Turkish Journal of Endocrinology and Metabolism, (2001) 1 : 31-38 **ORIGINAL ARTICLE**

Pars Plana Vitrectomy for High Risk Severe Proliferative Diabetic Retinopathy: Anatomical and Functional Outcomes

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To study the anatomical and functional results obtained from 72 eyes of 69 patients who underwent pars plana vitrectomy for severe proliferative diabetic retinopathy.

Indications for pars plana vitrectomy were: vitreous hemorrhage in 37 eyes (51.39%), tractional retina detachment in 15 eyes (20.83%), vitreous hemorrhage and tractional retina detachment in 16 eyes (22.22%), and combined tractional-rhegmatogenous retina detachment in 4 eyes (5.56%). Relief of the traction from peripheral fibrovascular membranes was obtained with an encircling scleral buckle in 41 eyes (56.94%) and delamination, segmentation or membrane peeling in 51 eyes (70.83%). In 42 eyes (58.33%), the surgery was combined with silicone–oil tamponade.

After the follow-up of 6 to 17 months (mean 9.01±3.43 months) the visual acuity was 1/10 or higher in 6.94% of the eyes. The visual acuity improved in 51.39% of the eyes, was unchanged in 36.11%, and became worse in 12.50%. The retina was completely attached in 54 eyes (75%) at the time of the last examination. In the postoperative period, vitreous hemorrhage occurred in 7 eyes (9.72%), ocular hypertension occurred in 8 eyes (11.11%) and cataract developed in 7 eyes (9.72%).

Pars plana vitrectomy for severe fibrovascular proliferation differs from conventional approaches to diabetic retinopathy in that relief of retina traction must be attained by scleral buckling and adequate dissection of peripheral fibrovascular tissue. Anatomic success rate tended to be better than functional success rate in high-risk severe proliferative diabetic retinopathy. So when severe fibrovascular proliferation occurs, complete removal of anteroposterior traction could only improve the anatomic success rate of the vitrectomy in most of the cases.

Key words: Severe proliferative diabetic retinopathy, pars plana vitrectomy, anatomical results, visual outcome

Introduction

As the lifetime of cases with Diabetes Mellitus (DM) is extended by providing early diagnosis and treatment, and with the achievements in medical treatment, long-term microvascular complications are more frequently encountered because the risk of Diabetic Retinopathy (DR) occurrence is closely related with the duration of the disease. The major sensitivity factors for microangiopathy are the duration of the disease and its metabolic control. The incidence of blindness due to diabetes has been reported in 64 per 100.000 diabetic population/year (1). Retinopathy develops in 60% of cases with type II diabetes and 10% of the cases have proliferative characteristics. This rate is much higher in type I diabetics (2,3). The overall incidence of Proliferative Diabetic Retinopathy (PDR) was 16.2 per 1000 person/year (4). Longer duration of diabetes was the only independent predictor of PDR for patients without PDR (3). The most effective treatment for DR in advanced stages is panretinal laser photo

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coagulation. However, according to the data of the Early Treatment Diabetic Retinopathy Study Group; a high-risk proliferative retinopathy develops in about 20% of these cases despite panretinal photocoagulation (5). Vitrectomy is used in the cases with PDR where fibrovascular proliferation progresses despite the application of a mean 3500 burns and peripheral cryocoagulation. To perform the surgery, the surgeon should not wait for the traction detachment of macula and development of vitreous hemorrhage (VH), the most frequent indications of vitrectomy (6).

With the addition of new indications to the known indications such as traction and rhegmatogenous detachment and VH in recent years, vitrectomy has been performed in earlier stages (7). The primary objective of surgery is particularly to achieve a useful visual acuity. Another important goal of the vitrectomy is to prevent further progress of diabetic neovascular process and thus, to achieve a long-term anatomical and functional success (8).

In this study, the anatomical and functional outcomes of the surgery on a group of cases undergone pars plana vitrectomy due to severe proliferative retinopathy, which is an extremely advanced stage of the diabetic eye disease, have been evaluated.

Patients and Methods

Seventy-two eyes of 69 cases that had severe proliferative diabetic retinopathy and were diagnosed as VH and/or retinal detachment, and underwent triple pars plana vitrectomy were included in this study. The age of the 33 female and 36 male cases ranged between 20-71 years (mean 53.36±13.21 years) in females and 23-75 years in males (mean 53.39±14.34 years). While 12 of the cases had type I DM and 57 had type II DM, the mean duration of diabetes was 19.42±4.96 years and 15.31±7.49 years in cases with type I and type II diabetes, respectively, and the preoperative mean follow up period of the cases was 4.25±3.61 months.

The following procedures were performed: all cases underwent a detailed ophthalmological examination and their intraocular pressures were measured. The vitreous and fundus examinations were performed using a double aspherical fundus lens (Volk, 90 dioptry) and Goldman's three-mirror contact lens after obtaining midriasis with 1% cyclopentolat and 10% phenylephrine. B-Scan ultrasonography and electrophysiological tests (ERG and VEP) were carried out in all cases where the posterior segment could not be seen. Progressive fibrovascular proliferation despite panretinal photocoagulation in 51 cases (70.83%) caused a surgical indication. Existence of fibrovascular tissue covering the macula and decreasing the vision was considered as an indication, even if there was no detachment in the macula. Also, surgery was performed in the cases with traction retina detachment and VH, even without posterior vitreous detachment. To sum up, our surgical indications were classified under 3 stages and headings: 1) Severe new vessel formation and red VH (new intravitreal hemorrhage developed in the last one month). 2) Severe new vessel formation and severe fibrous proliferations. 3) Severe new vessel formations, severe PVR and associated red VH.

Without considering the duration of VH in cases with severe new vessel formation or severe fibrous proliferation, vitrectomy was decided as soon as VH was determined. Although the most frequent indication of vitrectomy was VH, the presence and stage of other proliferative findings were more important than VH in deciding for surgery.

The cases who had undergone vitreoretinal surgery before, the cases with new vessel formation in the iris and/or the area of trabecular meshwork exceeding 45/360 degrees, the cases determined with neovascular glaucoma or those with an intraocular pressure higher than 30 mm Hg despite the treatment, and the cases at an advanced stage of chronic renal failure were all excluded from the study.

All of the cases were operated under general anesthesia. The Harmony vitrectomy device (Dorc) used also consisted of a phaco-fragmentation unit, diathermy, halogen light source, silicone and air pump in addition to vitrectomy. AVI large angular imaging system was used for imaging, a portable 532 nm wavelength Nd:YAG laser device (Alcon) was used for endolaser photocoagulation, and the BSS Plus solution (Alcon) with the addition of 1/1000 adrenaline cooled to 8°C was used for infusion.

Silicone band (No: 240) and equatorial encircling were applied in 41 cases (56.94%) after circumferential

perilimbal peritomy and pars plana vitrectomy was performed with classical triple procedure. The removal of all vitreous opacities, the resection of the posterior hyaloid and vasoprolipherative tissue completely, the separation of all membranes and bands between the vitreous base and optic nerve head, the removal of epiretinal membranes from the retina as for as possible, the segmentation of immovable fibrous tissue as separate islands, and the internal drainage of subretinal fluid were performed. Peripheral relaxing retinotomies were performed in the case of shortening in the retina and severe traction associated with intensive subretinal membrane. While lensectomy was performed by ocutom in the case of intensive anteriorly localized proliferation, extracapsular cataract extraction was performed in cases that had lens opacification preventing the visualization of the posterior segment. Silicone-fluid perfluorocarbon exchange was performed in 24 cases (33.33%), where 5000 cst silicone oil was used. Inferior iridectomy was performed in the cases that received silicone oil. Sulfur hexafluoride tamponade was used in 4 cases (5.56%). The operation was terminated with the repair of sclerotomies and peritomy.

The postoperative follow-up period of the cases ranged from 6 months to 17 months and the mean was 9.01±3.43 months.

Results

The distribution of the number of cases and duration of diabetes with respect to operation indications has been given in Table 1. The most frequent surgical indication is VH, which develops subsequent to PDR.

The preoperative and postoperative visual acuities in the eyes have been given in Table 2. It is seen from this table that the surgery resulted in an increased visual acuity (When the visual acuity a case was at the meter-finger counting level, an increase of 1 m or higher in the visual acuity after the operation; or when the visual acuity of a case was at the level of reading letters on the Snellen chart, success in reading one or more lines in addition to the preoperative line reading) for 51.39% of the eyes, it did not bring about any change in 36.11% of the eyes, and it reduced the visual acuity in 12.50% at the end of a 3 month follow-up period. With the performed surgery, the visual acuity that was 1/10 or higher in 1.39% of the cases preoperatively could be increased only to 6.94% postoperatively.

Table 2. Preoperative and postoperative 3rd month visual acuity of the eyes.

Visual Acuity	Preoperative Number of eyes (%)	Postoperative 3rd Month Number of eyes (%)
Light perception (-)	-	4 (5.56)
Light perception (+)	10 (13.89)	9 (12.50)
Hand movements - 1 m fc*	54 (75.00)	33 (45.83)
1 m fc – 3 m fc	5 (6.94)	15 (20.83)
4 m fc – 1/10	2 (2.78)	6 (8.33)
≥ 1/10	1 (1.39)	5 (6.94)

* meter-finger counting

The peroperative and postoperative complications encountered in 72 eyes were as follows: intraocular pressure increase (11.11%), cataract formation (9.72%), VH (11.11%), preretinal hemorrhage (2.78%), hyphema (2.78%), corneal edema-epithelial defect (12.50%), development of total retina detachment (4.17%), leakage of silicone oil under retina (1.39%) and endophthalmitis (1.39%) (Table 3).

A second operation was performed due to cataract in 4 cases (5.56%), anatomic failure or recurrence in 4 cases (5.56%), endophthalmitis in 1 case (1.39%),

Table 1. Number of cases in subgroups with respect to operation indications and duration of DM.

Diagnosis	Number of cases		
	Female (n=33)	Male (n=36)	Duration of DM
VH	17	18	14.66 ± 7.28
Tractional RD	7	7	12.50 ± 5.85
VH + Tractional RD	5	11	16.63 ± 8.52
Tractional + rhegmatogenous RD	4	-	15.75 ± 4.92

Table 3. Preoperative and postoperative complications in 72 eyes and rate of determination.

Complication	Number of Eyes (%)
Corneal edema	9 (12.50)
Intraocular pressure increase	8 (11.11)
Cataract formation	7 (9.72)
Hyphema	2 (2.78)
Recurrent detachment	4 (5.56)
Recurrent VH	7 (9.72)
Silicone, perfluorocarbon keratopathy	2 (2.78)
Endophthalmitis	1 (1.39)
Silicone oil leaking under retina	1 (1.39)
Uveitic reaction	1 (1.39)
Epiretinal Fibrosis	1 (1.39)

Table 4. Distribution of eyes according to anatomic situation determined at the end of postoperative follow-up period.

Anatomic Situation	Number of Eyes (%)
Completely attached retina	54 (75.00)
Progressing traction RD	3 (4.17)
Total retina detachment	2 (2.78)
Progressing VH	3 (4.17)
RD localized to lower section	1 (1.39)
Fundus not observed	8 (11.11)
Recurrent RD after silicone oil removal	1 (1.39)

and the aspiration of silicone leaked under the retina in 1 case (1.39%).

In 32 (76.19%) of 42 eyes, where silicone was used, the retina re-attachment was achieved, but an increase in visual acuity could be obtained in only 38.10% of these cases. In the eyes where silicone was used, cataract was observed in 3 (7.14%) eyes and re-proliferation was observed in 2 (4.78%) eyes. While the anatomic success was 82.93% in the cases where scleral buckling and vitrectomy were applied, the functional success-visual acuity increase was 41.46%.

At the end of the mean follow-up period of 9.01± 3.43 months, the anatomic success, in other words, the re-attachment of retina and/or the removal of existing VH and intravitreal opacities were achieved in 54 (75%) of the eyes. The posterior segment could be observed by ultrasonic examination due to VH in 3 (4.17%) cases, keratopathy in 2 (2.78%) cases and cataract formation in 3 (4.17%) cases. It was observed that total retina detachment developed in 2 (2.78%) cases and traction retina detachment progressed in 3 (4.17%) cases. The distribution of the cases with respect to their anatomic situations determined at the end of the postoperative follow-up period has been given in Table 4.

Discussion

With the widespread use of insulin and antidiabetic medications, the lifetime of diabetic patients has extended and microvascular complications of the disease have started to be commonly encountered. Nowadays, the most important cause of blindness in developed countries is DR, which is responsible for 12-20% of all blindness. The number of cases with diabetic blindness increases by a 12% annual addition of new cases (9). The frequency of severe proliferative retinopathy, a cause of blindness in type I diabetics, increases up to 41% when the duration of the disease exceeds 15 years. In type II DM, on the other hand, the rate of PDR is 3% when the duration of the disease exceeds 10 years. If the disease is not cured in the early stage, it turns into pathologies such as VH, retina detachment and neovascular glaucoma, treatment of which is rather difficult and prognosis is very poor (10). The most important method of treatment in advanced PDR is the application of laser photocoagulation as for as possible. Surgery is a commonly accepted method of treatment after completing laser photocoagulation. The objective of preoperative photocoagulation is to facilitate control of the vascular proliferative process. The outcomes of vitreous surgery in eyes where intensive photocoagulation has been applied are more satisfactory (7). In the advanced stages of DR, the external laser photocoagulation treatment could no longer be applied in the presence of preretinal and vitreous hemorrhage and intensive fibrovascular vitreoretinal tractions. Despite the intensive photocoagulation applied preoperatively, the proliferations were observed to continue in 70.83% of our cases. At this stage, vitreoretinal surgery and additional intraoperative endolaser photocoagulation were necessary (11).

Today, the most frequent indications of diabetic vitrectomy are still tractional retinal detachment

encompassing the macula and VH, and the situation is generally dominated by fibrotic membranes in which new vessel formations are subsidiary and stationary. The situation has been reported also to encompass the macula in at least 1/5 of the PDR cases in two years and cause a severe visual loss in 13% of the cases in 1 year (12). A reduction in the visual acuity and metamorphopsy begin when the detachment advances into the vessel arcade. Surgery is necessary at this moment and it should be performed as soon as possible. Because the ischemic damage develops in the inner retinal layers, the external retinal layers, on the other hand, are under severe damage threat (8).

Surgery is required in the presence of peripheral traction and rhegmatogenous detachment with or without the involvement of macula. Some of these cases are accompanied by chronic persistent or recurrent VH (13). Surgical indication may be determined according to the configuration of posterior tears. Particularly, if the scleral buckling is thought not to close the tear or relax the traction, the indication should be determined as vitrectomy (14).

The diabetic cases with active proliferations where useful visual acuity, i.e. 1/10 or higher visual acuity, is preserved, and the cases who have intensive premacular hemorrhage, progressive macular traction, bridging premacular fibrosis and posterior hyaloidal traction are evaluated among the new indications of diabetic vitrectomy and such cases greatly benefit from surgery. With the control of the proliferation process, visual acuity improves to a better degree in the long term. More than half of these cases who might also have red VH in addition to severe neovascularization and fibrosis are operated on in the early period, and serious complications are encountered in the case of late therapy (7, 15).

The existence of VH is an important indication of vitrectomy. The most frequent indication for surgery was also VH developed as a consequence of PDR in 51.39% of our cases, which was followed by traction retina detachment either combined with VH or alone. VH may be caused by either the vitreous tractions and the active neovascular disease associated with fibrovascular proliferation or it may appear during acute tractional detachment or together with posterior vitreous detachment without new vessel formation. Furthermore, venous occlusion and retina tears may also be the cause of hemorrhage in diabetics (8). According to the data by the Diabetic Retinopathy Vitrectomy Study Group, while the hemorrhage disappeared in only 20% of the cases, additional posterior segment complications requiring surgery developed in 10%, hemorrhage continued in 43% at a severity requiring surgery at the end of a one-year follow-up period, and 6% died due to systematic complications. As a result, vitrectomy is necessary in 53% of the diabetic VH cases followed up for a year. Where VH exists, early surgery should be considered especially for the cases that have progressive rubeosis iridis and progressive fibrovascular proliferation (11, 16).

The existence of cataract before and after surgery is an important problem in the proliferative diabetic eye diseases. Before surgery, lens opacity is present in about 25% of cases. In 5 of our cases, extracapsular cataract extraction was performed together with vitrectomy. In some cases, cataract development occurs as a surgical complication (17). In phacic cases where vitrectomy is applied, cataract may develop in cases reaching a rate of 20-35% Long duration of operation, surgical trauma and reoperations, use of intraocular tamponade materials and hemocyderinic effects of intraocular hemorrhage are the cataractogenic factors. In order to perform surgery on the cataract, which is generally posterior and subcapsular, it is recommended that at least 6 months should be allowed to elapse following the vitrectomy. Hutton et al. have reported achieving high visual acuity increase by adopting the above recommendation (18). In our cases, cataract developed in a total of 7 (9.72%) eyes, including 3 eyes in which silicone was used. In a case that underwent vitrectomy, an important complication caused by cataract extraction was that the risk of iris neovascularization and neovascular glaucoma development increased 3-4 times (19). With the indication of PDR and VH, cataract extraction performed at the same time as vitreous surgery and intraocular lens implantation has been applied (20).

The discussions on the use of silicone oil have not come to an end, although it is commonly used in diabetic vitrectomy. The most important and common indication of silicone use in diabetic vitrectomy is the existence of tractional retinal detachment (21).

According to the data by the Silicone Study Group, silicone used as a long-term intraocular tamponade material in the eyes with severe PVR after vitreo-retinal surgery was found o be certainly more successful than sulfur hexafluoride. There was traction retina detachment in 17 (40.48%) of 42 eyes in which silicone was used in our study. Although the retina is re-attached in 50-60% of cases, the visual acuity increase is achieved in fewer cases (7, 22). Although retina re-attachment was achieved in 32 (76.19%) of 42 eyes in which silicone was used of our cases, the rate of visual acuity increase remained at 38.10%. Cataract and redeveloped proliferation occurred in 16.67% and 4.76% of the eyes in which silicone was used of our cases, respectively, and re-operation was performed in 4.76% due to re-proliferations and in 1.39% due to the silicone, which leaked under the retina.

The major complications encountered after diabetic vitrectomy are VH, retina detachment, cataract and rubeosis iridis development and reoperation is necessary for 10-30% of the cases due to various complications (23). The most important indication for reoperation is VH, which generally appears in the early days after the first operation. The rate of postvitrectomy VH has been reported to vary between 3.3% and 69.2% (24,25). Recurrent VH develops at the rate of 60% in eyes undergoing diabetic vitrectomy, and fibrovascular ingrowth, sclerotomy site or anterior hyaloid proliferations could be the source of hemorrhage (26). The indication and timing of reoperation depend on the pathology and complications accompanying VH (27). Reoperation was required in 8.5% of Brown's cases, where the cause responsible for reoperation was recurrent VH, rhegmatogenous retina detachment and glaucoma in 51%, 44% and 5% of the cases, respectively (28). Reoperation was performed in our study because of various reasons such as recurrent VH in 7 (9.72%) eyes, cataract development in 4 (5.56%) eyes, recurrent detachment in 4 (5.56%) eyes, endophthalmitis in 1 (1.39%) eye and silicone leakage under the retina in 1 (1.39%) eye.

The postoperative development of retinal detachment is also one of the most severe complications of diabetic vitrectomy. The detachment appearing in 5-10% of the cases could be caused by atrophic retinal tears, the late contractions of vitreous incarcerations and peripheral tractions due to anterior hyaloidal proliferations. The postoperative retina detachment was observed in a total of 4 (5.56%) eyes, including one eye in which an encircling buckle was applied and 3 non-applied eyes in our study. The use of silicone may be needed in the tears posteriorly localized and associated with traction (29).

The development of endophthalmitis after vitrectomy has been reported to vary between 1.6% and 5.35% (24,30), being 1.39% in our cases. The intraocular pressure increase after vitrectomy has been reported to vary between 1.6% and 8.1% (23, 24, 30), being 11.11% in our cases.

While the rate of anatomic success obtained using only scleral buckling methods in the treatment of retinal detachment cases with severe proliferative retinopathy was 19-23%, it was 75% when the method was applied in association with pars plana vitrectomy (31). The rate of anatomic success was 82.93% in the cases with severe PDR, where we applied the scleral encircling and vitrectomy.

Generally the rate of functional success by surgery is 40-63% in the cases with PVR. In recurrent cases, on the other hand, the success rate is much lower (32-35).

Han suggests that the visual results are not satisfactory although the postoperative stabilization rate of retina behind the equator is 100% in DR with severe proliferations. Especially, the equatorial and more anteriorly localized fibrovascular proliferations decrease the rate of success. It may be required to relax the tractions as much as possible, apply the buckling and retinotomies, if necessary (36). The functional results are not satisfactory in the cases where proliferations covering the macula exist, even if detachment does not (6).

In De Bustros's progressive PDR series, visual acuity increase was achieved in 70% of the cases, while it was reduced in 22% of the cases, and it was unchanged in 8% of the cases. The visual prognosis was better in cases who were under 40, whose preoperative visual acuity was higher than 5/200, and who had no iris neovascularization. While the prognosis of a case in diabetic vitrectomy is related with the severity of retinopathy during

the first diagnosis, the presence or absence of detachment in the macula and duration of the existence of detachment, the period between the occurrence of VH and surgery is not so important (37).

In PDR cases of Sima et al., the vitrectomy indication in the eyes was as follows: VH and tractional RD in 32.3%, traction RD in 31.5%, VH in 26.2%, and combined tractional and rhegmatogenous RD in 10%. Re-attachment stabilization was achieved behind the buckle in 96% of the eyes in which silicone was used. A visual acuity increase was obtained in 76% and 81% of the eyes with tractional RD and combined detachment cases, respectively, and the visual acuity remained unchanged in 88%, reduced in 10% and increased in 1% of the eyes when the postoperative 3rd month and the last control values were compared. Recurrent VH, cataract, neovascular glaucoma and detachment developed in 13%, 26.8%, 6% and 8% of the eyes, respectively (38). While the most important indications of vitrectomy were fibrous proliferations and VH, anatomic success was obtained in 75% of the cases in the last examination. Recurrent VH, cataract, ocular hypertension and retina detachment developed in 9.72%, 9.72%, 11.11% and 5.56%, respectively. The rate of visual acuity increase was 51.39% but the visual acuity higher than 1/10 remained at 6.94%.

Visual prognosis after vitrectomy performed in severe diabetic retinopathy depends on the final macular function. Surgery for the VH without macular detachment produced, in most cases, a good visual acuity. On the other hand, vitrectomy for tractional macular detachment was followed by poor visual prognosis (39, 40). In Turkey, a remarkable number of cases with advanced stage and high-risk severe proliferative retinopathy either admits very late to centers or they are referred there. Even though anatomical success is achieved with surgery in such cases, functional results are not satisfactory. The authors are of the opinion that the rate of anatomic and functional success may be increased with the use of new medical agents decreasing the effects of diabetes and preventing the development of reproliferations, and developing more ideal intraocular tamponade materials.

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