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Wide spectrum of retinal detachments – an insight into pathogenesis, medical examination and treatment

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HIGHLIGHTS

This review highlights advancements in the diagnosis and treatment of retinal detachments, emphasizing the importance of early detection and intervention for preserving vision.

ABSTRACT

Retinal detachment is a serious condition requiring prompt treatment to prevent vision loss. This review covers diagnosis, treatment options, and factors influencing clinical decisions. Despite its rarity, untreated detachment often leads to blindness. Early detection and intervention are crucial. Advances in imaging enhance diagnosis accuracy. Treatment ranges from conservative to surgical interventions like pneumoretinopexy, scleral buckling and vitrectomy. The review emphasizes the importance of timely diagnosis and treatment, highlighting the impact of early intervention on disease progression and vision preservation.

Key words: rhegmatogenous retinal detachment, tractional retinal detachment, serous retinal detachment, therapeutics, diagnostic imaging

INTRODUCTION

Retinal detachment (RD) occurs when the layer of cells that senses light called the neurosensory retina (NSR) becomes separated from the layer beneath it known as the retinal pigment epithelium (RPE) [1]. It has a relatively low occurrence affecting only one in 10,000 individuals per year. RD can be categorized into 3 primary types based on their underlying causes: rhegmatogenous, traction and serous retinal detachment [2]. Recognizing symptoms and understanding the risk factors associated with RD are crucial for early intervention and preserving vision [3]. In our study, we delve into the pathogenesis, risk factors, and differential diagnosis of RD, while also exploring various management strategies tailored to each type of detachment.

TYPES OF RETINAL DETACHMENTS AND PATHOGENETIC MECHANISMS

Rhegmatogenous retinal detachment

Rhegmatogenous retinal detachment (RRD), the most common type of RD, is commonly associated with the existence of a retinal break and tractional forces which leads to the detachment of the retina from the underlying choroid [2]. Even in the presence of a full-thickness break in the retina, a RD will not occur as long as the vitreous remains completely unliquefied and the requisite traction is absent [4]. Pathogenesis of vitreous liquefaction results from age-related changes of the molecular structure of vitreous gel. Hyaluronic acid and collagen fibrils play crucial roles in the composition of the vitreous humour, providing it with its gel-like consistency and contributing to the maintenance of its shape. As individuals age, molecular changes of these components can undergo changes, leading to vitreous liquefaction (vitreous synchysis) [5, 6]. These alterations result in contracture of the vitreous and separation of the posterior vitreous cortex from the surface of the retina [7]. As the vitreous pulls away, it may exert traction on the retina, causing it to tear or detach [9]. This posterior vitreous detachment (PVD) is a common risk factor of RRD [8]. Acute retinal necrosis syndrome, toxoplasmosis, and cytomegalovirus infection represent rare causes of RRD. Additionally, obesity may exacerbate the thickening of retinal layers [10–12]. Although RRD can appear in any location of the retina, inferior-temporal and superior-nasal regions are predisposed to develop detachment [13]. A higher incidence of RRD has been observed in males, with cases also occurring at a younger age compared to females.

Tractional retinal detachment

Tractional retinal detachment (TRD) commonly arises from the development of scar tissue or fibrous bands on the retinal surface, exerting traction and resulting in detachment without retinal breaks [14]. This can occur due to various reasons, including proliferative diabetic retinopathy (PDR), which is the most prevalent cause of TRD, as well as sickle cell retinopathy, proliferative vitreoretinopathy (PVR), trauma, and posterior uveitis [14–16]. TRD is often classified based on its relationship to the macula (the central part of the retina responsible for detailed central vision) [17]. The classification typically includes: TRD recently involving the macula, extramacular TRD and long-standing macular TRD [18].

Serous retinal detachments

Serous retinal detachment (SRD) is associated with the accumulation of fluid in the space between the macula and the underlying RPE [19]. Subretinal retention could arise from various aetiologies such as inflammatory diseases, vascular diseases, haemorrhagic RD, ischemic damage, choroidal tumours or iatrogenic injuries [20, 21]. The excess fluid from the vessels of the retina or the choroid may not accumulate under the retina unless there is destruction of the RPE layer and a decrease in RPE activity [20]. However, when the RPE is no longer capable of directing the leaked fluid into the choroidal circulation, the fluid volume increases, consequently leading to RD [22].

PREDISPOSING CAUSES

Approximately 80–90% of cases of RRD occur concurrently with the emergence of retinal breaks during PVD [23]. RRD can happen independently of PVD in individuals with pre-existing retinal lesions, such as atrophic retinal holes, lattice degeneration, and retinal dialysis, often resulting from previous blunt trauma or idiopathic causes [24]. However, asymptomatic eyes with pre-existing abnormalities and no prior history of fellow-eye RRD have only 0.5% probability of experiencing an RRD over a follow-up period of 11 years [25]. Several primary factors contribute to the heightened risk of RRD, including myopia, male gender, cataract surgery, trauma, a previous history of RRD in the contralateral eye, and hereditary vitreoretinopathy such as Stickler syndrome [26]. The incidence of RRD is notably elevated among myopic patients, accounting for 10% of cases, and this risk escalates with greater degrees of myopia [27]. Individuals with moderate to severe myopia frequently exhibit elongated axial eye length, which increases centripetal vitreoretinal traction, predisposing them to earlier onset of PVD compared to those without myopia. Consequently, individuals with myopia are at an elevated risk of developing RRD even during early adulthood [9]. Moreover, male gender significantly influences the incidence rate of RRD, attributed to the greater eye length in males compared to females [30]. This correlation is also notable in trauma-related RRD, indicating a higher occurrence of trauma in males than in females [30]. There is also a higher incidence

of RRD in individuals who undergo cataract surgery, with approximately 0.5% to 0.6% of RRDs associated with prior surgical removal of the lens [25]. Additionally, rarer causes of RRD include a family history of RD, previous RD in one eye, genetic disorders like Stickler's syndrome, and lattice degeneration of the retina [1].

TRD primarily arises in conditions characterized by proliferative changes in the retina and vitreous [16]. These conditions include PDR, sickle cell retinopathy, retinopathy of prematurity, and PVR [1]. Additionally, TRD is frequently observed after penetrating trauma, where fibrous or fibrovascular tissue contracts within the vitreous cavity or around the retina, leading to TRD [2].

SRD occurs when fluid accumulates beneath the sensory retina and the RPE [31]. A variety of causes, including inflammation, idiopathic factors, infections, surgical interventions, and neoplastic conditions, can lead to the breakdown of the blood-retinal barrier, subsequently resulting in the development of SRD [32]. Table 1 lists the aetiologies contributing to SRD, as well as other types of RDs mentioned above.

TABLE 1

Risk factors for different types of retinal detachment [1, 2, 25–27, 30, 32].

Rhegmatogenous retinal detachment	Tractional retinal detachment	Serous retinal detachment
• Posterior vitreous detachment • Myopia (axial) • Trauma • Aging • Post cataract surgery • Male gender • Congenital eye diseases (glaucoma or cataract) • Cataract surgery • Lattice degeneration of the retina • Family history of retinal detachment • Retinal detachment in one eye • Hereditary vitreoretinopathy (Stickler's syndrome) • Retinopathy of prematurity	• Proliferative diabetic retinopathy • Proliferative vitreoretinopathy • Retinopathy of prematurity • Sickle cell retinopathy • Retinal vein occlusion • penetrating trauma	• Caused by fluid accumulation in the subretinal space. • Inflammatory (Vogt–Koyanagi–Harada syndrome, sarcoidosis, uveitis, scleritis) • Infectious (tuberculosis, dengue, syphilis, cat-scratch disease, *Cytomegalovirus*, retinitis, toxoplasmosis) • Neoplastic (choroidal melanoma, choroidal haemangioma, choroidal metastasis, retinoblastoma) • Vascular (toxemia of pregnancy, HELLP syndrome, Coat's disease, Goodpasture syndrome) • Surgical or postsurgical (panretinal photocoagulation, scleral buckle)

Ophthalmic examination

If symptoms such as blurred vision, flashes of light in the affected eye, and sudden onset of floaters (dark spots or lines that seem to drift through the field of vision), along with risk factors and patient history, suggest the presence of retinal breaks or detachment, further ophthalmic evaluation is necessary [22]. Patients suspected of RD should undergo a dilated fundoscopic examination [3].

Rhegmatogenous retinal detachment

The crucial aspect in diagnosing RRD is to identify any retinal breaks [33]. The best method of diagnosing RD is through binocular indirect ophthalmoscopy (BIO) of the fundus [34]. During a fundus examination for RRD, the ophthalmologist typically can find wavy movement of the retina and locate retinal tears causing the detachment [35]. When examining a detached retina through ophthalmoscopy, it appears as an opaque, raised, and rippled structure with a convex shape that moves fluidly with the eye's motions [13]. This presentation commonly coincides with the observation of vitreous syneresis, accompanied by the presence of PVD and traction exerted on the retinal tears [26]. Assessment of RRD should include extent of detachment, location of each break and determine the position of the detachment relative to the macula [36]. Most retinal tears associated with RD are predominantly found in the temporal periphery, with 60% located in the superior temporal quadrant, 15% in both the inferior temporal and superior nasal quadrants, and only 10% in the inferior nasal quadrant [13].

Tractional retinal detachment

A thorough binocular dilated examination is essential in the comprehensive assessment of a patient with TRD [37]. During a fundus examination for TRD, it is relevant to focus on the integrity of the posterior vitreous and its connections to the optic nerve and vascular arcades, as these are the primary sites from which RDs originate [38]. Careful examination of the retinal vessels can reveal subtle detachments or areas of impaired blood flow [37]. Notably, TRD can be confirmed by the presence of concave borders and elevated, immobile retina [39].

Serous retinal detachments

The primary method for identifying SRD relies on clinical diagnosis, which involves assessing a smooth retinal surface and fluid mobility influenced by patient positioning. However, further laboratory, radiographic, and ancillary tests are necessary to ascertain its specific aetiology [40]. The diagnostic approach for this condition should be personalized to each individual and may involve various tests including: complete blood cell count (CBC), differential leukocyte count, erythrocyte sedimentation rate (ESR), Mantoux test for tuberculosis, VDRL test (venereal disease research laboratory) and *Toxoplasma*, *Rubella*, *Cytomegalovirus*, *Herpes* (TORCH) markers for congenital infections [41].

EXAMINATION – DIAGNOSTIC IMAGING

The preoperative assessments comprising intravenous fluorescein angiography (IVFA), spectral-domain optical coherence tomography (OCT) and B-scan can also provide valuable insights [37].

If available, B-scan ultrasonography (OCT) can be an effective way to assess all 3 primary types of RDs, especially in situations where direct visualization of the retina is challenging due to factors such as an intraocular haemorrhage or cataracts [42]. In cases of RD, the detached retina appears as a distinct hyperechoic line anterior to the choroid layer, with a hypoechoic band of vitreous humour separating it from the underlying choroid [43]. On a B-scan, the detached retina can show an "X" shape if tented by a narrow vitreoretinal adhesion or an "H" shape if tented by broad adhesions [44]. Additionally, B-scan ultrasonography is valuable for surgical planning as it provides visualization of the detachment's topography .

IVFA is beneficial for identifying choroidal neovascularization, arteriovenous anastomoses, and for detecting the peripheral ischemic zone to strategize further appropriate management approaches [39].

OCT offers additional insight into the morphology of the macula [45]. In cases of macula-off RDs, the visual outlook is less dependent on immediate surgery, while timely surgical intervention is critical for macula-on detachments [46]. Additionally, OCT can assist in distinguishing between TRD and tractional retinoschisis [47].

In addition, optical coherence tomography angiography (OCTA) represents a ground-breaking and non-invasive 3-dimensional (3D) imaging technique capable of visualizing blood flow images with unparalleled resolution across all vascular layers of the retina [48]. Unlike fluorescein angiography (FA), and indocyanine green angiography (ICGA), OCTA produces clear images of the microvasculature without being affected by dye leakage, ensuring high contrast and detailed visualization. OCTA enables the examination of images from different perspectives, aiding in the precise localization of vascular pathology within the retina [49]. Moreover, wide-angle OCTA, an advanced imaging technique, provides clinicians with a broader field of view of the retinal and choroidal vasculature compared to conventional systems, facilitating earlier detection and more effective treatment planning. This is crucial, as asymptomatic retinal pathologies, such as RDs, often lie beyond a patient's apparent visual field [50]. To summarize, diagnostic features of different types of RDs are presented in table 2.

TABLE 2

Diagnostic features of different types of retinal detachment [13, 39, 40, 44].

Types	Rhegmatogenous retinal detachment	Tractional retinal detachment	Serous retinal detachment
Retinal examination	• Undulating bullae or folds • Clear subretinal fluid • Undulating bullae	• Concave borders, taut, elevated retina • Clear subretinal fluid	• Smoothly elevated bullae • Clear/turbid subretinal fluid • Bullae that moves according to gravity
Ultrasound findings	The detached retina may be tented by a narrow vitreoretinal adhesion, resulting in an "X" shape, or by broad adhesions, leading to an "H" shape, with enhanced reflectivity	The detached retina may be tented by a narrow vitreoretinal adhesion, resulting in an "X" shape, or by broad adhesions, leading to an "H" shape, with enhanced reflectivity	Retina represent as a dome shaped hyperechogenic elevation

TREATMENT

Rhegmatogenous retinal detachment

The management options for RRD currently include 3 main approaches:

- pneumoretinopexy (PnR)
- scleral buckling (SB)
- pars plana vitrectomy (PPV) [33].

In young phakic patients SB should be considered as the first treatment choice [51]. SB leads to improved final best-corrected visual acuity (BCVA), particularly in patients with natural lenses [52]. SB procedures successfully restore attachment in more than 90% of instances [53]. Intraoperative complications, such as scleral perforation, subretinal hemorrhage, and choroidal detachment, have been reported to occur in approximately 5% of SB procedures [54]. While the development of cataracts as a result of the procedure is rare, it has been documented in up to 46% of cases during a one-year follow-up period [55].

In pseudophakic eyes, PPV was associated with superior anatomical outcomes and is considered the first choice for treating primary pseudophakic RRD [55]. Moreover, PPV is a preferable choice for elderly patients with retinal tears occurring in various areas of the eye [51]. The primary reapplication rates typically range from 75% to 100%, ultimately resulting in a final rate of 96% to 100% [56]. Treating pseudophakic RDs with PPV may involve drawbacks like the requirement for postoperative positioning, restrictions on air travel, and the risk of endophthalmitis [57].

PnR represents a viable option for phakic patients with retinal breaks located superiorly, particularly within one clock hour above the 8- and 4-o'clock meridians, assuming clear vitreous and the patient's ability to adhere to the necessary

prone positioning [51]. However, following the surgical procedure, a notable complication that may arise is an elevated incidence of vitreoretinal proliferation (VRP), with rates potentially reaching as high as 24% [58].

Recently, there has been a noticeable trend towards using smaller gauge vitrectomy systems, including 23, 25, and 27 gauge variants, driven by their benefits such as decreased operating time, minimized postoperative inflammation, reduced conjunctival trauma, and consequently, expedited recovery time [59]. The utilization of smaller vitrectomy probes, notably the 27-gauge and 25-gauge variants, enables precise segmentation and extraction of the pre-retinal membranes, ensuring minimal disruption to the integrity of the underlying retina [60]. In the management of RRD with PPV, intraocular gases like sulphur hexafluoride (SF_6) or perfluoropropane (C_3F_8) play a vital role. They enable the closure of retinal breaks until a permanent choroidoretinal adhesion, induced by retinopexy, is established [32]. Recent findings revealed similar primary surgical success rates, approximately 91%, for both long-acting gas tamponades (C_3F_8) and short-acting gas tamponade (SF_6) [61]. SF_6, with its ability to enhance patient comfort by facilitating faster postoperative visual recovery and mitigating gas-related complications, such as intraocular pressure elevation, emerges as a pragmatic alternative to long-acting gas tamponades for managing RRD [61]. Silicone oil (SO) stands out as an alternative to these gases, providing a long-term, non-expansile tamponade, which may be preferred in situations where patients are unlikely to comply with postoperative positioning, such as children or individuals with cognitive impairments, as well as in cases where monocular patients desire faster visual rehabilitation [33]. The substitution of long-acting gas tamponades with SO may expedite the visual recovery process, mitigate the risk of hypotony, and reduce the likelihood of recurrent bleeding or rubeosis [62].

Laser demarcation is suitable for patients with subclinical RRD where the subretinal fluid (SRF) extends less than 2 disc diameters posterior to the equator and there are no visual field defects [51]. Laser demarcation typically achieves success rates between 81% and 100% in managing retinal conditions [63]. However, patients with multiple upper quadrant breaks, larger tears, and extensive subretinal fluid may face increased risks with this treatment approach [64].

Tractional retinal detachment

The involvement of the macula in TRD is the most crucial factor in determining the appropriate course of treatment [66]. Immediate surgical intervention is recommended for TRD involving the macula [18]. Extramacular TRDs can either be monitored or managed with panretinal photocoagulation (PRP), which may yield more favourable outcomes compared to surgical intervention [66]. Peripheral TRDs are typically not surgically treated due to their minimal impact on vision and infrequent progression to macula-involving TRD, with rates ranging from 14% to 15% at 1 year .

Indications for surgery in extramacular TRD involve instances where fibrovascular proliferation results in macular traction, along with situations where conventional office-based treatments prove ineffective in managing or halting the progression of the disease [67–69]. Individuals experiencing macula-on RDs generally exhibit favourable initial visual acuity and a more optimistic prognosis following successful surgery [13]. Poor visual acuity after successful repair can be attributed to factors such as the development of macular epiretinal membranes and the degeneration of foveal photoreceptors in cases of macula-off RDs [25].

Furthermore, the recent clinical trials provided evidence that administering anti-VEGF (e.g. bevacizumab, ranibizumab, aflibercept) injections prior to vitrectomy associated with surgical treatment of TRD, demonstrates remarkable therapeutic benefits, leading to enhanced surgical efficacy and superior vision outcomes [70]. The use of anti-VEGF injections contributes to a reduction in intraoperative bleeding and the need for endodiathermy, as well as a decrease in the average duration of the surgical procedure. Additionally, they expedite the reabsorption time of blood following vitrectomy, lower the incidence of recurrent vitreous haemorrhage, and enhance BCVA. Bevacizumab appears to have an advantage with its longer duration of action and lower dosage requirement, potentially lowering the risk of adverse effects compared to ranibizumab. Moreover, it may be a more cost-effective option for patients due to its lower price. However, in eyes affected by severe PDR with fibrovascular proliferation, bevacizumab has the potential to trigger the development of TRD [37, 70]. Efficacy of the pre-operative anti-VEGF therapy are listed in table 3.

TABLE 3

Efficacy of the pre-operative anti-VEGF therapy [37, 70].

Intraoperative
• Regresses neovascularization reduce intraoperative bleeding
• Reduce intraoperative iatrogenic retinal breaks
• Shorter surgical time (reduce vitrectomy time by approximately 26 min)
• Decrease rate of endotamponade with silicone oil
Postoperative
• Decreases rates of an early postoperative vitreous haemorrhage
• Decreases rates of incidence of recurrent vitreous haemorrhage
• Reduce vitreous haemorrhage clear-up time
• Decrease recurrent tractional retinal detachment
• Better visual outcomes at 1 month and at 6 months postoperatively

Serous retinal detachments

In contrast to RRD and tractional detachments, which typically require surgical intervention, SRD is usually managed

through conservative treatment with pharmacotherapy [71]. Management primarily targets the underlying pathology responsible for fluid accumulation in the eye [40].

In case of SRD originating from non-infectious uveitis, such as Vogt–Koyanagi–Harada syndrome, the conventional therapeutic approach typically involves initiating treatment with intravenous methylprednisolone pulse therapy at a dosage of 1 g/24 h for 3–5 days, followed by a transition to oral steroid administration [72]. In addition to corticosteroids, immunosuppressive medications like cyclosporine A, azathioprine and methotrexate have demonstrated efficacy in the successful management of Vogt–Koyanagi–Harada syndrome [73].

Treatment of choroidal tumours with SRD may involve options such as proton beam radiation or brachytherapy using a plaque. Surgical intervention, if necessary, may include PPV and draining subretinal fluid with the use of endotamponade.

Serous detachments resulting from pan-retinal photocoagulation or SB may improve with the application of topical and systemic anti-inflammatory medications or steroid therapy [74].

In case of subretinal fluid exudation, intravitreal bevacizumab can be crucial due to its anti-angiogenic and anti-permeability properties [73].

Surgical intervention should be considered as a last resort for SRD, only after exhausting all available medical treatments [30]. External drainage is typically the primary method used to reattach the retina [75]. However, vitrectomy may be an option if drainage proves ineffective or if long-standing exudative retinal detachment has advanced, leading to significant subretinal fibrin formation [76].

If necessary, vitreoretinal surgery can be contemplated earlier in the management of treatment-resistant SRD to reduce fibrosis and subretinal scarring, potentially leading to improved visual results [76].

CONCLUSIONS

RD represents a significant risk to visual integrity, requiring prompt surgical intervention. Its definitive diagnosis is optimally achieved through retinal examination employing the sophisticated technique of indirect ophthalmoscopy. Each type of RD requires a unique, individualized approach. The management of RRD is intimately related to individualization and typically involves one of three approaches: SB, vitrectomy, or PnR. Performing a vitrectomy for TRD along with supplementary pharmacotherapy has the potential to enhance the quality of life related to vision. Unlike RRD and TRD conservative treatment with pharmacotherapy is first-line treatment for presumed SRD. In this case, surgical intervention should be considered for cases that have demonstrated resistance to other forms of treatment.

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