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Research Article

Chorioretinectomy for Treatment and the Prevention of Proliferative Vitreoretinopathy in Traumatic and Non-Traumatic Patients.

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Abstract

Chorioretinectomy is a surgical technique that creates a zone of bare sclera around the exit wound or an intraocular foreign body impact site, serving as a barrier to prevent the scar from engulfing the retina. This technique was proposed as a proactive treatment in eyes with high-PVR risk injury but also as a treatment for cases where PVR is already present.

Aim*: The aim of the study is to present long-term results both in injured eyes with retinal detachment (RD) in the course of PVR formation and in non- injured eyes with different pathologies.*

Material and methods*: We retrospectively reviewed 6 trauma cases (4 eyes after perforating eye injury and 2 ruptured eyes) where PVR developed after the intial surgery. We also present two cases of tractional RD in the course of diabetic retinopathy (due to PVR formation), one case of RD in the course of toxoplasmosis related to retinal necrosis and one case of macular membrane growth emerging from CNV scar in juxtamacular region. All patients undewent 23G pars plana vitrectomy and chorioretinectomy, using the highest setting of the endodiathermy probe in order to destroy the source of PVR membrane formation.*

Results*: 2 years follow-up revealed no PVR formation, complete retinal attachment and useful central visual acuity both in traumatic and non-traumatic patients.*

Conclusion*: Choriorectinectomy seems to be useful and effective technique against PVR formation in trauma related retinal detachment. The technique can also be used in non-traumatic eyes where the potential site of PVR formation is well-defined.*

Introduction

Proliferative vitreoretinopathy (PVR) is a major risk factor of failure in retinal detachment surgery and in the treatment of severe posterior segment trauma [1-3].

It develops in up to 40–60% of patients with an open-globe injury [4]. It is seen in 5%-10% after surgery for rhegmatogenous retinal detachment (RRD) [5]. The major problem with the condition is that the PVR can reappear and lead to redetachment in 10-30% of cases [6]. RRD and/or trauma to the retina causes a breakdown in the blood–retinal barrier (BRB), triggering cell migration and proliferation, with the **principal**

cells involved being the retinal pigment epithelial (RPE) cells, fibrous astrocytes, fibroblasts, myofibroblasts, and macrophages. Five distinct stages appear to be important in PVR development: breakdown of the BRB, chemotaxis and cellular migration, cellular proliferation, membrane formation with remodeling of the extracellular matrix and contraction of the fibrous tissue[7 8]. Unlike neovascular eye diseases, which seem to be at least in part driven by a single agent (vascular endothelial growth factor –A e.i. VEGF-A), multiple growth factors and cytokines are implicated in the pathogenesis of PVR. PDGFR□ can be activated by many PDGF isoforms and even growth factors outside of the PDGF family [9]. Certain PDGF isoforms are associated with proliferative vitreoretinopathy (PVR), a sight-threatening complication that develops in a subset of patients. TGFβ2 is a potent chemoattractant secreted by RPE cells that plays a key role in transforming RPE cells into mesenchymal fibroblastic cells [10]. The mechanism of action is so complicated that so far no pharmacological agent is known to be decisive in PVR prevention after surgery. Many were tried with no success (table 1.)

Table 1. Pharmacological and physical agents used in trials of PVR prevention:

Agent	**Way of treatment**
Daunorubicin [11]	Adjunctive
Triamcinolone acetonide [12 13]	Intravitreal to inhibit tissue proliferation
5-fluorouracil+low molecular weight heparine [14]	adjunctive
13-cis retinoic acid [15]	oral
Dexamethazone (Ozurdex) [16]	Intravitreal to inhibit tissue proliferation
Colchicine [10]	Low dose oral
Bevacizumab [17 18]	Intravitreal
Metothrexate [19]	Intravitreal
Radiation therapy [20]	External, proliferation inhibitor

Since the RPE cells in the retina play a key role in PVR membrane formation chorioretinectomy during pars plana vitrectomy was proposed in order destroy these cells. The technique utilizes highest settings of diathermy probe applied on the retina and choroid in the high-risk area with 1 mm ring around the wound/impact site. The key feature is to destroy all tissue to the bare sclera, ideally before proliferation occurs [2 3]. Chorioretinectomy done before PVR membrane formation is a prophylactic measurement and it is called prophylactic chorioretinectomy. It proved its efficacy in trauma cases – perforating wounds, ruptures, deep impact intraocular foreign bodies (IOFB), incarcerated retinas into scleral wound [3 4 21].

It is used in PVR cases in RRD surgery. We attempted to apply it also in non-traumatic but high risk eyes for PVR development.

Aim: The aim of the study is to present long-term results both in injured eyes with retinal detachment (RD) in the course of PVR formation and in non- injured eyes with different pathologies.

Material

We consecutively reviewed 10 cases (10 eyes), 4 females, 6 males, at the age range 28y-71years (mean 47,5 years) operated and followed in Prof. Zagorski Eye Surgery Center in Nałęczów between 2012-2020. There were 6 trauma cases (4 after perforating injury, 2 postruptural) who developed PVR after initial surgery. 4 eyes had no trauma but they represented high risk of PVR development conditions: 2 patients with tractional RD with haemorrhages in the course of proliferative diabetic retinopathy, 1 case of RD with necrosis in the course of ocular toxoplasmosis and 1 patient with epimacular membrane emerging from a juxtamacular post-CNV scar in the better eye with the visual acuity drop. The other eye of this patient was amblyopic.

Methods

All patients underwent 23G pars plana vitrectomy with chorioretinectomy and endolaser around it and silicone oil tamponade. Best corrected visual acuity and fundus examination were taken before and 3, 6 and 24 months after operation. In 7 eyes silicone oil was removed successfully after 6-8 months. 3 patients required re-operation with silicone oil exchange.

Table.2. Traumatic case series with diagnosis and BCVA

Tab. 2.	Diagnosis	VA before	VA after 3 months	VA after 6 months	VA after 2 years
BJ 55y	Rupture RE	HM	CF 1m [32]	CF 1m	CF 1m (oil removed)
AK 60y	IOFB RE	LP	LP [32]	CF 1m	CF 2m
LT 46y	Perforating eye injury RE	LP, no proj.	CF 1m [32]	CF 1m [32]	CF2m (after oil exchange)
JB 52y	Rupture RE	HM	CF 1m [32]	0,05	0,2 (Oil removed, IOL sutured)
JK 64y	Contussion with haemorrhage, RD and schisis	0,3	0,2 [32]	0,2 (after oil exchange)	0,3
AD 28y	Perforating wound, RD, hemorrhage RE	0,2	0,05 [32]	0,2 (oil+ cataract)	0,3 (oil & cat. removed)

Table.3. Non-traumatic case series with diagnosis and BCVA

Patient	**Diagnosis**	**VA before**	**VA after 3 Months**	**VA after 6 Months**	**VA after 2 years**
GW 28y	RD Toxoplasmosis, Vitritis LE	HM	0,05 cc+4,0 [32]	CF at 2m (cataract + oil)	0,3 cc (cat and oil removed)
DF 36y Oil exchange	PDR, tractional RD RE	CF 1m	CF 2m [32]	Lp do 2m (cat+oil)	0,1 (cat and oil removed)
JT 30y	PDR, tractional RD, Intravitreal haemorrhage, LE.	0,05	0,03 [32]	0,2	0,6 cc (cat and oil removed)
JW. 71y	ERM + macular pucker RE. Better eye.	0,3 cc +3,5	0,3 cc +3,5	0,4 cc +3,5	0,5

Fig.1. RD with PVR and retinoschisis after contusion.

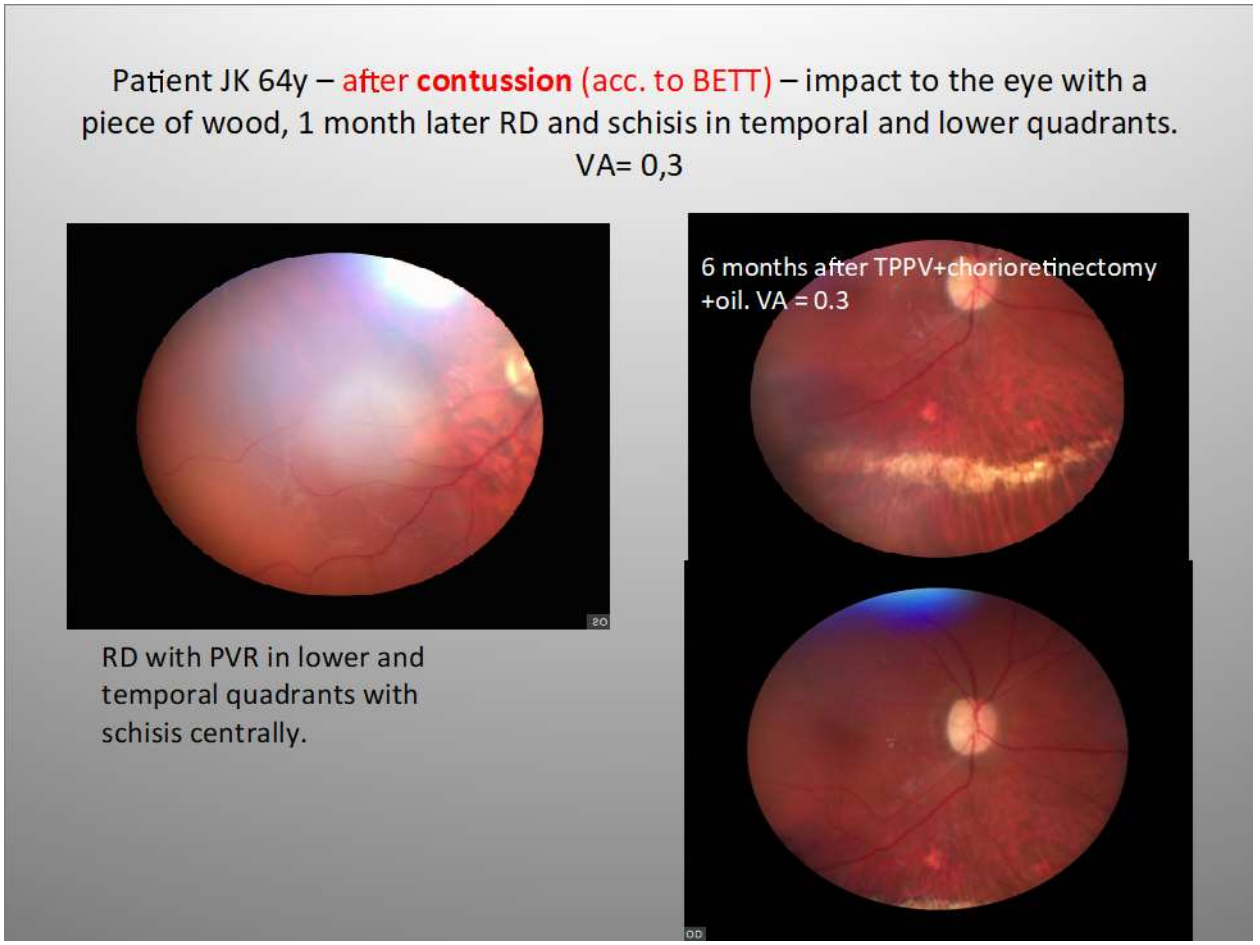


Fig.2. Perforating wound, after 1st vitrectomy retinal incarceration developed due to PVR formation.

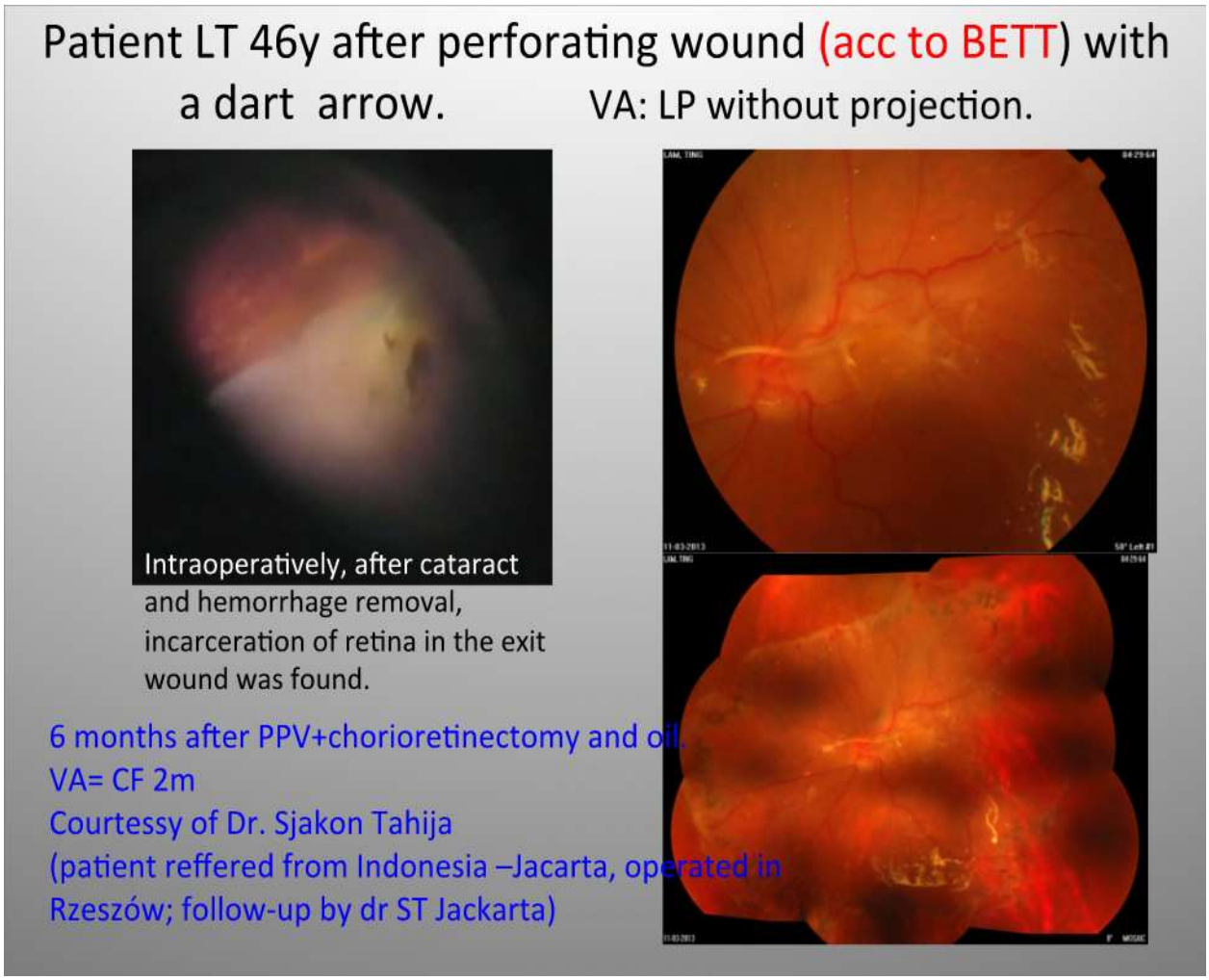


Fig.3. PRD with tractions and haemorrhages.

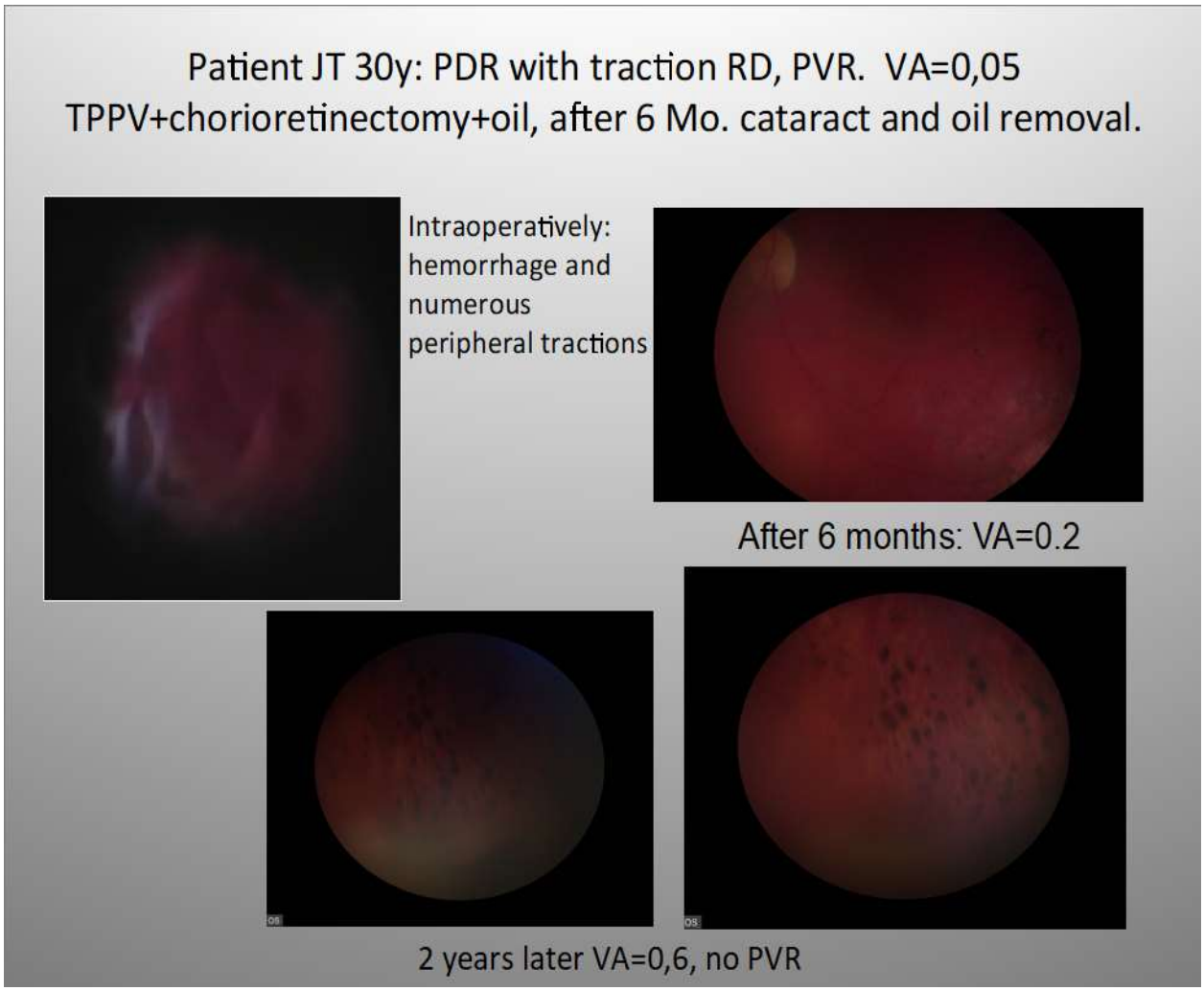


Fig.4. RD in the course of uveitis caused by Toxoplasma gondi. Chorioretinectomy was done at the edge of healthy retina after necrotic tissue removal.

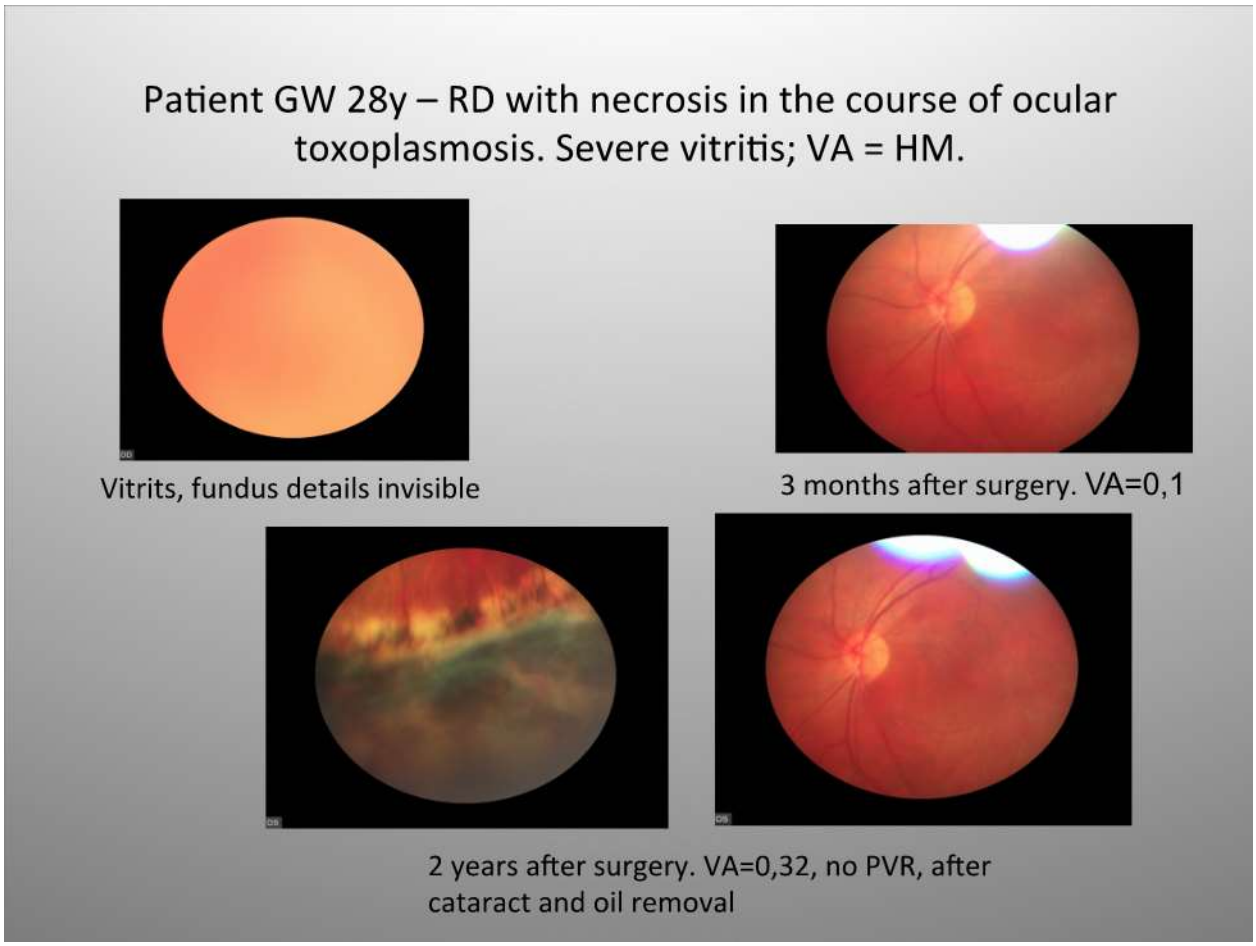
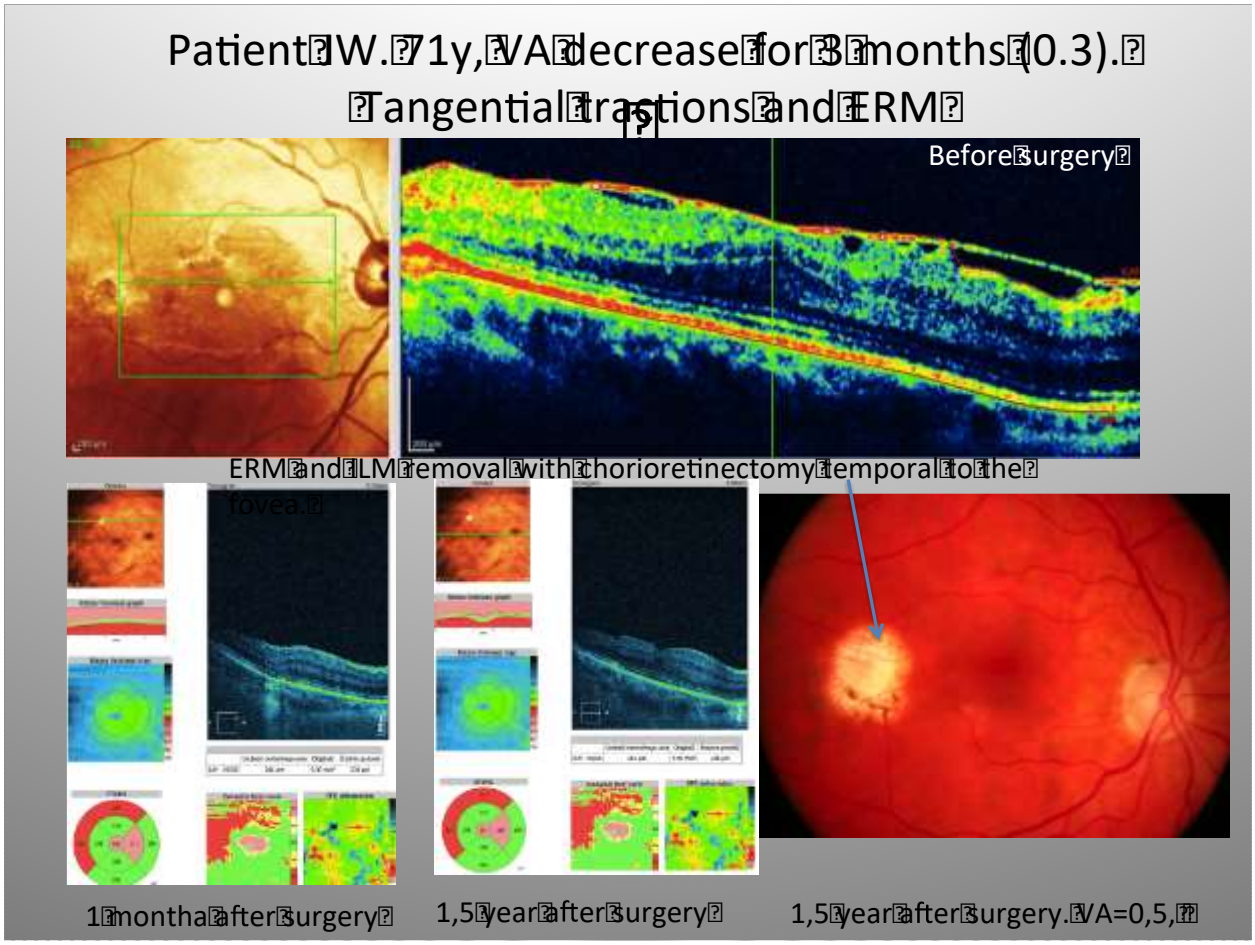


Fig . 5. Chorioretinectomy performed temporal to the fovea in order to destroy focal source membrane formation. Preoperatively pigmented scar after CNV was the origin of ERM which grew over the fovea and distorted it resulting in VA drop in the better eye. The other eye is amblyopic with VA 0,05.



Results

Our material was divided into two groups: traumatic with PVR already present and non-traumatic with high PVR risk. In all traumatic eyes with already existing PVR, PPV was done as a secondary procedure in order to at least stop the scarring process. BCVA measurements within observation period in trauma group are depicted in tabl.2. The BCVA in these patients was initially very low (from HM to 0,3) but improved or at least remained stable in a long run after successful PVR management. All patients needed silicone oil tamponade, which was removed in 4 cases after 6-8 months. Two eyes required oil exchange due to

intraoperative re-RD during 1st attempt of oil removal. But in these two eyes oil could be successfully removed in a second attempt after 8 more months. There was no PVR recurrence seen in these eyes after chorioretinectomy was done.

Fig 1. demonstrates the eye which developed retinoschisis with RD encompassing inferior and temporal quadrants with macula off 1 month after contusion (acc. to BETT) – the eye was hit by the piece of wood. Retinoschisis itself is a condition with 30-40% risk of PVR development and in this case the process has already started. Chorioretinectomy was performed along the retinotomy site (fig. 1B). 2 years later retina remained attached with no PVR (fig.1C). Another example in this group was a complex re-RD with retinal incarceration after perforating wound with dart arrow (Fig.2. a), VA was LP without localization. Retina was attached after PPV with 360 retinectomy and chorioretinectomy serving as a tool of liberating the retina from exit wound the retina was attached under oil (fig. 2 b- 1 month postop). No PVR 6 months postoperatively was found (fig.2c). It remained attached after oil removal 16 months later.

BCVA measurements and diagnosis in non-traumatic group is shown in tabl. 3.

There were two cases of tractional RD in the course of active PDR (fig. 3), 1 eye with RD in the course of retinal necrosis caused by Toxoplasma gondi active infestation. In this eye there was additionally heavy vitritis with lot of pigment particles liberated from the retinal tissue (fig. 4a). We suspected that without any preventive action PVR would have developed, especially because this patient was young. Postoperative appearance 3 months and 2 years after surgery is demonstrated on Fg 4 b-d. The retina remained attached with no signs of PVR. The last case from this group presented ERM emerging from extrafoveal hyperpigmented CNV scar. Epiretinal scar tissue grew over the macula causing deformation and pucker of the fovea accompanying with the vision drop and metamorphopsia. This was patient's better eye, the other eye was amblyopic. This case is demonstrated on fig. 5 with OCT and fundus photographs. After focal chorioretinectomy with complete destruction of the pigmented scar to the bare sclera, macula became smooth and VA improved with decrease of metamorphopsia. In non-traumatic group the initial BCVA was better than in trauma cases and the functional improvement was much better and also remained stable with time.

Discussion:[2 4 22]

PVR is the most dangerous condition for injured eye, carrying not only the risk of potential vision loss but also the risk of eyeball loss due to ciliary body destruction [4]; [3]; [23]. According to the literature at least

of 60% of eyes after trauma with posterior segment involvement develop PVR [1 24]. With the use of chorioretinectomy during surgery this rate can be reduced to less than 10% [3 21 22].

PVR is also the most common cause of failure in retinal detachment surgery irrespectively to the cause of RD [5]. It is a potential threat after any vitrectomy no matter for its indication. Inflammation in the posterior segment and haemorrhage are among the risk factors of PVR development [2]. That is why patients with proliferative diabetic retinopathy, which itself is pathologic membranes formation process, accompanying with bleeding, are at risk for PVR formation [25]. In our material we present two of such cases. Interestingly PDR and PVR share the same potential cellular mechanism of chemokines and their receptors activation together with leading to fibrovascular membranes formation. Chemokines together with VEGF expression can also promote inflammation [26].

In the case of toxoplasmotic uveitis infection activate cascades of events starting from RPE monolayer disruption and migration together with blood-retina barrier breakdown, which promote inflammation and may lead to membrane formation [27]. Toxoplasmosis usually presents as a focal necrotizing retinitis associated with vitritis – the typical picture was also seen in our case (fig. 4) [28, Frau, 1997 #853]. RD (5-6% affected eyes) develops either as rhegmatogenous type due to retinal breaks in the necrotic retina or a tractional one due to severe inflammation with PVR [28 29]. Our patient presented himself as an RD with severe retinal necrosis and vitritis was at high risk of PVR development according to these observations. Here PPV with ILM peeling and chorioretinectomy not only cleared the eye from inflammation threatening to tissue integrity, but also save potential retina destruction heavy scarring process. Such eyes, as it was decribed previously if left untreated, end up with no light perception and phthisis [28 30, Konstantinidis, 2009 #852].

The conditions with pigment liberation to the vitreous cavity are at elevated PVR risk e.g. retinal detachment with “tobacco dust” or CNV scars with pigment clusters (fig.5.) [8]. PVR may appear as a “normal” scar formation reaction by the body. It may be moderate to severe. The most aggressive PVR reaction is typically seen in posttraumatic eyes and in young people [2 4]. If untreated irrespectively to its initial cause PVR can lead to complete retinal and even eyeball destruction with phthisis. It is well known and accepted that cells responsible for PVR membrane formation are RPE and fibroblasts. It was shown [31] that these cells start to proliferate early – within hours after trauma or surgery. The ideal situation would be to have an pharmacological agent inhibiting the process but so far no such agent exists although many were tried [13 14];[17];[10];[11];[18];[16]; (tabl.1.). If PVR is already present the treatment is surgical with excision of all

PVR membranes and the use of intraoperative diathermy (highest settings) applied on the site of potential RPE source for PVR such as IOFB impact site, incarceration or scar tissue site [21 22]. The retina and choroid in that place has to be destroyed to the bare sclera and all what is inside the eye after this maneuver should be cleaned [1]. In our material it is clearly visible in the case of epiretinal membrane growing over the macula from the juxtamacular pigmented scar (fig.5.). After removal of that membrane and destruction of the scar tissue to the bare sclera there was no re-grow of the fibrotic tissue following the anatomical and functional improvement of the macula itself. Interestingly while chorioretinectomy is directed against RPE cells and does not affect fibroblasts but the latter, although can proliferate over bare sclera, do not cross the border of chorioretinectomy margin and thus they do not grow over the retina surrounding that site [4]. Chorioretinectomy and silicone oil tamponade are currently the only effective tools to reduce PVR risk and rate of re-occurrence [2 22]. So far it was mostly applied in trauma cases either for already existing PVR or prophylactic within 100hrs after injury [4].

In this article we decribed four non-traumatic cases but with well-defined foci potentially responsible for PVR formation such as area of necrosis, fibrovascular membranes bleeding and pulling the retina off in PRD cases or pigmented CNV scar. In all these cases destruction of that site to the bare sclera with cleaning of vitreous cavity and retina surface together with the oil tamponade seemed to effective in PVR prevention in non-injured, but still high risk eyes.

One has to mention that in any of these eyes vitrectomy should be as complete as it is possible especially in the periphery, where any vitreous left behind may contract and be a scaffold for new membranes formation. When the retina is shortened or necrotic it is better to cut it and consider diathermy at the edge as it was done for example in the inferior periphery of the fundus of patient with toxoplasmosis (fig.4.). The same was done in trauma patients but in this group already existed PVR required also careful and thorough cleaning the retina from all existing PVR membranes. In case depicted on fig.2. chorioretinectony served as a maneouver liberating the incarcerated retina from the exit wound (fig.2).

Our case series study encompasses the small sample but we think it gives promising results not only for injured eyes, but also opens chorioretinectomy application in non-traumatic eyes with high PVR risk due to other diseases.

Conclusions

Our experience suggests that chorioretinectomy can be successfully applied in the PVR prophylaxis and treatment not only in severe eye injuries, but also in other high-risk or existing PVR cases.

The technique can be used in non-traumatic eyes where the potential site of PVR formation is well-defined. Although it should be studied based on increased number of cases

Although pharmacologic agents have some potential in fighting PVR in the future, currently we recommend the surgical approach.

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