CLINICAL SCIENCE

Epiretinal membrane removal in diabetic eyes: comparison of viscodissection with conventional methods of membrane peeling

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Aims: To compare conventional methods of epiretinal membrane peeling with viscodissection.
Methods: 154 eyes with proliferative diabetic retinopathy (PDR) that underwent pars plana vitrectomy with membrane dissection (89 traditional, 65 viscodissection) were studied retrospectively. Incidence of retinal breaks (RBs), length of time under anaesthesia, postoperative intraocular pressure, retinal reattachment rate, and final visual acuity (VA) were measured.
Results: To compare cases of similar complexity, a "complexity score" was defined. The average complexity score for cases done with and without viscodissection was 4.7 and 3.2, respectively. The mean frequency of RBs in eyes undergoing viscodissection was 0.43 (SD 0.5) *v* 0.14 (0.35) RBs/eye without viscodissection. In complex cases, the frequency of posterior/peripheral RBs was 0.31 (0.47)/0.13 (0.34) RBs/eye, respectively, with viscodissection *v* 0.12 (0.33)/0.23 (0.43) RBs/eye without viscodissection. None of these differences were statistically significant. The average preoperative/postoperative VA (logMAR) in the viscodissection cohort was 1.7/1.3 (range 0.3 to >1.9/0.1 to >1.9) *v* 1.4/1 (range 0.48 to >1.9/0.1 to >1.9) in the non-viscodissection cohort, among eyes with 6 months of follow up. Anaesthesia duration was significantly shorter for cases done without viscodissection ($p=0.03$), but cases done with viscodissection were significantly more complex than cases done without viscodissection ($p<0.0001$).
Conclusion: Viscodissection appears to be a safe and effective alternative technique in eyes with PDR. Owing to the retrospective nature of the study, additional studies are warranted.

During the past 25 years, anatomical and visual results of vitrectomy for severe proliferative diabetic retinopathy have improved as a result of improved understanding of the pathoanatomy and improvements in surgical instrumentation.[1–5] En bloc dissection and bimanual surgical technique, for example, represent advances in the surgical treatment of severe proliferative diabetic retinopathy. Recently, we began to use viscodissection, first described by Stenkula and Tornquist,[6] for cases with severe proliferative diabetic retinopathy.

Viscodissection is a surgical dissection technique that facilitates removal of epiretinal membranes. It is done by injecting a viscous fluid between the retina and epiretinal tissue to separate hydraulically the epiretinal tissue from the subjacent retina. Viscoelastic substances (for example, Healon, Viscoat) are used commonly in ophthalmic surgery. The use of viscoelastic substances in eye surgery is generally safe. Viscoelastic substances are used, for example, to protect the corneal endothelium during phacoemulsification, to maintain anterior chamber volume (for example, during repair of corneal lacerations with uveal prolapse), to reposition the iris, and to expand the capsular bag before intraocular lens implantation. Moreover, viscoelastics can be useful in the management of intraoperative complications such as miosis, haemorrhage, and vitreous presentation associated with posterior capsular tears during cataract extraction.[7–13]

METHODS

The patient records and operative reports of 128 consecutive patients (154 eyes) with proliferative diabetic retinopathy that underwent pars plana vitrectomy with membrane peeling in the Institute of Ophthalmology and Visual Science at University of Medicine and Dentistry of New Jersey between June 1997 to September 2001 were reviewed. The New Jersey Medical School institutional review board approved this review.

Eighty nine eyes underwent standard three port pars plana vitrectomy, and membrane segmentation and delamination was carried out using traditional pick and scissors dissection with manually activated instruments. Although illuminated forceps and scissors were used occasionally, illumination normally was provided with a light pipe or light pick. Sixty five eyes underwent standard three port vitrectomy, and membrane segmentation and delamination was carried out using infusion of Healon with a viscodissector (BD Visitec 20 gauge × 1 inch cannula with 30 gauge × 3/16 inch tip extension) to separate the posterior hyaloid face and fibrovascular tissue from the underlying retina. Healon contains 10 mg/ml of sodium hyaluronate dissolved in physiological sodium chloride phosphate buffer; it is transparent with high viscosity and is manufactured by Pharmacia and Upjohn AB, Sweden for Pharmacia and Upjohn Company, Kalamazoo, MI, USA. Healon (usually 0.5–5 ml, depending on case complexity) was injected between the fibrovascular proliferation and retina using the viscodissector cannula attached to a syringe held by the surgical assistant. For almost all cases, contact lens biomicroscopy (*v* non-contact indirect viewing lenses) was used to visualise the fundus. Instrumentation varied from case to case and included the use of illuminated as well as non-illuminated cutting instruments and picks. When indicated, retinal tamponade was achieved using either SF_6 (phakic eyes) or C_3F_8 (aphakic or pseudophakic eyes). In occasional cases, silicone oil tamponade was used.

Three different surgeons performed surgery.

To compare results among cases of similar complexity, we developed a "complexity score" (CS). We reviewed the surgical

Table 1 Patient demographic characteristics

	Non-viscodissection	Viscodissection	Total
Number of eyes	89	65	154
Number of patients	77	51	128
Male/female	41/36 (53%/47%)	25/26 (41%/59%)	66/62 (52%/48%)
Average age (years)	51	53	53

reports (dictated immediately after surgery), which provided sufficient and reliable data for scoring. The complexity score was graded by quantifying: (1) the number of quadrants of fibrovascular proliferation (FVP, 1-4 quadrants, each quadrant involved corresponds to a one point increase in the CS, FVP in one quadrant is defined as a plaque of fibrovascular tissue proliferation in the same quadrant); (2) the location of FVP: anterior to the equator (one point), posterior to the equator (0 points), both anterior and posterior (two points), as case complexity is greater if FVP is located anterior to the equator; (3) tractional retinal detachment (TRD, one point); (4) traction-rhegmatogenous retinal detachment (TRRD, two points); (5) the presence or absence of a posterior vitreous detachment (absence of PVD, one point). All intraoperative iatrogenic retinal breaks were counted and classified as peripheral or posterior according to whether they occurred in the area of the vitreous base or occurred further posteriorly, respectively. Anatomical and visual outcome was evaluated 6 months after surgery in all cases with sufficient follow-up. Complete retinal reattachment or only localised, stable extramacular traction was regarded as a successful anatomical outcome.

We did not systematically record operating time during the course of this study. Operating room records did establish the duration of anaesthesia, however, which we used as a surrogate measure of operating time.

Statistical methods

Analysis of the tendency of different surgeons (CS, LD, and MZ) to choose a particular dissection technique for a given case complexity score (CS 2, CS 3, CS 6) was done by χ^2 test using a 2 × 5 contingency table. Originally there was a 2 × 8 table, but because the extreme cells (CS 1, 7, and 8) had expected values less than 5, we collapsed the table by combining the three extreme cells with the next most extreme cells. The restricted analysis of CS 4 and 5 was limited by extreme sample size.

A χ^2 test using a 2 × 5 contingency table was used to analyse treatment by complexity score for each surgeon as well as to compare complexity scores in cases done with and without viscodissection. For each analysis, there was originally a 2 × 8 table, but because the extreme cells (CS 1, 7, and 8) had expected values less than 5, we collapsed the tables by combining the three extreme cells with the next most extreme cells.

Analysis of covariance (ANCOVA) was used to examine both the average surgery duration and the incidence of retinal breaks in cases done with and without viscodissection since there were both categorical and numerical factors (complexity score-numerical, type of treatment-categorical). An additional factor for break location (peripheral, posterior) was added to the incidence of RB analysis.

The analysis of the difference between preoperative and postoperative visual acuity in the viscodissection and non-viscodissection groups was done using the *t* test. All visual acuity values were reported on the logarithm of the minimum angle of resolution (logMAR) scale. The larger the logMAR number, the worse the visual acuity.

RESULTS

The study population comprised 128 patients (154 eyes), 62 female and 66 male, of which 62 (48%) were African-Americans, 50 (39%) were Hispanic, 12 (9%) were white, and four (3%) were of other racial origin. There were no differences in the racial composition of patients undergoing surgery with or without viscodissection (Table 1).

Surgical indications are summarised in Figure 1.

Time under anaesthesia was used as a surrogate measure of operating time. We found that as case complexity increased, anaesthesia time increased significantly (p= 0.009), and anaesthesia time was significantly (p=0.03) longer for cases done with viscodissection versus those done without viscodissection, regardless of case complexity score (Table 2; see Appendix 1 on *BJO* website).

The average complexity score for cases with and without viscodissection was 4.7 and 3.2, respectively. The distribution of cases by complexity indicates that the cases done by viscodissection were significantly ($p<0.0001$) more complex than those done without viscodissection (Fig 2; see Appendix 2 on *BJO* website).

As noted above, three different surgeons performed the surgery. Table 3 summarises the data for surgeons A (CS), B (LD), and C (MZ). Data for surgeon A were excluded from the statistical analysis of the choice of the dissection technique and the analysis of the treatment by complexity score, because of the small number of cases. There was no significant difference between two surgeons B (LD) and C (MZ) in the choice of dissection technique for a given complexity score (CS 2, CS 3, CS 6; see Appendix 3 on *BJO* website).

The analysis of the treatment by complexity score for surgeon B showed that there was a tendency to use viscodissection in cases with greater complexity (from CS 2–4), but the results are not statistically significant (ρ= 0.2). (The graph in Appendix 3A clearly shows a tendency to use viscodissection in cases with higher CS (from CS 2–4); however, the trend

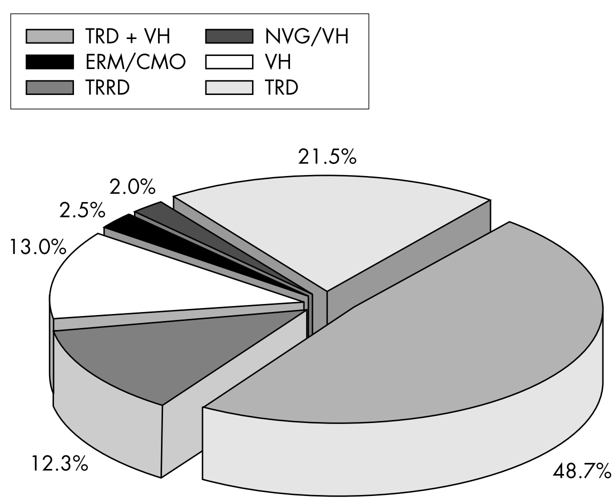
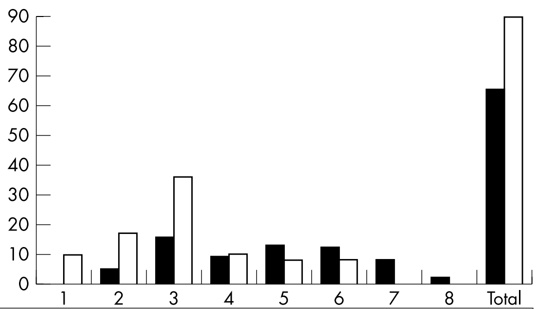


Figure 1 Surgical indications: all cases (154 eyes). Tractional retinal detachment (TRD) in 33 (21.5%) eyes. Traction-rhegmatogenous retinal detachment (TRRD) in 19 (12.3%) eyes. Traction retinal detachment with vitreous haemorrhage (TRD+VH) in 75 (48.7%) eyes. Non-clearing vitreous haemorrhage (VH) in 20 (13%) eyes. Neovascular glaucoma with vitreous haemorrhage (NVG/VH) in three (2%) eyes. Macular oedema with a taut thickened posterior hyaloid face (ERM/CMO) in four (2.5%) eyes.

Table 2 Anaesthesia time as a function of case complexity: viscodissection *v* non-viscodissection cases

	Complexity score								
	1	2	3	4	5	6	7	8	Total
Number of cases	0	5	16	9	14	11	8	2	65
Viscodissection anaesthesia time (mean (SD))		138 (59)	161 (44)	201 (50)	160 (49)	211 (95)	232 (112)	282 (127)	180 (81)
Number of cases	10	17	36	10	8	8			89
Non-viscodissection anaesthesia time (mean (SD))	96 (32)	137 (82)	139 (55)	167 (58)	137 (63)	160 (106)			148 (65)



	1	2	3	4	5	6	7	8	Total
Visco	0	5	16	9	13	12	8	2	65
Non-visco	10	17	36	10	8	8	0	0	89

Figure 2 Distribution of cases by complexity score and surgical technique. Cases done with viscodissection were significantly more complex than those done with pick and scissors dissection alone. See text for details.

is not statistically significant, and the number of patients is small.) The analysis of the treatment by complexity score for surgeon C showed that there was a statistically significant tendency to use viscodissection in cases with greater complexity (p<0.0001; Appendix 3A on *BJO* website).

A total of 101 eyes had follow up 6 months. Data for this cohort are summarised in Table 4. Among these eyes, 91 (90%) were fully attached, and 10 (10%) had recurrent retinal detachment (Fig 3).

The average preoperative/postoperative visual acuity (logMAR) in the viscodissection group was 1.7/1.3 (range 0.3 to >1.9/0.1 to >1.9) *v* 1.4/1.0 (range 0.48 to >1.9/0.1 to >1.9) in the non-viscodissection group. Final best corrected visual acuity in viscodissection group improved three or more Snellen lines in 19 (44%) eyes, remained unchanged in 19 (44%) eyes, and worsened by three or more lines in five (12%) in comparison with the group without viscodissection, in which final best corrected visual acuity improved three or more Snellen lines in 28 eyes (48%), remained unchanged in 20 eyes (34.5%), and worsened in 10 eyes (17.5%). Final visual acuity did not differ among cases done with and without viscodissection (p=0.54) (Fig 4; see Appendix 4 on *BJO* website).

Eyes undergoing viscodissection did not show increased postoperative intraocular inflammation. On postoperative day 1, intraocular pressure (IOP) >21 mm Hg was found in 39 (60%) eyes undergoing viscodissection and in 38 (43%) eyes done without viscodissection. The difference was borderline statistically significant (p=0.0502). The average IOP in eyes with elevated postoperative IOP (that is, >21 mm Hg) in the viscodissection group was 34 mm Hg (range 22–63 mm Hg) *v* 35 mm Hg (range 22–56 mm Hg) in the non-viscodissection group.

Iatrogenic retinal breaks occurred in 12 eyes (18%) in the viscodissection group and in 10 eyes (11%) in the non-viscodissection group. The mean frequency of iatrogenic retinal breaks per eye, including all the cases regardless of the complexity score, was 0.43 (SD 0.5) for the viscodissection group (n=65 eyes) and 0.14 (0.35) for the non-viscodissection group (n=89 eyes) The difference in the frequency of retinal breaks in the two cohorts was not significantly different (p>0.05) (see Appendix 5 on *BJO* website).

Analysing the data by complexity score and location of the retinal break (that is, peripheral *v* posterior), the incidence of peripheral and posterior iatrogenic retinal breaks per eye was 0.14 (0.35) and 0.30 (0.46) respectively, in the viscodissection cohort. The incidence of peripheral and posterior iatrogenic retinal breaks per eye in the non-viscodissection group was 0.10 (0.30) and 0.04 (0.20). The differences between the viscodissection and non-viscodissection cohorts were not statistically significant (see Appendix 5 on *BJO* website). Similarly, among "complex" cases (CS 4-6), the incidence of peripheral, posterior, and mean total number of iatrogenic retinal breaks per eye was 0.12 (0.32), 0.29 (0.46), and 0.41 (0.50), respectively, in the viscodissection cohort. Among complex cases done without viscodissection, the incidence of peripheral, posterior, and mean total number of iatrogenic retinal breaks per eye was 0.23 (0.43), 0.12 (0.33), and 0.35 (0.49), respectively. The differences between the viscodissection and non-viscodissection cohorts were not statistically significant (see Appendix 5A on *BJO* website).

One of the limitations of this retrospective analysis is that different surgeons may have used different inclusion criteria for choosing viscodissection as well as different non-viscodissection dissection techniques. Therefore, we analysed

Table 3 Number of eyes operated with ("Visco") and without ("No visco") viscodissection by different surgeons

	Surgeon A (CS)			Surgeon B (LD)			Surgeon C (MZ)			
CS	Visco	No visco	Total	Visco	No visco	Total	Visco	No visco	Total	Total
1	0	0	**0**	0	3	**3**	0	7	**7**	**10**
2	0	1	**1**	2	2	**4**	3	14	**17**	**22**
3	0	3	**3**	5	8	**13**	11	25	**36**	**52**
4	0	0	**0**	3	0	**3**	6	10	**16**	**19**
5	0	0	**0**	0	0	**0**	13	8	**22**	**21**
6	0	0	**0**	1	1	**2**	11	7	**18**	**20**
7	0	0	**0**	0	0	**0**	8	0	**8**	**8**
8	0	0	**0**	0	0	**0**	2	0	**2**	**2**

Table 4 Anatomical and visual outcome among cases with at least 6 months of follow up[1]

	Viscodissection					No viscodissection				
			Visual acuity					Visual acuity		
Preoperative diagnosis	No of eyes	Retina flat	Improved ≥3 lines	No change	Worse ≥3 lines	No of eyes	Retina flat	Improved ≥3 lines	No change	Worse ≥3 lines
TRRD	9	8 (89%)	4 (44%)	4 (44%)	1 (12%)	5	5 (100%)	1 (20%)	2 (40%)	2 (40%)
TRD	10	8 (80%)	3 (30%)	5 (50%)	2 (20%)	11	10 (91%)	3 (27.5%)	5 (45%)	3 (27.5%)
TRD/VH	20	16 (80%)	9 (45%)	9 (45%)	2 (10%)	26	25 (96%)	15 (58%)	8 (31%)	3 (11%)
Taut PHF	0	0	0	0	0	4	4 (100%)	3 (75%)	1 (25%)	0
Non-clearing VH	3	3 (100%)	3 (100%)	0	0	11	10 (91%)	6 (55%)	4 (36%)	1 (9%)
VH/NVG	1	1 (100%)	0 (0%)	1 (100%)	0	1	1 (100%)	0	0	1 (100%)
Total	43	36 (84%)	19 (44%)	19 (44%)	5 (12%)	58	55 (95%)	28 (48%)	20 (34%)	10 (18%)

TRRD = traction rhegmatogenous retinal detachment; TRD = traction retinal detachment; VH = vitreous haemorrhage; PHF = posterior hyaloid face; NVG = neovascular glaucoma.

the mean incidence of peripheral (viscodissection/no viscodissection 0.16 (0.38)/0.11 (0.31)) and posterior (viscodissection/no viscodissection 0.33 (0.48)/0.01 (0.12)) iatrogenic retinal breaks per eye for surgeon C separately and found statistically similar results (see Appendix 5B on *BJO* website).

Analysis of the frequency of retinal breaks revealed that complexity score (p=0.1), type of treatment (p=0.4), and retinal break location (p=0.7) were not associated with the frequency of retinal breaks in a statistically significant way. Although the incidence of retinal breaks increased by about 0.05 (5%) per unit of complexity, when the subgroup of cases of relatively high complexity (that is, CS 4-6) were analysed, no statistically significant effect on the frequency of retinal breaks was detected for any of these factors (that is, complexity score, p = 0.5; type of treatment, p = 0.7; location of the retinal break, p = 0.7). This restricted analysis was limited by small sample size (see Appendices 5 and 5A on *BJO* website).

Analysis of the incidence of retinal breaks for surgeon C indicated that the frequency of retinal breaks was higher in the viscodissection cohort compared to the non-viscodissection cohort. However, the difference was not statistically significant (p=0.15). The frequency of retinal breaks did not increase significantly with increasing case complexity (p=0.33) or with retinal break location (p=0.93) (see Appendix 5B on *BJO* website).

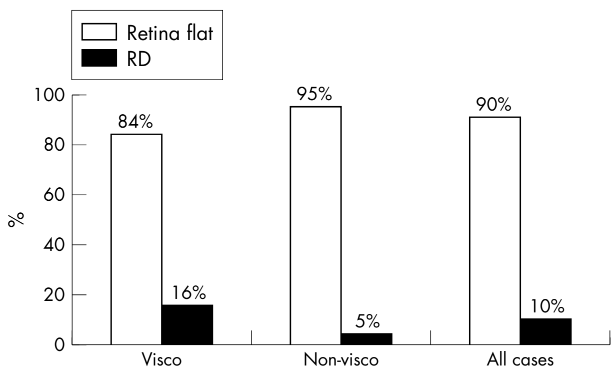


Figure 3 Anatomical outcomes. Outcome is reported for those cases with 6 or more months of follow up (101 eyes total). With 6 months or more follow up, the retina was fully attached in 36/43 eyes (84%) done with viscodissection and 55/58 eyes (95%) done without viscodissection.

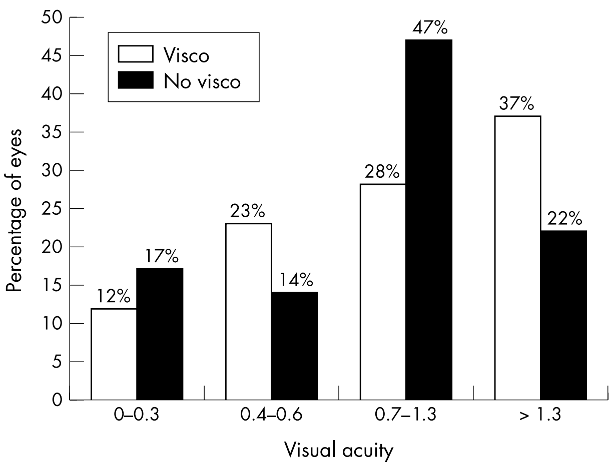


Figure 4 Visual outcome (expressed as logMAR) after vitrectomy: viscodissection *v* no viscodissection. (With logMAR, better visual acuities correspond with smaller numbers.) Data are reported for eyes with 6 months of follow up (n=43, viscodissection; n=58, no viscodissection).

DISCUSSION

Dissection of fibrovascular proliferation and complete separation of non-vascularised postbasal vitreous cortex reduces postoperative rebleeding and recurrence of retinal detachment in proliferative diabetic retinopathy. The use of viscoelastics in posterior segment surgery previously has been reported to be valuable for dissection of preretinal or epiretinal membranes.[1 2 4 5] Healon, a transparent viscoelastic, is a disaccharide unit of N-acetyl glucosamine and sodium glucuronate linked by glucosidic bonds.

Stenkula and Tornquist[6] described a method of dissecting epiretinal membranes using sodium hyaluronate. McLeod *et al*[4] reported a series of 40 eyes with proliferative diabetic retinopathy that underwent pars plana vitrectomy and membrane peeling in which injection of 1% methylcellulose or 1% sodium hyaluronate (Healon) was employed to separate attached vitreous cortex and fibrovascular epiretinal membranes from the retina. In this series, viscodelamination was particularly successful in eyes with combined traction-rhegmatogenous retinal detachment, and anatomical success was achieved in 28 (70%) of 40 eyes. Postoperative complications included iatrogenic retinal breaks (12 total), retinal bleeding, and postoperative epiretinal membrane proliferation. McLeod *et al* reported increased bleeding following delamination with Healon. We did not observe this phenomenon and, in contrast, feel that Healon helps to maintain the clarity of the view during surgery by limiting diffusion of blood into the vitreous cavity. McLeod *et al* also mentioned having occasional difficulty removing the Healon from the eye. We did not encounter difficulty with Healon removal, as evidenced by a similar frequency of increased intraocular pressure after surgery among viscodissection and non-viscodissection cases. We routinely used active aspiration to remove Healon from the vitreous cavity at the end of the case. Crafoord and Stenkula reported a series of 24 eyes in which a more viscous sodium hyaluronate (Healon-GV) was used to dissect epiretinal membranes.[5]

In our study the anatomical outcome was found to be very successful for both viscodissection and non-viscodissection surgery with no significant difference between the techniques.

In our study, the overall frequency of retinal breaks per eye, including all cases and all complexity scores, was higher for viscodissection (mean 0.43 (SD 0.5)) than for non-viscodissection (0.14 (0.35)) cases, but the difference was not statistically significant. Among cases with greater complexity (arbitrarily defined as having a complexity score ⩾ 4), the frequency of breaks per eye was very similar among cases done with viscodissection (0.41 (0.5)) and without viscodissection (0.35 (0.49)). The incidence of posterior retinal breaks in cases done with viscodissection versus those done without viscodissection was 0.29 (0.46) *v* 0.12 (0.33), respectively. The incidence of peripheral retinal breaks in cases done with viscodissection versus those done without viscodissection was 0.12 (0.32) *v* 0.23 (0.43), respectively, but the difference was not statistically significant. The frequency of iatrogenic retinal breaks in cases done without viscodissection tended to increase with increasing complexity score whereas among cases done with viscodissection, the frequency of retinal breaks tended to be independent of case complexity.

The retrospective nature of this study limits comparison of the two techniques. There was a definite selection bias to do more complex cases using viscodissection as reflected in the greater number of cases with high complexity operated with this technique (Fig 2). This selection bias may underlie the following trends in the data. We noted that the location of iatrogenic breaks tended to be more posterior with viscodissection cases compared with non-viscodissection cases, in which they tended to be more peripheral. This result might be related to the fact that insertion and removal of instruments from the eye, which we feel is more frequent without viscodissection, may increase the risk of peripheral retinal breaks. The greater frequency of posterior retinal breaks with viscodissection may reflect our tendency to use this technique in cases with atrophic retina in which the degree of posterior vitreous detachment is limited. It is possible that use of a lower viscosity viscoelastic would result in a lower incidence of retinal breaks with this technique (Dr Mario Stirpe, personal communication).

Another bias of the study arises from inadequacy in the definition of case complexity. The complexity score describes the level of difficulty of a case only approximately since the score does not account for the degree of adhesion of the cortical vitreous and retina or the degree of retinal atrophy. We believe these two features of a case strongly affect the likelihood of creating a retinal break. Therefore the complexity score may not be a good predictor of the amount of traction necessary to dissect a membrane.

We did not systematically measure operating time. It is our impression that operating time is less, particularly in highly complex cases (for example, traction-rhegmatogenous retinal detachment with limited posterior vitreous detachment and atrophic detached retina) with viscodissection. It is also possible that viscodissection would be associated with a lower incidence of complications than pick and scissors dissection in the hands of less experienced surgeons as viscodissection facilitates identification of a surgical cleavage plane.

CONCLUSION

The conclusions of the study are limited by the retrospective nature of the database. Based on the results of this retrospective consecutive case series, we conclude that conventional dissection with pick and scissors and viscodissection (with adjunctive use of pick and scissors) are equally effective in the surgical management of diabetic retinopathy when performed by experienced vitreoretinal surgeons.

The appendices for this paper are on the *BJO* website (www.bjophthalmol.com/supplemental).

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