Fellow eye vitrectomy for proliferative diabetic retinopathy in an inner city population

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ABSTRACT

Aim To describe the rate of fellow eye vitrectomy for proliferative diabetic retinopathy in an inner city population.

Methods Retrospective interventional case series. Medical and surgical records of 434 consecutive eyes of 358 patients undergoing primary diabetic vitrectomy in an inner city institutional practice were reviewed. Kaplan–Meier statistical analysis was employed to evaluate the rate of fellow eye vitrectomy and visual outcomes were determined for patients with ≥3 months follow-up.

Results Fellow eyes underwent diabetic vitrectomy at a rate of 24% within 1 year, 34% within 3 years and 36% within 5 years of primary vitrectomy. A surgical indication of non-clearing vitreous haemorrhage (VH) in the primary eye was associated with a lower rate of fellow eye surgery compared with non-clearing VH with extrafoveal traction retinal detachment (TRD) at years 1, 3 and 5 ($p \leq 0.02$), and TRD at years 3 and 5 ($p \leq 0.03$). Younger patients underwent fellow eye vitrectomy at a higher rate than older patients ($p \leq 0.01$). Surgical intervention was associated with improvement in mean visual acuity ($p < 0.01$).

Conclusions Approximately a third of fellow eyes required diabetic vitrectomy within 3 years of primary eye vitrectomy. Primary eye surgical indication and younger age were significant predictors of need for fellow eye surgery.

INTRODUCTION

Diabetic retinopathy is a leading cause of visual morbidity and affects approximately 4.1 million adults in the USA.[1] The incidence of retinopathy is expected to rise precipitously as a consequence of the ageing population and the increase in age-specific disease prevalence.[1] In advanced proliferative diabetic retinopathy (PDR), surgical intervention is often employed to clear media opacities, relieve traction, treat retinal breaks and stabilise the proliferative process.[2]

For patients undergoing diabetic vitrectomy, the status of the fellow eye and potential need for future surgical intervention are a significant concern. However, few studies[2 3] have attempted to evaluate the need for surgical intervention in the fellow eye, despite the bilateral nature of the disease. The goal of this study was to describe the rate of fellow eye vitrectomy for PDR in an inner city population.

METHODS

The medical and surgical records of consecutive patients who underwent primary pars plana vitrectomy for complications relating to PDR by a single surgeon (DE) at the Kresge Eye Institute of Wayne State University School of Medicine (Detroit, Michigan, USA) were reviewed retrospectively. All patients underwent standard 3-port pars plana vitrectomy for non-clearing vitreous haemorrhage alone (VH), non-clearing vitreous haemorrhage with extrafoveal traction retinal detachment (VHTRD), traction retinal detachment involving the fovea (TRD) with or without VH, combined traction and rhegmatogenous retinal detachment (TRRD), or neovascular glaucoma (NVG). Preoperative and postoperative best-corrected Snellen vision was converted to logarithm of the minimum angle of resolution (logMAR) units to facilitate statistical comparison. Functional outcome was determined by visual acuity at last follow-up for patients with at least 3 months follow-up.

Numerical computations were performed using a spreadsheet package (Excel 2003; Microsoft, Redmond, Washington, USA). Statistical comparison of categorical findings was performed using the χ^2 test. Kaplan–Meier statistical analysis and survival curve for fellow eye surgery were performed using public domain statistical software (Epi Info V.3.5.3; Centers for Disease Control and Prevention, Atlanta, Georgia, USA). A p value of ≤ 0.05 was considered statistically significant.

This study followed the tenets of the Declaration of Helsinki and received approval from the institutional review board of Wayne State University School of Medicine. Medical charts were reviewed in compliance with the Health Insurance Portability and Accountability Act.

RESULTS

A total of 434 consecutive eyes of 358 patients underwent primary pars plana vitrectomy for complications related to PDR. A subset of 315 eyes of 260 patients had at least 3 months of follow-up. Patient demographics were analysed for primary and fellow eyes (table 1).

The overall rate of surgical intervention on the fellow eye was 21% for all patients (76/358) and 21% for patients with at least 3 months follow-up (55/260). Mean and median follow-up duration was 23 and 13 months for all eyes, respectively, and 31 and 23 months for eyes with at least 3 months of follow-up, respectively. There was no significant difference in gender or laterality of eye between the two groups.

Patients requiring vitrectomy on both eyes were significantly younger than patients requiring surgery on the primary eye only. Overall, the mean age for primary and fellow eye vitrectomy was 55 and 50 years ($p < 0.01$), respectively, and the median age for primary and fellow eye vitrectomy was 56 and 52 years, respectively. Patients with at least 3 months follow-up demonstrated a similar

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Table 1 Baseline characteristics for all eyes and eyes with at least 3 months of follow-up

	All eyes			Eyes with ≥3 months follow-up		
Preoperative characteristic	All eyes	Primary eyes	Fellow eyes	All eyes	Primary eyes	Fellow eyes
# Patients (%)	434	358 (82)	76 (18)	315	260 (83)	55 (17)
Age						
Mean (years)*	54	55	50	53	54	50
SD	13	14	12	14	14	13
Median	55	56	52	54	55	52
Sex						
Male (%)	205 (47)	167 (46)	38 (50)	143 (45)	115 (44)	28 (50)
Female (%)	229 (52)	191 (53)	38 (50)	172 (54)	145 (55)	27 (49)
Eye						
Right (%)	196 (45)	166 (46)	30 (39)	144 (45)	122 (46)	22 (40)
Left (%)	238 (54)	192 (53)	46 (60)	171 (54)	138 (53)	33 (60)
Follow-up						
Mean (months)	23	23	25	31	31	35
SD	27	27	28	27	27	28
Median	13	13	14	23	23	30
Low	0	0	0	3	3	4
High	123	123	112	123	123	112

*Mean age was significantly lower for fellow eyes compared with primary eyes for all eyes (p<0.01), and there was a trend towards lower mean age for fellow eyes compared with primary eyes (p=0.06) for eyes with ≥3 months follow-up.

trend, with a mean age for primary and fellow eye vitrectomy of 54 and 50 years (p=0.06), respectively, and a median age for primary and fellow eye vitrectomy of 55 and 52 years, respectively. Subgroup analysis stratifying patients into younger (<40 years) and older groups (≥40 years) revealed a higher rate of fellow eye surgery in the younger group (35% vs 19%) for all eyes (p=0.05).

The most common indication for diabetic vitrectomy was VHTRD followed by TRRD, TRD, VH and NVG. Surgical indications were similar between all eyes and eyes with at least 3 months follow-up (table 2).

There was no significant difference in surgical indications between the younger and older groups. For each subgroup, there was no significant difference in surgical indication between primary eyes and fellow eyes.

Overall, surgical intervention resulted in a significant improvement in visual acuity for eyes with at least 3 months follow-up (table 3).

Mean visual acuity improved from 1.75 logMAR (20/1125) to 1.51 logMAR (20/647) (p<0.01), and median visual acuity improved from 1.60 logMAR (20/796) to 1.30 logMAR (20/399). Primary eyes had a significant improvement in mean visual acuity from 1.77 logMAR (20/1178) to 1.53 logMAR (20/678) (p=0.001), whereas fellow eyes had a trend towards improvement (p=0.09) in mean visual acuity from 1.68 logMAR (20/957) to 1.43 logMAR (20/538). Median visual acuity improved from 1.60 logMAR (20/796) to 1.30 logMAR (20/399) in primary eyes, and improved from 1.60 logMAR (20/796) to 1.18 logMAR (20/303) in fellow eyes. Mean preoperative and postoperative visual acuities were similar between the younger and older patient groups. The postoperative visual acuity distribution improved relative to the preoperative distribution for all eyes, primary eyes and fellow eyes (p≤0.03). Approximately 50% of eyes demonstrated ≥0.30 logMAR gain in visual acuity postoperatively.

A Kaplan–Meier survival curve was constructed because of variable follow-up duration (figure 1). Overall, the percentage of patients who did not require fellow eye surgery was 76% at 1 year, 66% at 3 years and 64% at 5 years (table 4).

Patients undergoing vitrectomy in the primary eye for VH had significantly less risk for fellow eye surgery compared with those who underwent intervention for VHTRD at years 1, 3

Table 2 Surgical indication for all eyes and eyes with at least 3 months of follow-up

	All eyes			Eyes with ≥3 months follow-up*		
Surgical indication	All eyes	Primary eyes	Fellow eyes†	All eyes	Primary eyes	Fellow eyes‡
VH (%)	81 (19)	72 (20)	9 (12)	56 (18)	49 (19)	7 (13)
VHTRD (%)	136 (31)	111 (31)	25 (32)	99 (31)	81 (31)	18 (33)
TRD (%)	91 (21)	70 (20)	21 (28)	67 (21)	54 (21)	13 (24)
TRRD (%)	97 (22)	79 (22)	18 (24)	81 (26)	66 (25)	15 (27)
NVG (%)	29 (7)	26 (7)	3 (4)	12 (4)	10 (4)	2 (4)
Total	434	358	76	315	260	55

*Surgical indication was similar between all eyes and eyes with ≥3 months follow-up (p=0.97).
†Surgical indication was similar between primary eyes and fellow eyes (p=0.25) for all eyes.
‡Surgical indication was similar between primary eyes and fellow eyes (p=0.87) for eyes with ≥3 months follow-up.
NVG, neovascular glaucoma; TRD, traction retinal detachment involving the fovea; TRRD, combined traction and rhegmatogenous retinal detachment; VH, non-clearing vitreous haemorrhage alone; VHTRD, non-clearing vitreous haemorrhage with extrafoveal traction retinal detachment.

Table 3 Visual outcome of eyes with at least 3 months follow-up

	All eyes			Primary eyes			Fellow eyes		
Visual acuity	**Preoperative**	**Postoperative**	**p Value**	**Preoperative**	**Postoperative**	**p Value**	**Preoperative**	**Postoperative**	**p Value**
Mean (logMAR)	1.75	1.51	0.0002	1.77	1.53	0.001	1.68	1.43	0.09
SD (logMAR)	0.75	0.97		0.75	0.95		0.79	1.08	
Median (logMAR)	1.60	1.30		1.60	1.30		1.60	1.18	
Low (logMAR)	0.18	0.00		0.18	0.00		0.18	0.10	
High (logMAR)	2.70	3.00		2.70	3.00		2.70	3.00	
Distribution*									
≥20/40	5 (2)	30 (10)	<0.0001	3 (1)	21 (8)	0.0005	2 (4)	9 (16)	0.06
20/41–20/200	63 (21)	96 (31)	0.006	50 (20)	78 (30)	0.01	13 (24)	18 (33)	0.43
20/201–5/200	39 (13)	50 (16)	0.31	33 (13)	42 (16)	0.38	6 (11)	8 (15)	0.81
<5/200	199 (65)	138 (44)	<0.0001	166 (66)	118 (46)	<0.0001	33 (61)	20 (36)	0.02
Unknown	9	1		8	1		1	0	
≥0.20 logMAR gain (%)		152 (50)			123 (49)			29 (54)	
≥0.30 logMAR gain (%)		149 (49)			121 (48)			28 (52)	

*Postoperative visual acuity distribution improved following surgical intervention for all eyes (p<0.0001), primary eyes (p<0.0001) and fellow eyes (p=0.03) compared with preoperative distribution.
logMAR, logarithm of the minimum angle of resolution.

and 5 (p≤0.02), TRD at years 3 and 5 (p≤0.03), and a trend towards less risk compared with TRRD at year 5 (p=0.07). There was no significant difference in risk of fellow eye surgery among all other indications for primary eye surgery. Median time to fellow eye surgery (all eyes) was 5.6 months, and mean time was 10.5 months (SD 19.2 months). There was no significant difference in time to fellow eye surgery for diagnoses of VH, VHTRD, TRD, TRRD and NVG. Younger patients required fellow eye surgery at a higher rate compared with older patients at years 1, 3 and 5 (p≤0.01) (table 4). Subgroup analysis demonstrated that younger patients who underwent primary eye vitrectomy for VH or VHTRD had a higher rate of fellow eye surgery compared with older patients (p≤0.04).

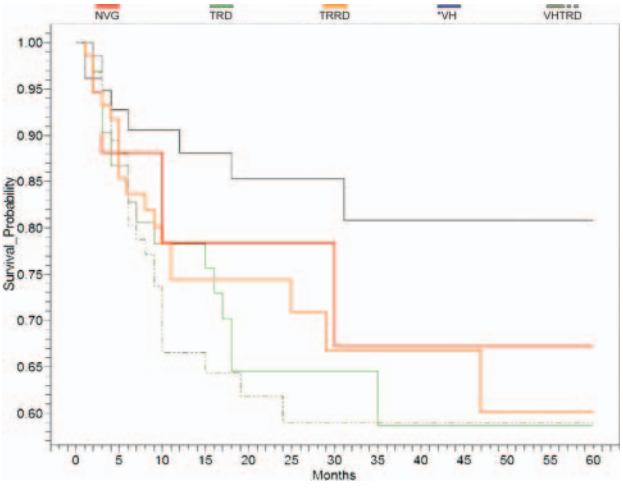

Figure 1 5-year Kaplan–Meier survival curve for fellow eye surgery. *Lower rate of fellow eye surgery for patients who underwent primary eye vitrectomy for VH compared with those who underwent primary eye surgery for VHTRD at years 1, 3 and 5 (p≤0.02), TRD (p≤0.03) at years 3 and 5, and a trend towards less risk compared with TRRD (p=0.07) at year 5. There was no significant difference compared with a diagnosis of NVG. NVG, neovascular glaucoma; TRD, traction retinal detachment involving the fovea; TRRD, combined traction and rhegmatogenous retinal detachment; VH, non-clearing vitreous haemorrhage alone; VHTRD, non-clearing vitreous haemorrhage with extrafoveal traction retinal detachment.

DISCUSSION

The goal of this study was to determine the rate of fellow eye vitrectomy for patients with advanced PDR in an inner city population. Our analysis revealed that fellow eyes underwent diabetic vitrectomy at a rate of 24% within 1 year, 34% within 3 years and 36% within 5 years of primary eye surgery, despite attempted close follow-up and extensive application of panretinal photocoagulation. Median time to fellow eye surgery (all eyes) was 5.6 months, and mean time was 10.5 months. Younger patients (<40 years) were at higher risk for requiring fellow eye diabetic vitrectomy compared with older patients (≥40 years) at years 1, 3 and 5 (p≤0.01).

We identified the surgical indication of the primary eye as an important predictor of whether surgery would be required for the fellow eye. Patients who underwent vitrectomy for non-clearing VH demonstrated significantly lower rates of fellow eye surgery compared with patients with VHTRD at years 1, 3 and 5 (p≤0.02), TRD at years 3 and 5 (p≤0.03), and a trend towards lower risk relative to TRRD at year 5 (p=0.07). These findings were not surprising, given that non-clearing VH represents the mildest manifestation of PDR requiring vitrectomy. Since PDR is a bilateral disease, albeit often asymmetric, it is reasonable to assume that primary eyes with less advanced disease are less likely to require vitrectomy on the fellow eye.

Patients undergoing surgical intervention experienced significant visual benefits (table 3). Overall, mean visual acuity improved from 1.75 logMAR (20/1125) to 1.51 logMAR (20/647) (p<0.01), and median visual acuity improved from 1.60 logMAR (20/796) to 1.30 logMAR (20/399). Subgroup analysis demonstrated that primary eyes had an improvement in mean visual acuity (p<0.01), whereas fellow eyes had a trend towards improvement (p=0.09). Visual acuity distributions were significantly improved postoperatively for all eyes, primary eyes and fellow eyes (p≤0.03), and approximately 50% of eyes experienced a visual acuity gain of ≥0.3 logMAR. These findings are consistent with previous studies that assessed functional outcomes following diabetic vitrectomy.[4–6]

Table 4 Kaplan–Meier survival for fellow eye surgery at 1, 3 and 5 years following primary eye surgery

	Fellow eye survival (no diabetic vitrectomy)								
	All patients			Patients ≥40 years			Patients <40 years		
Surgical indication of primary eye	1 year (%)	3 years (%)	5 years (%)	1 year (%)	3 years (%)	5 years (%)	1 year (%)	3 years (%)	5 years (%)
VH*	88*	81*,†	81*,†,‡	93	87	87	74§	50§	50§
VHTRD	67	59	59	71	65	65	36¶	24¶	24¶
TRD	78	59	59	82	56	56	65	65	65
TRRD	74	66	60	76	71	60	71	59	59
NVG	78	67	67	80	66	66	67	67	67
All	76	66	64	79	69	67	61**	51**	51**

*Lower rate of fellow eye surgery at years 1, 3 and 5 ($p \leq 0.02$) for patients who underwent primary eye vitrectomy for VH compared with those who underwent surgery for VHTRD.
†Lower rate of fellow eye surgery at years 3 and 5 ($p \leq 0.03$) for patients who underwent primary eye vitrectomy for VH compared with those who underwent surgery for TRD.
‡Trend towards lower rate of fellow eye surgery at year 5 ($p=0.07$) for patients who underwent primary eye vitrectomy for VH compared with those who underwent surgery for TRRD.
§Higher rate of fellow eye surgery at years 1, 3 and 5 ($p \leq 0.04$) for patients <40 years compared with patients ≥40 years who underwent primary eye vitrectomy for VH.
¶Higher rate of fellow eye surgery at years 1, 3 and 5 ($p \leq 0.01$) for patients <40 years compared with patients ≥40 years who underwent primary eye vitrectomy for VHTRD.
**Higher rate of fellow eye surgery at years 1, 3 and 5 ($p \leq 0.01$) for patients <40 years compared with patients ≥40 years, overall.
NVG, neovascular glaucoma; TRD, traction retinal detachment involving the fovea; TRRD, combined traction and rhegmatogenous retinal detachment; VH, non-clearing vitreous haemorrhage alone; VHTRD, non-clearing vitreous haemorrhage with extrafoveal traction retinal detachment.

This study also highlights the perils of reporting proportions in clinical studies: a commonly employed but potentially misleading analytical method.[7] In our study, 21% of patients (76/358) required diabetic vitrectomy in the fellow eye. Yet, we reported that 36% of patients required fellow eye surgery within 5 years of primary eye vitrectomy. This difference can be attributed to the fact that use of proportions or percentages in a population does not account for variable follow-up or the effect of time. If all 358 patients were followed up to 5 years, then it would be appropriate to report that 21% (76/358) of patients required fellow eye surgery at 5 years. However, since some patients were lost to follow-up, the population that potentially needed fellow eye surgery at 5 years was significantly smaller. In this scenario, Kaplan–Meier survival analysis was appropriately employed to account for variable follow-up duration.

Previous studies have attempted to evaluate the rate of fellow eye surgery in PDR. A report[2] from the Bascom Palmer Eye Institute, which focused primarily on assessing the impact of vitrectomy on overall visual function, reported as a secondary outcome that 24% of fellow eyes required diabetic vitrectomy at final follow-up (mean of 17.6 months, range of 3–79 months). At final follow-up, 79% of all fellow eyes demonstrated a visual acuity of ≥5/200, and 23% experienced visual loss that was defined as halving of the visual angle or no light perception vision. However, this study had a relatively short mean follow-up duration of 17.6 months, and the variable follow-up of the study population precluded a detailed interpretation of the rate of fellow eye vitrectomy.[7] Our study demonstrated a longer mean follow-up period of 23 months for all eyes and 31 months for eyes with at least 3 months of follow-up, and employed Kaplan–Meier survival analysis to account for variable follow-up.

Another study[3] conducted in New Zealand on a predominantly Maori and Pacific Islander population reported that 38% of fellow eyes required diabetic vitrectomy with a mean time of 1.6 years following primary eye surgery (mean follow-up of 4 years, range of 1 day–8.4 years). The study correlated the absence of VH (ie, TRD or TRRD alone without VH) as a significant predictor of need for fellow eye surgery compared with the presence of VH (with or without TRD or TRRD). The report also identified the duration of diabetes and poor diabetic control as independent predictors of time to fellow eye surgery. Of note, the population in this study was in particularly poor health and 57% of patients had died at the time of data analysis (mean of 4.3 years following surgery).

It is important to note that our study population is not representative of the general population, since our patients were predominantly inner city, uninsured and underinsured (Medicaid), and African American (75%). Cardiovascular morbidities were common in our population with high rates of prior myocardial infarction and congestive heart failure, and many patients had chronic renal failure requiring renal dialysis. In addition, our patients had low rates of prior ophthalmic care and panretinal photocoagulation on initial presentation. The reasons underlying patient loss to follow-up are likely multifactorial and attributable to a combination of socioeconomic, educational, systemic health and insurance-related issues. Patients lost to follow-up may have experienced a different rate of fellow eye disease, and this is a possible confounder in our study.

In summary, in this primarily urban, underinsured, African American patient population with complex vitreoretinal pathology due to severe complications of PDR, patients who underwent diabetic vitrectomy were at significant risk for requiring surgical intervention on the fellow eye despite attempted close follow-up and extensive panretinal photocoagulation. Approximately a third of fellow eyes underwent diabetic vitrectomy within 3 years of primary eye vitrectomy. Patients who underwent vitrectomy for non-clearing VH in the primary eye had a significantly lower risk of requiring fellow eye surgery compared with those who underwent surgery for VHTRD and TRD. Younger patients were at significantly higher risk of needing surgical intervention on the fellow eye.

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