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CASE REPORT

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Radius-Maumenee syndrome: A case series with a long-term follow-up

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Abstract

The aim of the case series is to highlight the surgical challenges experienced like failed intervention, choroidal effusion, a postoperative cystoid macular oedema, and describe treatment options for Radius-Maumenee syndrome. Authors reported on 3 bilateral cases of Radius-Maumenee syndrome which underwent medical treatment, trabeculectomy with Mitomycin C, implantation with XEN45, Ahmed glaucoma valve, Baerveldt glaucoma implant, and cyclophotocoagulation.

KEYWORDS

ab-interno subconjunctival gel stent, glaucoma drainage device, idiopathic elevated episcleral venous pressure, Radius-Maumenee syndrome, secondary open-angle glaucoma, trabeculectomy with mitomycin C

1 | INTRODUCTION

The Radius-Maumenee syndrome is characterized by an idiopathic elevated episcleral venous pressure first described in 1968 as a cause of secondary open-angle glaucoma with unknown incidence.[1,2] According to Goldmann equation, aqueous humor dynamics and intraocular pressure (IOP) are directly affected by episcleral vein pressure.[3] Therefore, elevated episcleral vein pressure induces resistance for aqueous outflow through the trabecular meshwork and Schlemm's canal. Consequently, an increased IOP predisposes these patients to development of glaucoma.[4,5]

The Radius-Maumenee syndrome is defined as a condition by exclusion while other pathologies of elevated episcleral venous pressure should be investigated. Increased episcleral venous pressure could be related to episcleral, orbital, neurological conditions, or systemic causes.[6] Even today, there are no approved methods to measure the episcleral vein pressure in practice. The diagnosis is made clinically by observing dilated episcleral vessels, an increased IOP and performing an imaging to exclude any secondary cause. The surgical treatment strategy for Radius-Maumenee syndrome is still under question due to its rare nature and the lack of evidence-based guidelines. Several reports have described the outcomes of trabeculectomy with or without Mitomycin C (MMC), non-penetrating deep sclerectomy, deep sclerectomy in combination with viscocanalostomy and implantation of

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a collagen matrix, carbon dioxide laser-assisted sclerectomy surgery, penetrating cyclodiathermy, sclerectomy, and posterior sclerostomy as a primary intervention.[2,7–12]

The authors of the study report on 3 retrospective cases of Radius-Maumenee syndrome with long-term follow-up. The aim of the report is to highlight surgical challenges experienced and describe treatment options for this rare entity.

2 | FINDINGS

The following cases will describe three patients with bilateral Radius-Maumenee syndrome. All patients had dilated, tortuous episcleral vessels, an open angle on gonioscopy and increased IOP in both eyes. None of the patients had proptosis and chemosis, and they presented with full extraocular movements.

In all cases, the diagnosis of Radius-Maumenee syndrome was made clinically observing dilated, tortuous episcleral vessels, elevated IOP, an open angle on gonioscopy and excluding other causes of increased episcleral venous pressure. Unfortunately, there is no clinically accepted device to measure the episcleral venous pressure.

The patients had no history of ocular trauma and inflammation, ocular radiotherapy. Thyroid gland parameters were inside normal limits. Computerized tomography (CT), CT angiography, brain magnetic resonance imaging (MRI) with contrast medium, and MRI angiography/venography for orbits and head were unremarkable. Also, the following conditions were excluded—superior vena cava obstruction, jugular vein obstruction, and pulmonary venous obstruction.

2.1 | Case 1

A 56-year-old female patient presented in the tertiary medical center for further treatment. She had been diagnosed with the Radius-Maumenee syndrome already for 20 years since 1994. The highest pressure previously reported in the history was 42 mm Hg in both eyes (OU).

The previous medical history revealed multiple procedures. In 1995, she had undergone trabeculectomy augmented with MMC in the right eye (OD) followed by revision of the bleb and repeated trabeculectomy with MMC in the same year. In 1996, a cyclophotocoagulation for the OD was performed. The IOP decreased after the procedure from 28 to 14 mm Hg, and it caused choroidal effusion which resolved by conservative treatment. In 2003, an uncomplicated cataract surgery (phacoemulsification with in-the-bag lens implantation) in the OD led to a postoperative cystoid macular oedema. Before the surgery, the patient received dorzolamide/timolol fixed combination twice a day in the OD. Due to a continuously raised IOP with value of 26 mm Hg on 4 glaucoma medications in the OD, the patient underwent an implantation of a non-valved glaucoma drainage device (Baerveldt® implant, Abbott Medical Optics) in 2007. After the surgery, the IOP was 15 mm Hg in the OD and once again it led to choroidal effusion which this time required treatment with systemic steroids and sclerotomy.

The left eye (OS) was not exposed to any surgical treatment during this period.

On the presenting day in 2014, best corrected visual acuity (BCVA) was 20/200 (OD) and 20/20 (OS). The IOP was 12 mm Hg (OD, without glaucoma medications) and 24 mm Hg (OS, on 4 medications). The central corneal thickness (CCT) was 524 µm (OD) and 529 µm (OS) with an axial length of 20.82 and 20.99 mm respectively. The spherical equivalent (SE) values were +1.13 diopter (D) OD and +2.5 D OS. The target pressure OD was ≤12 mm Hg and OS ≤15 mm Hg. The patient presented full ocular movements and no signs of proptosis.

The objective examination of the anterior segment revealed tortuous, dilatated episcleral vessels OU (Figure 1). Anterior chamber angle (OU) was open (grade 3–4 on Shaffer grading system). No blood was seen inside the Schlemm's canal.

The OD had a cup-to-disc (C/D) ratio of 0.7 and no macular oedema at that time. The OS showed a C/D ratio

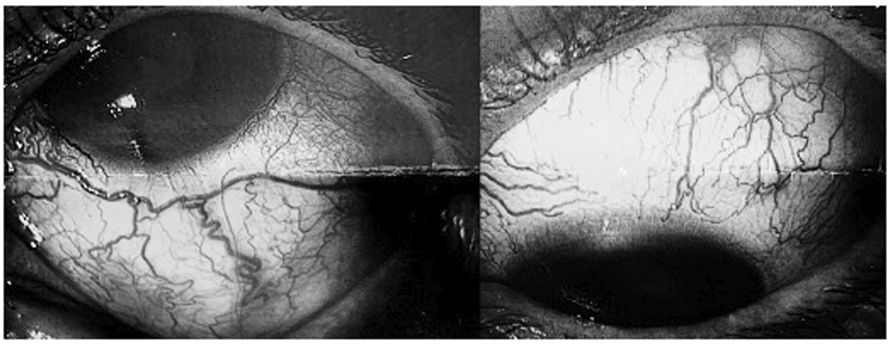

FIGURE 1 Slit-lamp appearance of dilated episcleral vessels in both eyes. No signs of active inflammation of ocular surface were observed.

of 0.7 (Figure 2). Changes in the pattern of retinal blood vessels in the manner of dilated retinal veins were observed (OU). Examination of the visual field (VF, Figure 3) and the peripapillary retinal nerve fiber layer (pRNFL, Figure 4) was performed.

The patient was scheduled for implantation of the subconjunctival gel stent (XEN® 45, Allergan INC) in the OS due to progressive glaucoma damage and uncontrolled IOP. Described complications for filtrating surgery in patients with Radius-Maumenee syndrome suggested that a less invasive method could be a better option.[11,13] A previously published technique for implantation of the subconjunctival gel stent was applied without any intraoperative complications.[14] On the first post-surgical day, the IOP was 10 mm Hg in the OS off-glaucoma medications, and the subconjunctival gel stent was in the right position (Figure 5).

One week after the surgery, the IOP was 14 mm Hg and a small, non-sight threatening choroidal effusion developed, which was treated conservatively. After 3 months, the patient was scheduled for a needling due to a non-functional, flat filtrating bleb and increased IOP equal to 24 mm Hg. At the same time, the patient noticed decrease in VA in the OD. She was diagnosed with a choroidal

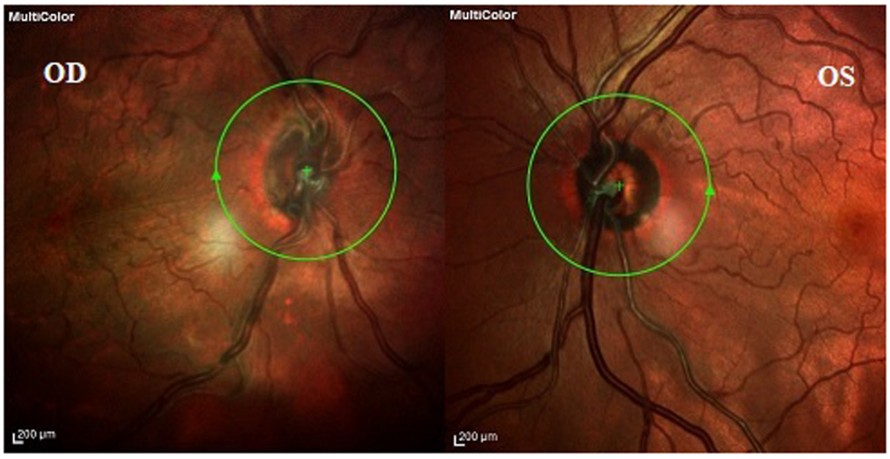

FIGURE 2 Patient's optic nerve head and surrounded retinal vasculature changes in the right (OD) and left eye (OS). A cup-to-disc ratio was 0.7 in both eyes.

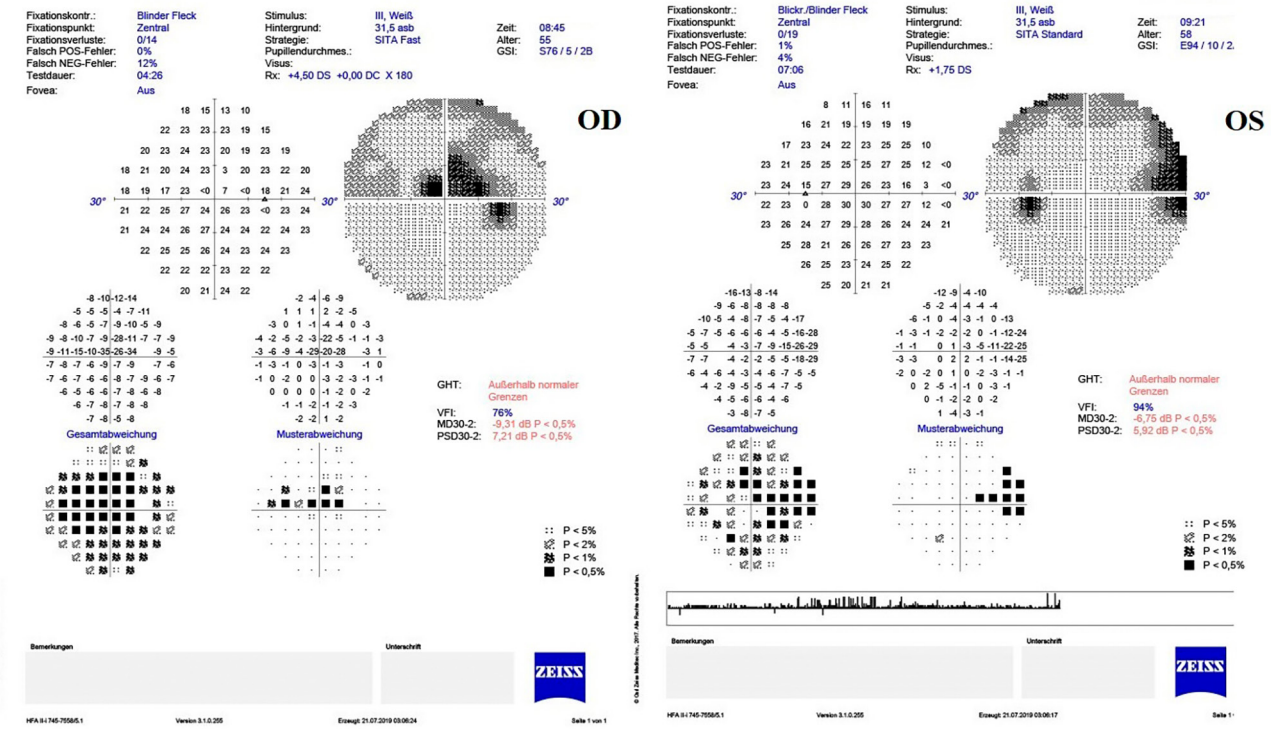

FIGURE 3 Visual field of both eyes. In the right eye (OD), a paracentral scotoma was noticed mostly due to changes of post-cystoid macular oedema and epiretinal membrane. In the left eye (OS), scotoma affected the nasal part. The mean deviation was −9.31 dB (OD) and −6.75 dB (OS).

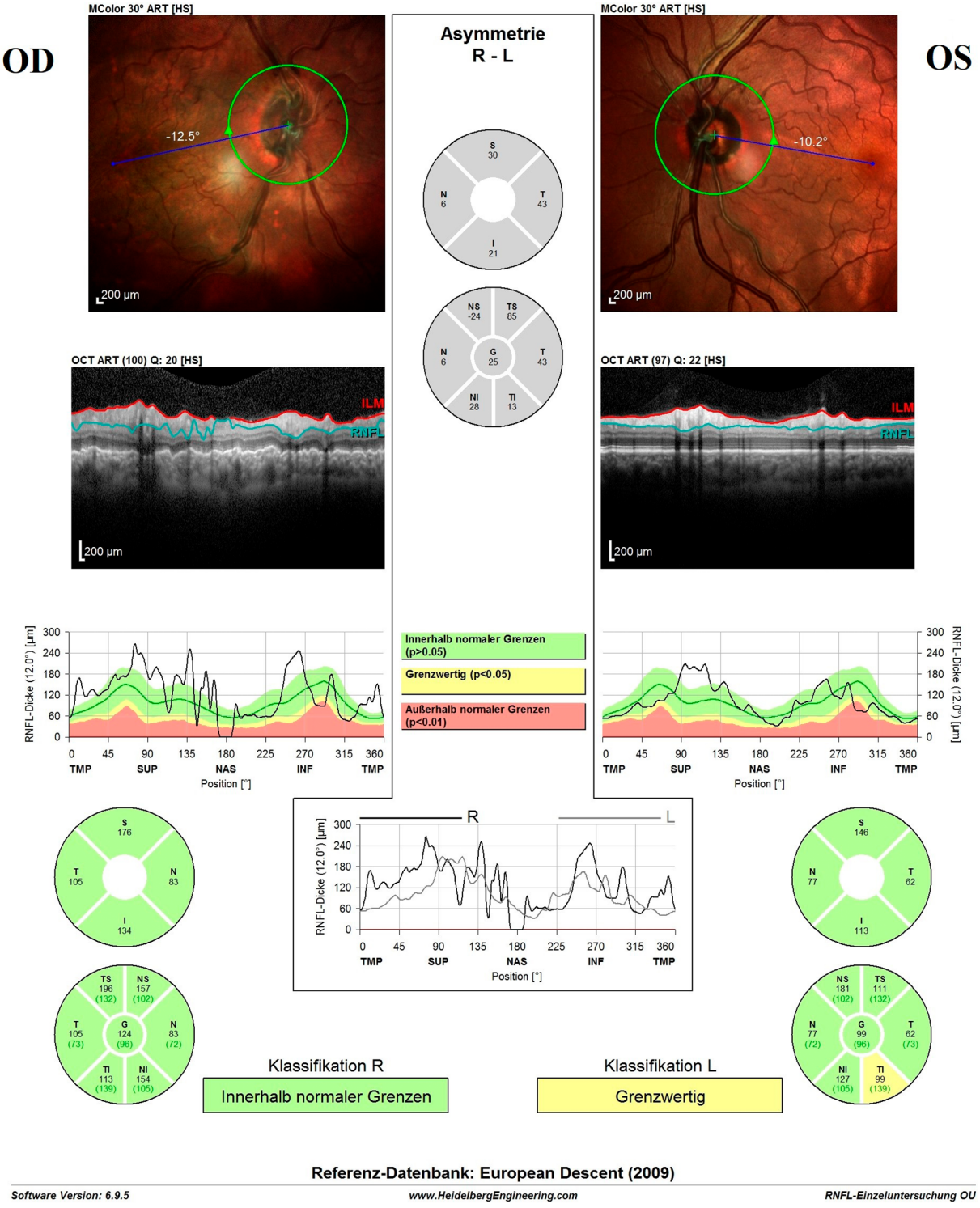

FIGURE 4 Peripapillary retinal nerve fiber layer for both eyes. Significant artifacts were seen in the scan for the right eye (OD). The temporal inferior segment showed borderline value in the left eye (OS).

neovascular membrane (CNVM) in the center of the macula, so treatment with aflibercept (Eylea®, Bayer Vital GmbH) was initiated in the OD.

Ten months after the implantation of gel stent, the patient underwent an uncomplicated cataract surgery with in-the-bag lens implantation in the OS. After 16 months, she was diagnosed with a postoperative cystoid macular oedema in the OS. Consequently, the patient received a dexamethasone intravitreal implant (Ozurdex®, Allergan INC).

At the last follow-up, after 73 months, the BCVA was hand movements in the OD and 20/30 in the OS. The IOP was well controlled in both eyes with the value of 13 mm

FIGURE 5 Location of subconjunctival gel stent on the first post-surgical day. The anterior segment optical coherence tomography revealed an appropriate position of the gel implant. A bleb was rather flat.

Hg without any topical glaucoma medication. The OD had a C/D ratio of 1.0, and the OS showed a C/D ratio of 0.9. During the follow-ups, the patient had received eight intravitreal injections of Eylea in the OD and 14 injections of Ozurdex implants in the OS. However, the cystoid macular oedema was still an issue in the OS at the last follow-up. Functional and structural outcomes at the last follow-up are demonstrated in Figure 6. Unfortunately, these examinations were not possible to perform for the OD due to opacification of optical media (caused by band keratopathy, posterior capsule opacification) and changes of macular area, as well as glaucomatous optic neuropathy.

2.1.1 | Learning points

A subconjunctival gel stent could be a less invasive primary approach to treat patients with Radius-Maumenee syndrome surgically. However, the implantation of the stent may promote a choroidal effusion—as well as described for filtrating surgery. Furthermore, an uncomplicated cataract surgery could cause a postoperative cystoid macular oedema with challenging management in Radius-Maumenee syndrome patients.

2.2 | Case 2

A 37-year-old female patient presented in the tertiary medical center for the second opinion. She had been diagnosed with bilateral Radius-Maumenee syndrome since 2005 for 13 years.

According to the patient's medical history, in 2005, when the condition was diagnosed for the first time, the IOP for OU was 32 mm Hg, BCVA 20/20 and C/D ratio 0.3. The patient was subjected to trabeculectomy with MMC in the OS in 2017. After the surgery, the IOP dropped significantly to 8 mm Hg and a choroidal effusion developed which was treated by conservative treatment.

The objective findings on the day of the presentation in 2018 were as follows: BCVA 20/20 OD (SE −0.25) and 20/200 OS (SE −0.88) with axial length 22.65 mm OD, 22.59 mm OS. CCT OD was 669 µm and OS 659 µm. IOP was 20 and 33 mm Hg in the OD and OS accordingly. OU were under treatment of fixed combination of bimatoprost/timolol before bedtime. The anterior segment findings reflected dilated episcleral vessels. The OD had a C/D ratio of 0.3, the OS 0.8. The highest pressure was 32 mm Hg OD and 48 mm Hg OS, the target pressure OD was ≤18 mm Hg, OS ≤12 mm Hg. Visual field (Figure 7) and examination with optical coherence tomography (Figure 8) were performed.

After eight months experiencing several needlings in the OS, the patient was scheduled for repeated trabeculectomy with MMC. No anterior chamber maintainer was used during the surgery, and sutures were applied according to surgeon's experience. IOP dropped to 3 mm Hg next day, and over-filtration was reduced conservatively. Soon afterwards, due to conjunctival scarring, the filtration bleb was not performing properly anymore and the IOP increased to 24 mm Hg. Because of previous unsuccessful needlings, the patient was scheduled for combined implantation of the subconjunctival gel stent and cataract surgery in the OS after 10 months. Unfortunately, the subconjunctival stent was not working properly, and the IOP raised to 34 mm Hg due to severe conjunctival scarring.

After 12 months, considering all manipulations previously failed, the patient was advised to receive a glaucoma valve (Ahmed® Glaucoma Valve; New World Medical) in the OS. The IOP after the procedure was 6 mm Hg. After 13 months, a cystoid macular oedema developed and was treated with one intravitreal injection of aflibercept. After 20 months, the patient underwent a glaucoma valve revision because of a tenon cyst and choroidal effusion developed due to significant reduction IOP with value of 5 mm Hg (OS). After 23 months, a repeated revision of the valve (OS) was scheduled due to IOP having reached 26 mm Hg.

At the last follow-up, 46 months after the first visit in the clinic, the BCVA in the OD and the OS was 20/20 and 20/50 accordingly. The IOP was 17 mm Hg (OD) and 13 mm Hg (OS). The OD was on topical treatment with 4 glaucoma medications (dorzolamide twice a day, brimonidine twice a day, a bimatoprost/timolol fixed combination at bedtime). A bimatoprost/timolol fixed combination was administered in the OS. Visual fields (Figure 9) and the

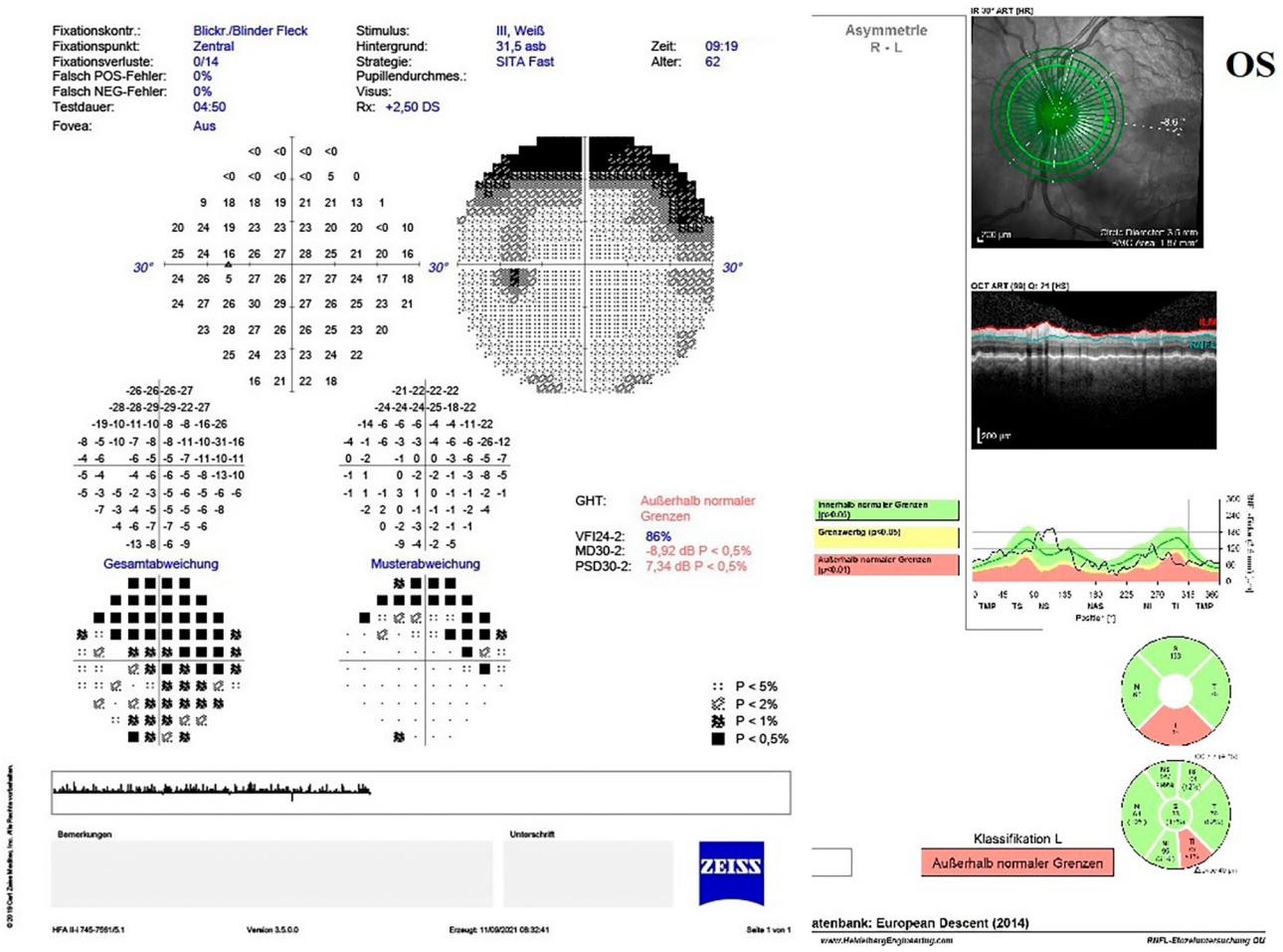

FIGURE 6 Visual field and peripapillary retinal nerve fiber layer (pRNFL) in the left eye (OS). pRNFL from the baseline examination revealed changes in inferior quadrants. The pRNFL for the right eye (OD) was not available. The visual field of the OS showed a mean deviation of −8.92 decibels (dB). The visual field for the OD was not possible to be performed.

pRNFL analysis (Figure 10) indicated findings of the OU at the last follow-up.

2.2.1 | Learning points

Repeated surgical manipulations could be necessary to control IOP. Severe scaring may significantly affect outcomes for young patients with Radius-Maumenee syndrome. Long-term follow-ups are mandatory to evaluate surgical success.

2.3 | Case 3

A 42-year-old male patient presented in the clinic for further treatment due to a blebitis in the OS.

He had a history of increased IOP and red eyes since 1986; Radius-Maumenee syndrome was diagnosed by the year 1990 in OU. The highest pressure recorded was 35 mm Hg OD and 38 mm Hg OS; the target pressure OU was ≤12 mm Hg. In 1990, he had received an argon laser trabeculoplasty (ALT) for both eyes twice. In 1992, he had undergone a trabeculectomy augmented with MMC in the OS. In 2004, he had received a selective laser trabeculoplasty (SLT) in the OD twice. CCT of the OD was 469 µm and of the OS 488 µm respectively.

The last available visual field was from 2007 (Figure 11).

On the current presentation, he had a blebitis and a corneal ulcer in the OS. The corneal ulcer was in the periphery of superior part of the cornea, adjacent to blebitis, involving superficial stromal layer and in size of about 2 mm × 3 mm. Around the defect slight corneal oedema was noticed including the central area. Corneal sensitivity was unaltered. BCVA was 20/20 (with correction, SE −1.88) OD and 20/100 (with correction, SE -1.13) OS. The IOP was 17 and 18 mm Hg, respectively, under treatment with latanoprost. The objective findings of anterior segment for OU showed engorged, dilated episcleral veins. The optic nerve head displayed a C/D ratio of 0.9 in OU.

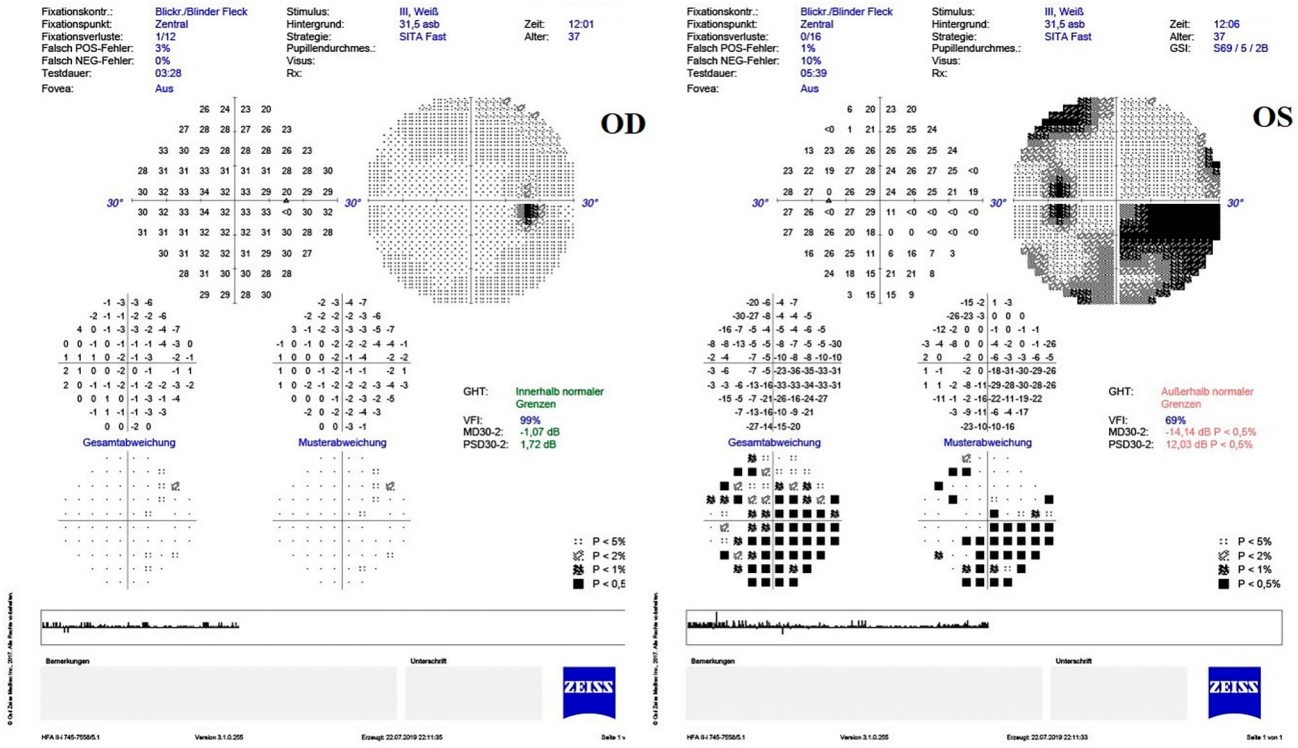

FIGURE 7 Visual field for both eyes. The right eye (OD) was within normal limits. However, the left eye (OS) displayed significant glaucomatous damage (MD −14.14 dB).

The patient was hospitalized and treated according to the guidelines for blebitis of the clinic. Initially, a swab over the bleb and corneal ulcer was performed. The treatment was started with levofloxacin 0.5% and cefmenoxime 0.5% eye drops every hour, and further adopted according to the microbiological report to levofloxacin 0.5% eye drops every hour and fusidic acid 1% ointment before bedtime. Microbiological work-up revealed *Staphylococcus aureus* infection. Preservative-free lubricant eye drops were installed 6 times per day. After significant improvement at the demission, the patient was suggested to have a consultation after 3 days.

Unfortunately, the patient was lost from further follow-ups.

2.3.1 | Learning point

There is no evidence that laser trabeculoplasty could improve the control of IOP in cases when increased episcleral venous pressure is a reason for elevated IOP.

3 | DISCUSSION

This study reflected the surgical management of bilateral Radius-Maumenee syndrome and postoperative complications experienced after its treatment. The case series described long-term outcomes of trabeculectomy with MMC, Baerveldt glaucoma implant, XEN45 and Ahmed glaucoma valve applied for treating idiopathic elevated episcleral venous pressure (IEEVP). According to previous publications, topical treatment frequently is not enough and the Radius-Maumenee syndrome predisposes these patients to possible complications of filtrating surgery.[9,13,15,16] Therefore, the surgical technique should be chosen carefully considering its possible risks and benefits.

At least one eye of every patient of all the cases described underwent trabeculectomy with MMC. Case number 1 and 2 demonstrated the possibility of trying a repeated trabeculectomy but it has a risk of a failure once again. In the end, a glaucoma drainage device helped to control the IOP for these eyes. Surgeons should be aware of choroidal effusion without hypotony when a significant drop of the IOP is reached. In the case series, this happened to two patients. Choroidal effusion without hypotony is frequently described in Radius-Maumenee patients with filtrating surgery in intraoperative[13,16] and postoperative period.[9,15–17] Parikh et al.[16] reported intra- and postoperative choroidal effusion for the same patient. Authors suggested that an intraoperative choroidal effusion could be caused by rapid transudation from capillaries induced by pressure gradient in ciliary

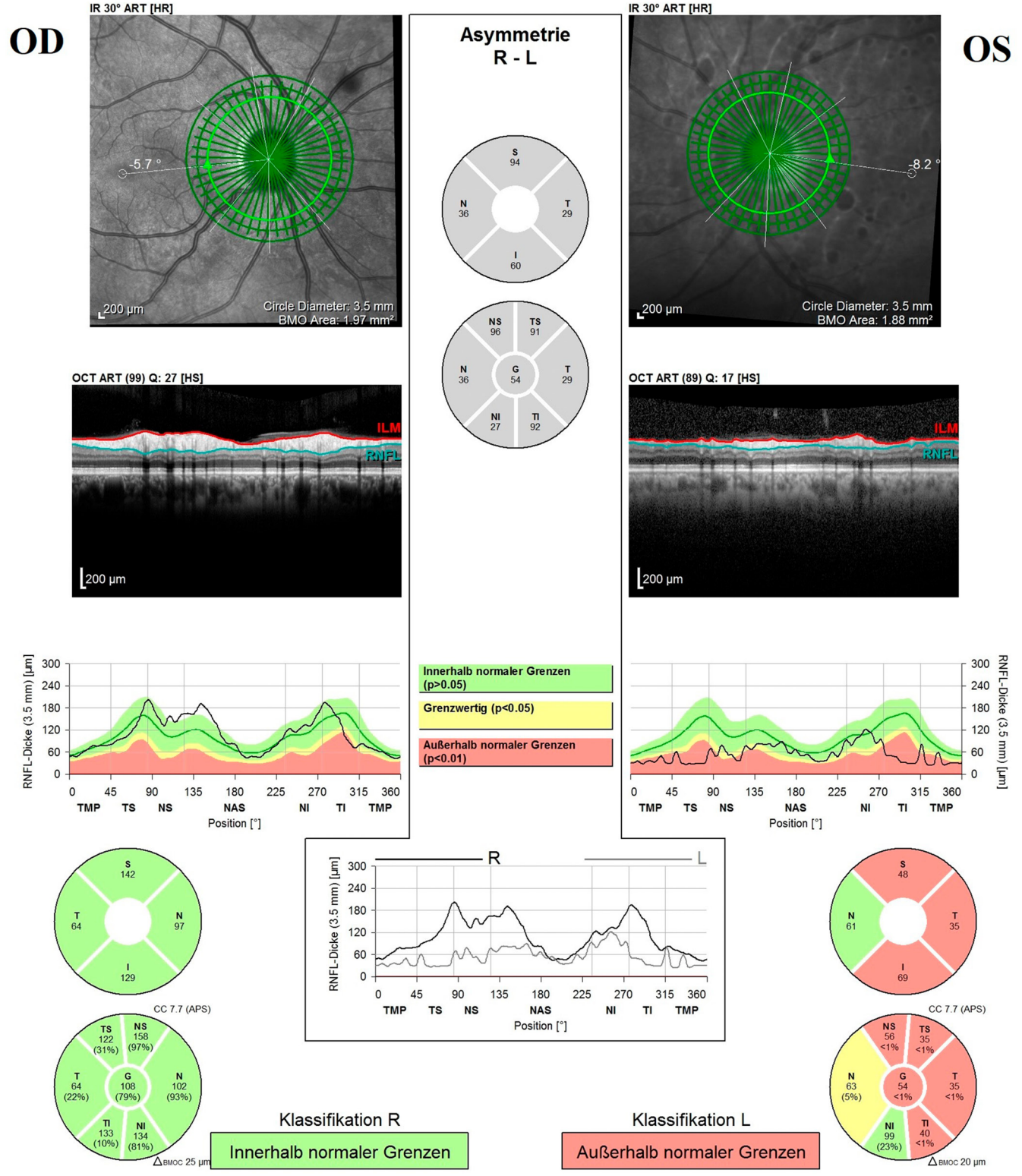

FIGURE 8 Optical coherence tomography for optic nerve head measuring peripapillary retinal nerve fiber layer (pRNFL). The right eye (OD) had pRNFL within normal limits. The left eye (OS) demonstrated advance glaucomatous changes.

body, choroid and episcleral veins.[13] Within the scope of the report, a sclerotomy was performed for only one eye with choroidal effusion. To avoid choroidal effusion in these cases, precautious surgical steps like anterior chamber maintainers, tight sutures for scleral flap in trabeculectomy and surgical technique to prevent rapid drop of IOP intraoperatively could be implemented to gradually lower IOP. Other late complications of trabeculectomy with MMC (like blebitis for Case 3) should be kept in mind.

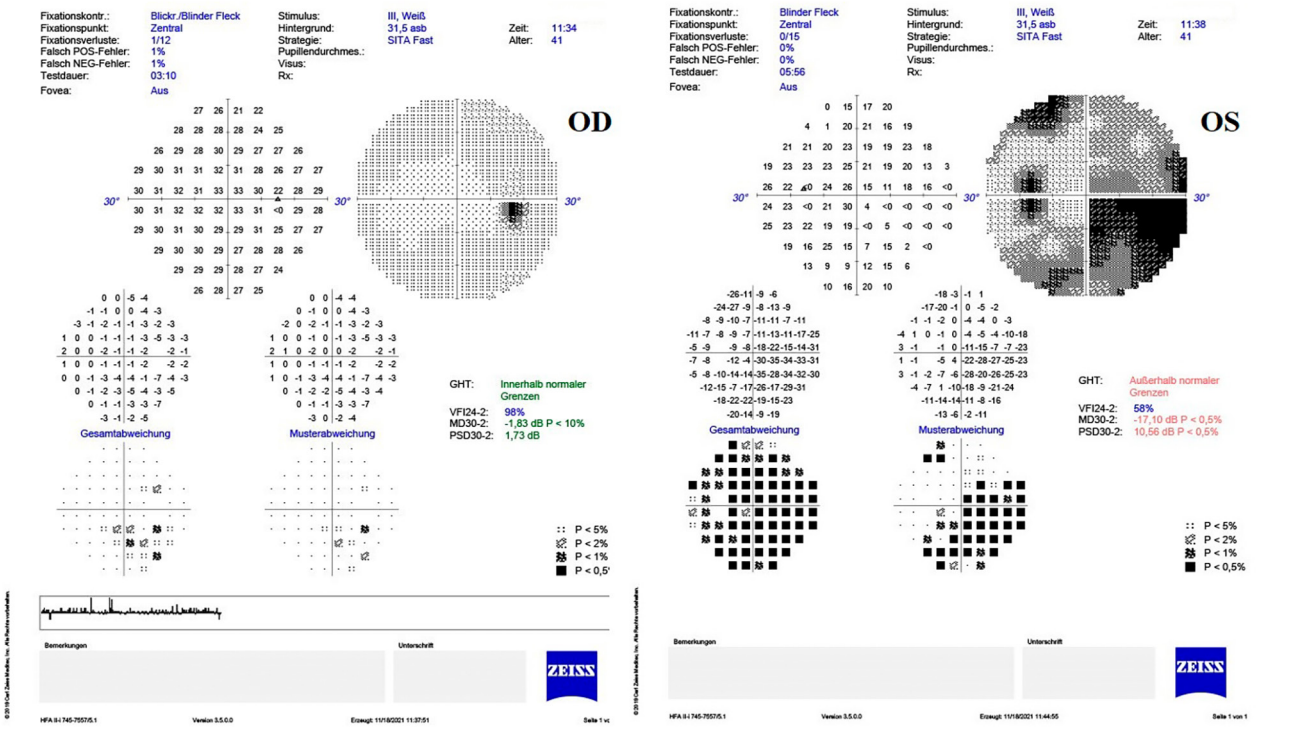

FIGURE 9 Visual fields at the last follow-up for both eyes. The right eye (OD) did not indicate significant changes. The left eye (OS) showed progression (MD −17.10 dB).

After penetrating surgery, the aqueous leaves from the anterior chamber to subconjunctival space. Further, the aqueous could drain in one of the following ways—with lymphatic system of conjunctiva, through normal and atypical aqueous veins, degenerated veins, or directly passing the conjunctiva and joining the tear film.[18–21] The conjunctival lymphatic system has no connection with conjunctival vessels, and it is believed to have the most important role within the aqueous drainage pathway after glaucoma surgery.[22] Several publications have described a reduction in episcleral congestion after surgical decrease of the IOP.[9,23] Authors hypothesized that after trabeculectomy, when the IOP is reduced, the choroidal outflow path mainly involving vortex veins is decompressed and the choriocapillaris flow increases. The blood from the ciliary arteries once again enters the choroidal system. A shift in blood volume and lowering of vascular pressure could explain the reduction in vascular congestion after a surgery.[23,24] The cases implied in the study reflected a refractory vascular tortuosity and congestion even after glaucoma surgeries, which goes in line with the information from other publications.[25] The authors believe that it could be related to already chronical changes in the blood vessels.

The results from Case 1 lead towards an assumption that *ab interno* subconjunctival stent implantation could be an alternative to the gold standard of glaucoma surgery—the trabeculectomy—with good long-term outcomes. As a result, it reflects the possible benefits of a less invasive approach in these challenging cases. The patient selection should be done carefully. The implantation of a gel stent would be a good option instead of performing a trabeculectomy to avoid conjunctival tissue opening, possible damage of episcleral veins and significant bleeding. Considerable studies have shown that a subconjunctival gel implant is not inferior to trabeculectomy in terms of glaucoma control.[26,27] The XEN45-implant drains the aqueous humor directly into the subconjunctival space with controlled pattern and reduces both the IOP and the medication burden.[28] The prospective study demonstrated that a choroidal effusion in primary open-angle glaucoma patients was developed in 1.8%.[29] Regarding the rare nature of Radius-Maumenee syndrome, little is known about choroidal effusion development without hypotonus IOP, as it was reported for the Case 1. According to the authors' knowledge, it is the first case series that described successful long-term outcomes for treatment of IEEVP. However, Case 2 reflected the unsuccessful surgical result of subconjunctival stent implantation after previously failed trabeculectomy; thus, it should be considered as a possible risk factor for a failure.

The development of technologies allows more advanced surgical approaches like the Baerveldt glaucoma implant and the Ahmed glaucoma valve, to be applied and investigated for treating Radius-Maumenee syndrome. The goal of the treatment remains the same as for any type

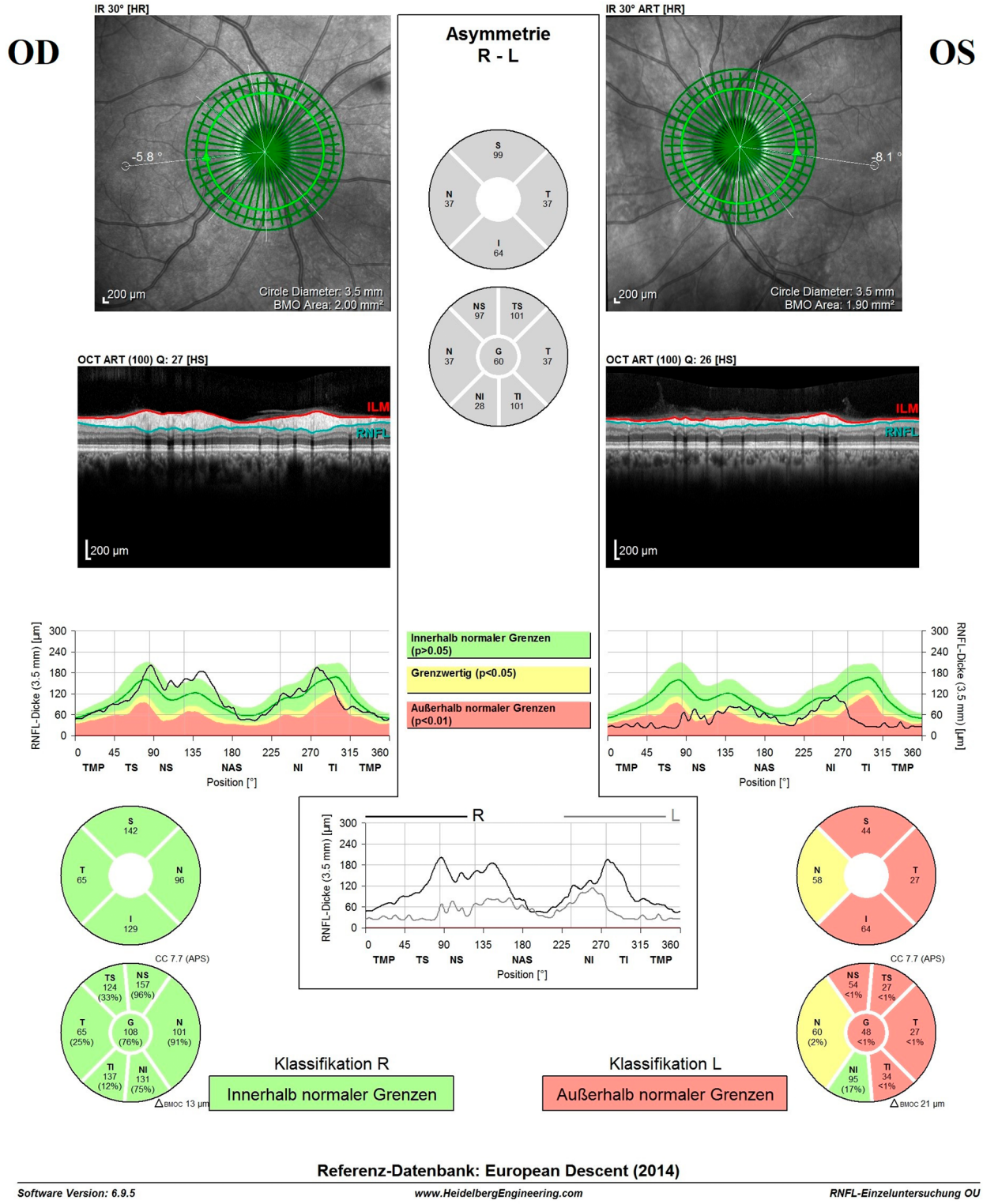

FIGURE 10 Peripapillary retinal nerve fiber layer for both eyes. No significant changes at the last follow-up were observed in the right eye (OD). The left eye (OS) reflected slight changes.

of glaucoma—reduce the IOP and prevent any further damage of optic nerve. Devices for the treatment of refractive glaucoma reflected benefits for those patients who required a significant reduction of IOP and failed the conventional approaches. The tube-versus-trabeculectomy study reported about better 5-years outcome for a glaucoma drainage device than trabeculectomy with MMC for repeated surgical intervention.[30] Similar success rates have been observed with Baerveldt and Ahmed glaucoma drainage devices.[31]

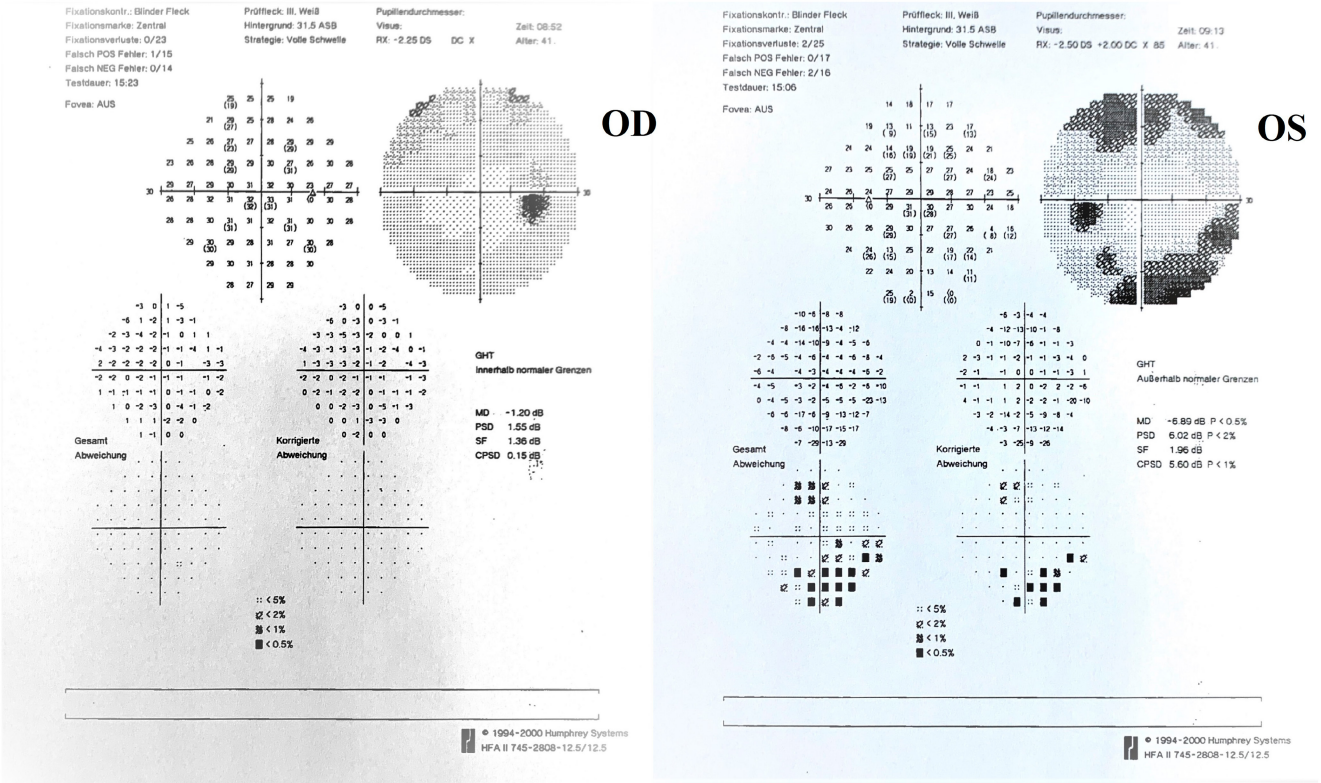

FIGURE 11 Visual field at the last follow-up. The right eye (OD) was without glaucomatous damages. The left eye (OS) reflected the inferior arcuate scotoma (MD −6.89 dB).

Non-penetrating deep sclerectomy with or without canaloplasty[11,24,32] has been suggested by authors as a less invasive procedure to deal with IEEVP and avoid choroidal detachment. In addition, previous studies have addressed a good safety profile for the technique in open-angle glaucoma patients.[33,34] However, a question has raised: Will a non-penetrating surgery provide acceptable long-term control of glaucoma for Radius-Maumenee syndrome? These patients may gain more advantages from a filtrating approach regarding the level of IOP reduction.

One of the patients described had received ALT and SLT to reduce IOP. The authors would like to highlight that there is no evidence that trabeculoplasty could improve the control of the IOP in cases when an increased episcleral venous pressure (EVP) is a reason for elevated IOP. The data gained in this study go in line with other publications regarding the effect of trabeculoplasty.[24,35] One eye of the case series underwent a cyclophotocoagulation procedure resulting in significant reduction of the IOP. It was followed by a choroidal effusion without hypotony. Further surgical interventions were necessary. Quagliano and colleagues described choroidal effusion after diode laser cyclophotocoagulation for a patient with Sturge–Weber syndrome also without hypotony.[36]

Sun et al. have claimed that by the beginning of the year 2020 approximately 55 cases of Radius-Maumenee syndrome were reported in the literature. The syndrome is also called “idiopathic elevated episcleral venous pressure” or “idiopathic dilated episcleral veins.” The youngest patient diagnosed was only 15 years old.[11] Even today, the etiology of Radius-Maumenee syndrome is unknown. Only several hypotheses about its development have been suggested. Some of them are related to a genetic background and vascular abnormalities.[2,25] The treatment of the disease is based on the same guidelines as those for open-angle glaucoma. Most of the cases are unilateral or bilateral with asymmetric manifestation.[11] IOP might even reach 50 mm Hg, and it is refractory to topical glaucomatous treatment.[37] Patients are presented with open angle during gonioscopy; frequently, blood is noticed in the Schlemm's canal.[11,15] A familial case has been described.[1]

Most of the aqueous humor leaves the eye trough the trabecular meshwork leading to the Schlemm's canal, followed by collector channels, aqueous veins. These vessels subsequently merge into episcleral veins. Afterwards, episcleral veins drain into anterior ciliary veins, followed by vortex veins and finally into the superior ophthalmic vein. The inferior ophthalmic vein with possible variations also

connects to the superior ophthalmic vein and they drain into the cavernous sinus, then to superior and inferior petrosal sinuses which deliver the blood to the internal jugular vein. As follows, the blood goes to the right atrium of the heart trough superior vena cava.[38–40] In general, episcleral vascular system incorporates arteries, veins, arteriovenous anastomosis, and a relatively small number of capillaries mostly located in the limbal region.[41–43]

The balance between aqueous humor production and outflow affects the IOP. Increased EVP reduces aqueous humor outflow through the conventional trabecular pathway and predisposes to elevation of IOP. Previously, EVP has been measured invasively for scientific reasons in animal models and non-invasively in humans by applying force to collapse an episcleral vein with venomanometry.[43,44] Unfortunately, there is no clinically accepted device to measure the EVP in the clinic. Normal EVP ranges from 8 to 10 mm Hg.[45,46] There are no data about EVP values in patients with Radius-Maumenee syndrome but the study by Phelps and Armaly[47] has reflected twice-increased EVP in unilateral cases of Sturge–Weber syndrome comparing to the unaffected eye.

Radius-Maumenee syndrome is diagnosed by exclusion. It is characterized by dilated episcleral veins, an elevated IOP and an open angle on gonioscopy with possible variations of blood in Schlemm's canal and without chemosis or proptosis.[11,15] Before the condition is approved, other pathologies affecting episcleral venous system should be investigated.[5] Differential diagnoses include any disease that causes dilated and tortuous episcleral vessels and elevated IOP. Reasons for an increased EVP can be divided into three categories: venous obstruction, arteriovenous malformation, and idiopathic.[48]

Causes of venous obstruction are thyroid eye disease, anterior scleritis, retrobulbar tumors, orbital inflammation, cavernous sinus thrombosis,[49] superior vena cava syndrome,[50] and pulmonary hypertension.[51] To exclude these causes, careful examination for thyroid function and associated eye disease, orbital color Doppler imaging, evaluation of proptosis, chemosis, cranial nerve deficiencies, orbital and the brain imaging (CT, CT venography, magnetic resonance imaging with contrast and magnetic resonance venography/angiography), evaluation for cyanosis of the face and neck as well as dilatation of veins of the head, neck, chest, and upper extremities should be done.[48]

Arteriovenous abnormalities as a cause of an elevated episcleral venous pressure involve arteriovenous fistula (carotid-cavernous fistula, dural arteriovenous shunts), orbital varices, and Sturge–Weber syndrome. Carotid-cavernous fistula is the most common cause of ocular injection and elevated IOP resulting from increased EVP.[5] Evaluation for pulsating exophthalmos, orbital bruit, restricted motility, ocular ischemia, and brain imaging with angiography should be performed. Proptosis that increases with Valsalva maneuver could suggest orbital varices. However, glaucoma in these cases is uncommon.[52]

Postoperative cystoid macular oedema was reported in 3 eyes. None of these patients had diabetes or took prostaglandins before the surgical intervention. Postoperative cystoid macular oedema developed in one case after the implantation of an Ahmed glaucoma valve. According to publications, cystoid macular edema is the third most common late postoperative complication for Ahmed valve.[53] One patient was diagnosed with bilateral pseudophakic cystoid macular oedema after uncomplicated cataract surgery with in-the-bag lens implantation. The previously reported incidence of macular oedema after cataract surgery was between 0.1% and 3.8%.[54–57] At the moment, there are no data and explanation of pathogenesis about postoperative cystoid macular oedema for Radius-Maumenee syndrome after surgical manipulations. The macular oedema significantly affected visual acuity for the patients reported. The first-line treatment of pseudophakic macular oedema includes topical nonsteroidal anti-inflammatory drugs and topical corticosteroids, followed by periocular steroids.[58]

Case 1 was diagnosed with refractory pseudophakic cystoid macular oedema. This patient was not a steroid responder; therefore, an intravitreal dexamethasone implant was injected resulting in good clinical outcomes from the side of retina. Recent studies have reported successful results in terms of intravitreal injections of anti-vascular endothelial growth factors (anti-VEGF), too.[59] However, there is a lack of large- scale long-term studies. Currently, there are no high-quality trials evaluating all treatment modalities for pseudophakic cystoid macular oedema that would provide evidence-based guidelines.[57] The use of intravitreal dexamethasone for glaucoma patients could be debatable. The regression of the visual field in Case 1 could be related to repeated surgical interventions and retinal complications.

The authors of the study reported on 3 cases of bilateral Radius-Maumenee syndrome treated surgically. As described above, various treatment methods can be applied to achieve the target IOP and prevent further damage of the optic nerve. During follow-up period, patients underwent medical treatment, trabeculectomy with MMC, implantation with XEN45, Ahmed glaucoma valve, Baerveldt glaucoma implant, cyclophotocoagulation, ALT, and SLT. The complications reported were choroidal effusion and postoperative cystoid macular oedema.

Despite having applied several surgical interventions, Case 1 and Case 2 reflected progression of glaucoma. In authors' experience, the treatment of Radius-Maumenee syndrome is very challenging even when applying advanced glaucoma surgical devices. The cause of the results

of our study being inferior to those of other case reports could be related to the significantly longer period of follow-up after the treatment. Also, they might be affected by the requirement for repeated surgical interventions which could affect the visual field progression.

4 | CONCLUSIONS

Patients with dilated episcleral vessels and increased IOP should be investigated for all causes that could promote dilatation of episcleral veins and elevation EVP to exclude life threatening neurovascular reasons.

Radius-Maumenee syndrome is a rare entity which possess treatment challenges. According to our cases, topical antiglaucomatous medication frequently was not enough and surgical approach was significant to control IOP and prevent the further optic nerve damage.

Surgical treatment may cause complications, and significant reduction of IOP could promote choroidal effusion without hypotony.

Long-term follow-up is mandatory, and several various surgical procedures for IOP reduction could be necessary to prevent blindness for Radius-Maumenee syndrome.

AUTHOR CONTRIBUTIONS

Veit Steiner: Writing – original draft; writing – review and editing. **Melchior Hohensinn:** Validation; writing – review and editing. **Herbert A. Reitsamer:** Supervision; writing – review and editing. **Markus Lenzhofer:** Conceptualization; supervision; writing – original draft; writing – review and editing. **Eva Elksne:** Data curation; writing – original draft.

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Data are available upon request from the corresponding author.

CONSENT

The authors certify that they have obtained the written informed consent form the patient to publish this report in accordance with the journal's patient consent policy. This report does not contain any personal information that could lead to the identification of the patient.

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