviations:** AC, anterior chamber; NCBI, National Center for Biotechnology Information.

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