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Assessment of Visual Function in Patients with Retinal Detachment after Vitrectomy with and without ILM Peeling

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Abstract

Purpose: To determine the influence of peeling the internal limiting membrane (ILM) on visual acuity, M-Charts, visual field and OCT in patients with retinal detachment.

Methods: We have analyzed 63 patients in three groups. The first group (group B) consisted of 26 patients who underwent vitrectomy with ILM peeling performed after staining with Brilliant Peel. The second group (group G) consisted of 23 patients, in whom ILM peeling was performed after staining with indocyanine green. The third group (group Z) consisted of 14 patients in whom ILM peeling had not been performed. Ocular examination involved the assessment of visual acuity for distance and near vision, visual field testing, metamorphopsia quantification, dilated fundus exam and OCT.

Results: There was a statistically significant improvement in the postoperative best corrected visual acuity for distance vision in groups B (p=0.00007), G (p=0.0002) and Z (p=0.003). There were statistically significant differences in the prevalence of ellipsoid layer photoreceptors abnormalities between the groups (p=0.004), with more abnormalities in group Z (64%) as compared to groups B (20%) and G (17%). Statistical analysis also revealed significant differences in the epiretinal membrane (ERM) incidence between the three groups (p=0.02), with ERM occurring more frequently in group Z (29%) as compared to groups B (4%) and G (4%).

Conclusions: ILM peeling does not adversely or positively affect the distance and near vision, visual field and M-Charts. Therefore ILM removal could be considered in only selected cases of "macula-off" retinal detachment.

Keywords: Retinal detachment; Brilliant peel, Indocyanin green; ILM peeling; M-Charts; Visual field

Introduction

The improvement of surgical techniques over the last years has resulted in nearly perfect anatomical success in the treatment of patients with rhematogeneous retinal detachment (RD). However, restoration of anatomical structures does not always translate to patient satisfaction. Patients after vitrectomy performed due to "macula-off" RD complain primarily of metamorphopsia, decreased near and distance vision, visual field narrowing, and lower contrast sensivity, especially in dim light. Patients also often experience the disappearance of a previously viewed image or letters.

Internal limiting membrane (ILM - internal limiting membrane) is the innermost layer of the retina composed of Müller cell basal membrane, proteoglycans, type IV collagen fibers, and a plasma membrane. Its thickness is on average from 4 to 6 microns [1]. Its structure, characteristic of the basement membrane, can provide a scaffold on which, and through which, other cells migrate and proliferate to form epiretinal membranes (ERM). The first report of the removal of ILM was published by Morris et al. in 1990, describing a case of Terson syndrome with the presence of blood between ILM and other layers of the retina [1]. In turn, in 1993 Wendel et al. suggested a modification of ILM removal in the treatment of idiopathic macular hole (MH) [2]. ILM peeling is particularly recommended during vitrectomy performed due to macular hole, diabetic macular edema, retinal vein thrombosis, or primary ERM as well as in some forms of retinal detachment [3-7].

Most surgeons agree on ILM peeling in macular detachment, giant holes, multiple holes, concomitant vitreoretinopathy or PVR stage C [3,5,8]. The debate concerns ILM peeling in retinal detachment, which does not involve the macula or in the absence of macular pathology such as the presence of ERM, traction, or macular hole [9]. Literature is scant on the impact of ILM peeling on visual function in patients operated due to rhematogeneous retinal detachment and only few studies focused on assessing retinal morphology and visual acuity [3,8].

The purpose of this study was to objectively assess parameters contributing to vision improvement in these patients, and to find the relationship between the surgical technique – ILM peeling, the type of dye used triphenylmethane - Brilliant Peel (BP) or cyanine - indocyanine green (ICG) and the evaluated parameters. We also wanted to determine to what extent visual acuity can be improved, what limitations arise from RD, and what techniques should be used to

maximize the chance for vision improvement. The evaluated surgical techniques included trans pars plana vitrectomy (TPPV) with or without ILM peeling.

Material and Methods

This was a non-randomized, prospective study. Patients included in the study had undergone one retinal detachment surgery, pars plana vitrectomy with ILM peeling in group B and G and without peeling in group Z. The "macula off" RD was diagnosed preoperatively in all patients. All patients had the dilated fundus examination. Patient characteristics are presented in Table 1.

Excluded from the study were patients who had more than one retinal surgery for recurrent retinal detachment, PVR greater than C2, diabetes, AMD and post-traumatic retinal detachment. Determination of the degree of proliferative vitreoretinopathy was based on the classification of the Retina Society Terminology Committee [10].

	Group B	Group G	Group Z	P-value
Age/mean ± SD	65.76 ± 9.44	63.26 ± 9.30	66.92 ± 11.75	0.31
Sex F/M	13/13	12/11	2/12	
No. of eyes	26	23	14	
BCVA for distance vision before surgery ± SD	0.12 ± 0.17	0.10 ± 0.16	0.10 ± 0.08	0.21
Duration of retinal detachment ± SD	9.15 ± 4.69	9.34 ± 5.23	9.85 ± 3.65	0.08
No. of breaks ± SD	2.25 ± 0.85	1.95 ± 0.82	1.92 ± 0.73	0.08
Grade of PVR (%)				
A	38.46	39.13	35.71	
B	30.76	30.43	35.71	
C1	30.76	30.43	28.57	
Silicone oil removal/month/ ±SD	7.2 ± 3.1	8.0 ± 2.2	10.3 ± 3.3	

Table 1: Characteristics of the patient population in group B, G and Z.

Surgical technique

In group B, 20G vitrectomy was performed in 15 patients, and 23G vitrectomy was performed in 11 patients. In 15 patients Chandelier light was used. Posterior vitreous detachment (PVD) was performed intraoperatively in cases where it had not detached spontaneously. BP was used for selective ILM staining. ILM peeling was performed after perfluorocarbon injection, then laser photocoagulation was performed around the retinal holes. Silicone oil tamponade was administered in 14 patients, and gas tamponade (SF6) in 12 patients.

In group G, ILM staining was performed using a 0.1% solution of ICG diluted in 5% glucose solution. We stained with ICG under perfluorocarbon in order to reduce the risk of getting ICG under the retina. 23G vitrectomy was performed in 10 patients, and the 20G vitrectomy was performed in 13 patients. Gas tamponade (SF6) was used in 21 patients and silicone oil tamponade in 2 subjects. Chandelier light was used in 10 patients.

In group Z, 20G vitrectomy was performed in all patients. Surgery followed the same stages, except for selective ILM staining and peeling. Silicone oil tamponade was used in all cases. Xenon light was used in all patients. Functional and anatomic evaluation was performed at 6 months ± 1,2 months. In patients with silicone oil, tests were performed after its removal. In patients with gas tamponade (SF6) a single vitrectomy procedure was performed. In patients with silicon tamponade, vitrectomy was performed twice, during the second procedure silicone oil was removed.

Ocular examination at follow up included best corrected visual acuity for distance and near vision (BCVAd and BCVAn), macular field testing (M2-Octopus), metamorphopsia quantification using M-Charts, dilated fundus exam and OCT (optical coherence tomography).

Values of measurable variables were expressed as mean, standard deviation (SD) and confidence interval (CI). Values of immeasurable variables were expressed as numbers and percentages. Distribution normality of measurable variables was assessed using the Shapiro-Wilk test. Chi-squared test for homogeneity was used for the assessment of qualitative variables, unrelated to the differences between the compared groups. The database and statistical analyses were carried out using STATISTICA v. 10.0 software (StatSoft, Poland).

Results

Mean preoperative BCVAd was 20/150 (SD=0.18) in group B, 20/100 (SD=0.10) in group G, and 20/200 (SD=0.08) in group Z (p=0.55). Mean postoperative BCVAd was 20/40 (SD=0.17) in group B, 20/40 (SD=0.19) in group G, and 20/50 (SD=0.22) in group Z (Figure 1). Mean postoperative BCVAn was 0.83 (SD=0.37) in group B, 0.78 (SD=0.56) in group G, and 1.01 (SD=0.62) in group Z. Statistical analysis showed no significant differences in BCVAd (p=0.35) or BCVAn (p=0.63) between the groups (Figure 1). A statistically significant improvement was observed in postoperative BCVAd in group B (Z=3.97; p=0.00007), group G (Z=3.69; p=0.0002), and group Z (Z=3.01; p=0.003). Most significant improvement was

achieved in groups B and G, and the lowest improvement was achieved in group Z. No correlation was observed between PVR stage and BCVAd or BCVAn in any group.

No statistically significant differences were observed in the mean vertical metamorphopsia score between the three groups (p=0.95) (Figure 2). Although there were no statistically significant differences in the mean horizontal metamorphopsia score between the three groups (p=0.97), scores were lower in groups B and G (Figure 2). Although no statistically significant differences were observed in the value of CRT between groups (p=0.20), highest scores were observed in group Z (Figure 3). No statistically significant AT difference was found (p=0.62) (Figure 4). No statistical correlation was found between the visual acuity, retinal thickness and CRT in any treatment group (p>0.05). Swelling was slightly more common, but not statistically significant (p=0.24), in group Z (28%) as compared to groups B (24%) and G (9%).

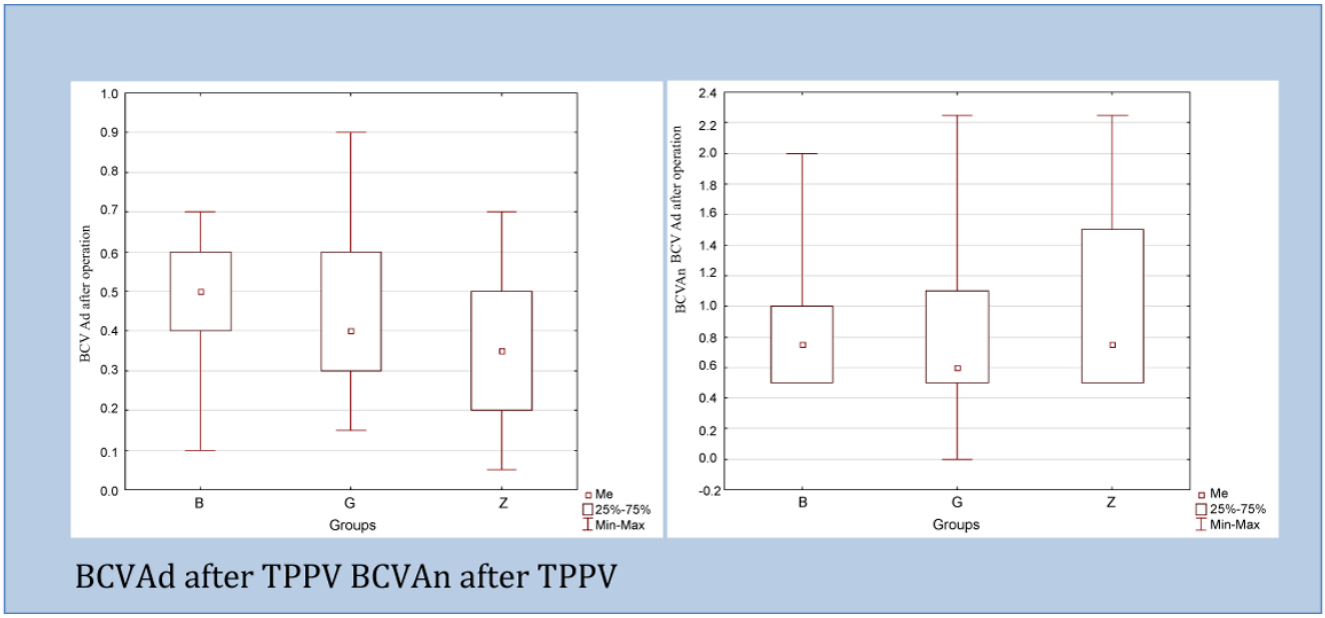

Figure 1: The values of BCVAd and BCVAn after TPPV in the groups.

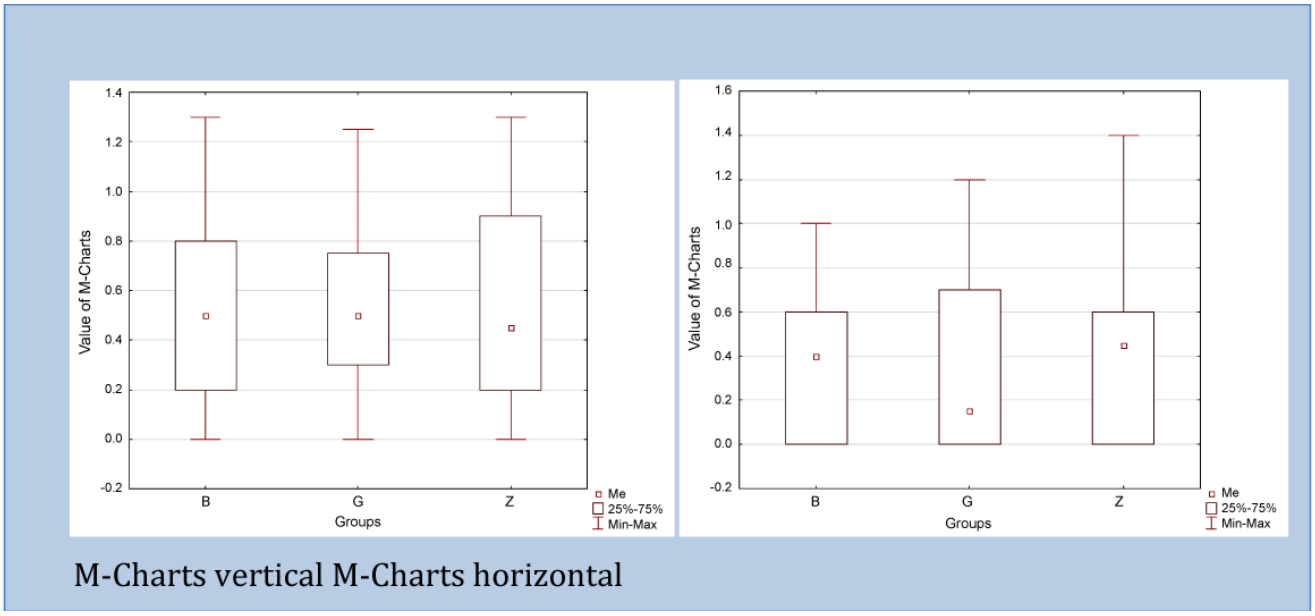

Figure 2: The value of M-Charts vertical and horizontal in the groups.

Significant differences were observed in the prevalence of ellipsoid layer abnormalities (p=0.004). These occurred more frequently in group Z (64%) as compared to groups B (20%) and G (17%).

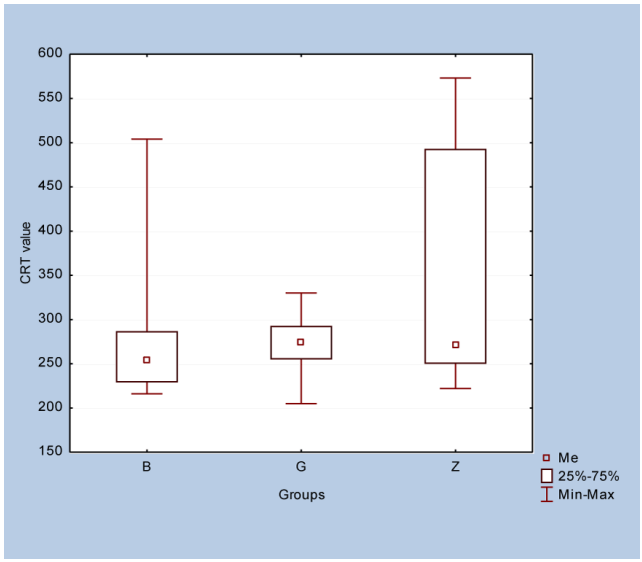

Figure 3: The value of CRT in the groups.

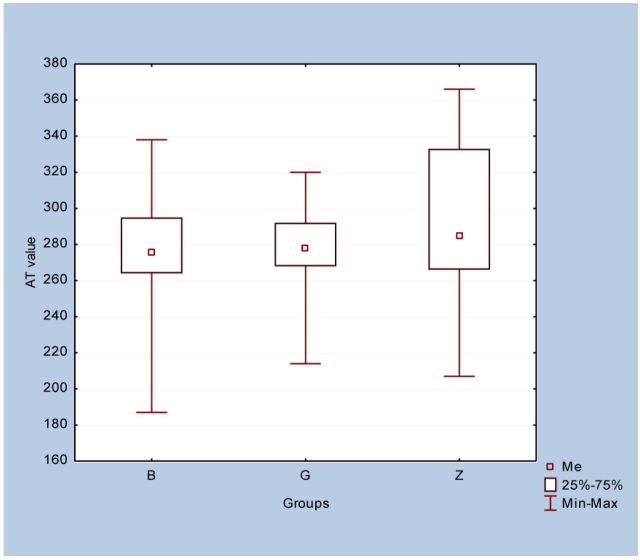

Figure 4: The value of AT in the groups.

No positive correlation was found between BCVAn, BCVAd and ellipsoid zone abnormalities across the three groups (p> 0.05%). Moreover, epiretinal membrane (ERM) occurred more frequently in group Z (29%) as compared to groups B (4%) and G (4%) (p=0.02). The assessed macular field parameters included mean deviation (MD) and square root loss of variance (SLV). MD was 7.92 (SD=5.54) in group B, 6.49 (SD=3.66) in group G, and 5.36 (SD=6.32) in group Z (p=0.71). SLV was 3.67 (SD=1.42) in group B, 1.74 (SD=3.27) in group G, and 3.31 (SD=2.05) in group Z (p=0.88).

Discussion

Visual acuity measurement remains the gold standard in the assessment of visual function in patients treated surgically due to retinal detachment. We cannot overestimate the value of this measurement, because - as previously mentioned - it does not fully reflect the retinal function, and thus the outcomes will not reflect the level of patient satisfaction. We know that the post-operative visual acuity of patients depends on many factors. Histopathological analyses confirmed that prolonged retinal detachment duration leads to retinal layer atrophy, death of photoreceptor cells, synaptic remodeling, hypertrophy and proliferation of Müller cells, as well as the altered expression of apoptosis inducing factor [11,12]. The largest photoreceptor loss occurs on second day after retinal detachment [11]. Unfortunately, retinal reattachment does not stop all processes initiated by the detachment. The average detachment duration in our treatment groups was 15 days, and it certainly affected the analysed parameters. Another interesting finding is that the macular photoreceptor atrophy may occur whether or not the "macula-off" detachment takes place [12]. Prognosis for vision improvement depends on ellipsoid layer abnormalities and the external limiting membrane (ELM) disruption [11,13]. The evaluation of these zones is particularly important prior to vitrectomy, in patients with macular hole, diabetic macular edema, and ERM [3,14-16]. On the other hand, the impaired photoreceptor layer integrity can significantly worsen the prognosis for vision improvement, despite the properly performed, uncomplicated vitrectomy [14].

We observed no statistically significant differences in postoperative visual acuity for both distance and near vision between the study groups. This may mean that ILM peeling has no effect on the improvement of visual acuity and does not affect its deterioration. Cox et al. in the Silicone Study Reports (SSR) observed a statistically significant difference in visual acuity between patients undergoing surgeries with or without ILM peeling [8]. It is possible that the discrepancy between SSR and our studies stems from the fact that the former investigated only the visual acuity in patients with ERM in comparison with patients who did not have ERM. Furthermore, the stage of ERM was more advanced [8,17].

ERM prevalence was statistically different between the three groups of our investigation (p=0.02). The occurrence of ERM in one patient from groups B and G may have been caused by incomplete ILM peeling. In our patients the ERM covered the macula, not involving the foveal area. ERM in group Z (29%) were not so aggressive stage 0 to 1 and did not significantly affect visual acuity. In contrast, Odrobina et al. found ERM in 17% of patients in whom the ILM peeling had not been performed, whereas no ERM case was identified in the group with ILM peeling [18]. Kiss et al. found that ERM develops in 20.5% of patients with complicated retinal detachment, treated with vitrectomy with silicone oil tamponade [5]. We did not find a relationship between the degree of PVR and visual acuity, probably due to the fact that in the studied groups PVR was never greater than stage C1. Other researchers confirmed that more severe PVR was associated with poorer prognosis for vision improvement, probably due to the increased retinal photoreceptor apoptosis. This happens if the PVR stage is equal or greater than C1 [11,18]. The vertical and horizontal metamorphopsia score, assessed using M-CHARTS V, was similar across the groups in our study. Matsumoto, on the other hand, reported higher values in patients with advanced (grade 2) ERM [17,20]. The result was dependent on the severity of ERM in the group without ILM peeling.

The analysis of mean central retinal thickness showed no statistically significant differences between the three study groups. There was no correlation between the visual acuity and retinal thickness in any treatment group [17,20]. A similar association was found by Massin et al., who analyzed the postoperative visual acuity against retinal thickness changes in patients with ERM [21]. However, Michalewski observed that visual acuity in patients with ERM appears to be correlated to CRT [14].

Our findings showed no statistically significant difference between the three patient groups in the severity of retinal edema as related to the stage of ERM. However, in our opinion, ILM peeling creates better conditions for the absorption of retinal fluid.

Visual field parameters assessed for each group included the mean deviation (MD) and square root loss of variance (SLV). The analysis showed no statistically significant differences in MD between the treatment groups (p=0.71). The highest MD values were found in groups G and B, and the lowest - in group Z. There were no statistically significant differences in SLV values between the groups (p=0.88). This indicates that ILM peeling may cause minor damage to the inner layers of the retina, fortunately it does not cause the statistically significant mechanical damage to the retinal nerve fiber layer.

In all patients in group G xenon light was used, and 0.1% ICG solution diluted in 5% glucose was used for staining. We stained with ICG under perfluorocarbon to reduce the risk of getting ICG under the retina. The use of dyes, such as ICG or BP, simplifies maneuvering during ILM peeling by reducing the ILM adhesion to other retinal layers [22]. Similarly, other authors found no differences in BCVA and visual field parameters between the two groups despite ICG staining [23]. We had similar observations, concluding that the functional parameters did not deteriorate as a result of ICG use in group G as compared to groups B and Z.

We observed a statistically significant difference (p=0.004), in favour of group B, in the occurrence of ellipsoid layer abnormalities between the three groups. It can be suspected, that ILM peeling has a positive effect on ellipsoid zone integrity. Nevertheless, we found no positive correlation between BCVAn / BCVAd improvement and ellipsoid layer abnormalities in groups B, G and Z. In contrast, Wakabayashi et al. noted a statistically significant relationship between postoperative BCVA and improved integrity of ellipsoid zone and the ELM [23]. Similarly, Theodossiadis et al. working on abnormalities of the ellipsoid layer and the ELM, noticed that both pathologies are critical to improving vision in retinal detachment secondary to ERM [16].

In conclusion, ILM peeling was neutral to visual acuity but caused visual field defects, although not statistically significant, compared to the group without ILM peeling. This could be partly due to the primary pathology. ILM peeling prevented the formation of secondary ERM, which also did not have a significant impact on the improvement of visual acuity because the membranes present in group Z (without ILM peeling) proved to be less advanced with small progression and severity. ILM peeling also did not cause significant metamorphopsia in the M – Charts but had a positive effect of improving ellipsoid layer integrity.

Based on our results, one should consider whether it is appropriate to perform ILM peeling in each case of "macula off" associated retinal detachment. We recommend ILM peeling to be limited to cases with documented pathology of macular membrane, macular hole or severe PVR greater than C1. In other cases, it seems advisable not to perform ILM peeling. Whenever secondary ERM occurs, one should consider reoperation in cases with blurred vision or significant progression.

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