Review Article

Pregnancy-related retinal disorders: clinical features, systemic associations, and management insights

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ABSTRACT

Background: Pregnancy induces profound hormonal, hemodynamic, and metabolic changes that can trigger or exacerbate retinal disorders, some of which may signal systemic complications. This narrative review summarizes current knowledge on retinal diseases specifically induced or worsened during pregnancy.

Methods: A targeted narrative literature search was conducted in PubMed/MEDLINE, Embase, Web of Science, and Google Scholar through 30 September 2025, supplemented by manual screening of reference lists of selected records. Search terms included "pregnancy," "preeclampsia," "eclampsia," "HELLP syndrome," "hemolysis, elevated liver enzyme levels, and low platelets syndrome," "retinal disease," "retinopathy," "hypertensive retinopathy," "serous retinal detachment," "central serous chorioretinopathy," "diabetic retinopathy," "Valsalva retinopathy," "retinal vein occlusion," "retinal artery occlusion," "idiopathic intracranial hypertension," and "artificial intelligence." Selected articles included case reports, case series, observational studies, reviews, and meta-analyses describing retinal conditions specifically induced or worsened during pregnancy. Data were synthesized narratively.

Results: Pregnancy can precipitate sight-threatening retinal pathology or accelerate pre-existing disease. Hypertensive retinopathy associated with preeclampsia and eclampsia is among the most clinically significant conditions, presenting with arteriolar narrowing, retinal hemorrhages, cotton-wool spots, and, in severe cases, serous retinal detachment. Metabolic adaptations, particularly in women with pregestational diabetes, may accelerate the progression of diabetic retinopathy, with some patients advancing from nonproliferative to proliferative stages over short intervals. Pregnancy has also been implicated in serous retinal detachment, central serous chorioretinopathy, Valsalva retinopathy, retinal vascular occlusions, and, less commonly, papilledema secondary to idiopathic intracranial hypertension. These disorders range from transient, self-limited entities to sight-threatening events and often reflect systemic pathology, including preeclampsia, eclampsia, or hypercoagulable states. Optical coherence tomography, optical coherence tomography angiography, and fundus photography provide safe, noninvasive diagnostic and monitoring modalities. Artificial intelligence (AI)-based retinal imaging has demonstrated promising performance in detecting diabetic and hypertensive retinopathy in general populations, although pregnancy-specific clinical validation remains limited. Management emphasizes stabilization of maternal systemic disease, optimization of glycemic and blood pressure control, and multidisciplinary care. Several pregnancy-associated conditions, particularly hypertensive retinal changes, serous retinal detachment, and central serous chorioretinopathy, improve postpartum, but retinal vascular occlusion, advanced diabetic retinopathy, or optic nerve injury may cause persistent visual impairment, making prompt recognition essential.

Conclusions: Pregnancy can precipitate or exacerbate a range of retinal disorders, reflecting the complex vascular, hormonal, and metabolic changes of gestation. Noninvasive imaging, interdisciplinary collaboration, and vigilant monitoring are essential to optimizing maternal and fetal outcomes. Awareness and early detection of pregnancy-associated retinal disorders, together with emerging AI-based tools, may further improve outcomes. Longitudinal studies are needed to establish evidence-based screening and management protocols.

KEYWORDS

pregnancies, gestation, preeclampsia, eclampsias, HELLP syndrome, retina, hypertensive retinopathies, diabetic retinopathies, central serous chorioretinopathies, retinal vein occlusions, retinal artery occlusions, idiopathic intracranial hypertension, computer vision system, machine intelligence

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INTRODUCTION

Pregnancy represents a unique physiological state characterized by profound systemic adaptations that support fetal development and prepare the maternal body for childbirth [1]. These changes encompass significant hemodynamic alterations, endocrine fluctuations, metabolic modifications, and immunologic adaptations. Although generally advantageous or clinically insignificant, such changes can unmask preexisting disorders, aggravate underlying conditions, or initiate new pathologies, including those involving the ocular system; this in turn affects visual health in both the mother and the neonate [2, 3]. The retina, with its high metabolic demand, intricate microvascular architecture, and sensitivity to vascular and inflammatory insults, is particularly susceptible to such pregnancy-related changes [4].

Ocular alterations during pregnancy are often transient and physiological such as a reduction in intraocular pressure or changes in corneal sensitivity. However, in certain circumstances pregnancy can trigger sight-threatening retinal pathology or accelerate pre-existing disease [5]. Among the most clinically significant entities are hypertensive retinopathy associated with preeclampsia and eclampsia, which may present with arteriolar narrowing, retinal hemorrhages, cotton-wool spots, and, in severe cases, serous retinal detachment (SRD) [6]. Metabolic adaptations, particularly in women with pregestational diabetes, may lead to rapid progression of diabetic retinopathy (DR), sometimes advancing from nonproliferative to proliferative stages within a few months [7]. Pregnancy has also been implicated in the development of central serous chorioretinopathy (CSCR), retinal vascular occlusions, and less common inflammatory or autoimmune-mediated retinal disorders [8].

The pathophysiological mechanisms underlying these conditions are multifactorial. Hemodynamic expansion can increase retinal perfusion pressure, hormonal changes may alter vascular permeability and choroidal circulation, and pregnancy-induced immune modulation can influence the activity of inflammatory retinal diseases. Additionally, the hypercoagulable state inherent to pregnancy predisposes affected individuals to retinal vein or artery occlusions (RVO or RAO) [9].

Management of retinal disease during pregnancy requires a careful balance between preserving maternal visual function and ensuring fetal safety. Diagnostic imaging modalities and pharmacologic interventions may be restricted due to potential teratogenic or fetotoxic risks, limiting therapeutic options. Consequently, optimal care often necessitates close, multidisciplinary collaboration between ophthalmologists, obstetricians, and other relevant specialists [10].

Despite the clinical importance of this topic, the existing literature remains fragmented, largely comprising isolated case reports, small case series, and disease-specific reviews. A comprehensive synthesis is therefore warranted. This review consolidates current evidence on retinal diseases induced or exacerbated by pregnancy, examining their epidemiology, pathophysiology, clinical manifestations, diagnostic considerations, and management strategies. By integrating ophthalmological and obstetric perspectives, it aims to provide a practical, evidence-based resource to guide clinical decision-making and improve maternal and fetal outcomes.

METHODS

A targeted narrative literature search was conducted to identify studies reporting retinal diseases induced or aggravated by pregnancy from database inception through 30 September 2025. The databases PubMed/MEDLINE, Embase, Web of Science, and Google Scholar were searched. Additional relevant studies were identified through manual screening of the reference lists of selected articles.

Search terms included combinations of keywords and Medical Subject Headings (MeSH) related to pregnancy and retinal pathology, including “pregnancy,” “preeclampsia,” “eclampsia,” “HELLP syndrome,” “hemolysis, elevated liver enzyme levels, and low platelets syndrome,” “retinal disease,” “retinopathy,” “hypertensive retinopathy,” “serous retinal detachment,” “central serous chorioretinopathy,” “diabetic retinopathy,” “Valsalva retinopathy,” “retinal vein occlusion,” “retinal artery occlusion,” “idiopathic intracranial hypertension,” and “artificial intelligence.” Selected articles comprised case reports, case series, observational studies, reviews, and meta-analyses describing retinal conditions specifically induced by or worsened during pregnancy. Articles were selected according to their relevance to the clinical features, diagnosis, systemic associations, or management of pregnancy-associated retinal disorders; no formal systematic-review protocol or risk-of-bias assessment was undertaken. Data from selected studies were synthesized narratively.

RESULTS and DISCUSSION

Retinal Diseases Induced or Aggravated by Pregnancy

Hypertensive Retinopathy

Hypertensive retinopathy is a common and clinically important ocular manifestation of hypertensive disorders during pregnancy, including preeclampsia, eclampsia, and hemolysis, elevated liver enzymes, and low platelets (HELLP) syndrome [11–13]. These conditions are associated with widespread endothelial damage and vascular constriction, and ocular changes often serve as early indicators of disease severity [11]. Visual complaints such as blurred vision, photopsias, scotomas, and diplopia are frequent and may result from either retinal abnormalities or disruptions in the cortical visual pathways [14].

In hypertension, retinal findings have historically been described in three categories [15, 16]. The spastic category involves transient constriction of retinal arterioles, which may cause reversible vision loss such as amaurosis fugax. The sclerotic category reflects hypertensive changes superimposed on existing vascular sclerosis, leading to signs like vascular narrowing, arteriovenous crossing changes (Gunn’s and Salus’s signs), and alterations in light reflex, such as copper- or silver-wiring of the

vessels. The retinopathy category includes the appearance of cotton-wool spots, microaneurysms, hemorrhages (flame-shaped or blot), hard exudates, and swelling of the optic disc, reflecting underlying ischemia and vascular leakage [15, 17].

In preeclampsia, these retinal findings may occur de novo or worsen pre-existing ocular conditions. Research indicates that 40%–100% of individuals with preeclampsia develop retinal vascular changes, including arteriolar narrowing, tortuosity, vasospasm, and vascular occlusion [18]. The extent of these changes is closely linked to diastolic blood pressure levels, making them useful as noninvasive markers of disease severity. Advanced imaging techniques, such as fundus photography, optical coherence tomography (OCT), and OCT angiography have identified complications like SRD, subretinal drusenoid deposits, and choroidal vascular changes, all of which are also observed in malignant hypertension [19–21].

Both retina and choroid are implicated in the disease process. The choroid, which has the highest blood flow per unit area in the body and is sensitive to vascular endothelial growth factor (VEGF), is particularly vulnerable to sudden spikes in blood pressure. Choroidal ischemia may result in dysfunction of the retinal pigment epithelium (RPE), leading to retinal damage and potential long-term visual impairment. OCT studies show increased choroidal thickness in patients with preeclampsia, usually subsiding after childbirth [6, 22–24].

Neurological visual disturbances can also accompany these ocular findings. Posterior reversible encephalopathy syndrome, a condition involving vasogenic edema mainly in the occipital lobes, affects up to one-third of patients with preeclampsia with neurological symptoms and may lead to temporary or lasting vision loss. Other complications such as cortical blindness, visual field loss, and sixth cranial nerve palsy leading to diplopia have also been described [25–27].

Hypertensive retinopathy is not only a key ocular finding in hypertensive pregnancy disorders but also a valuable prognostic tool. Its recognition should prompt vigilant monitoring and may necessitate timely delivery. Routine eye examinations are crucial for detecting and managing ocular and neurologic complications to optimize outcomes for both mother and fetus [28].

Serous Retinal Detachment

SRD is an uncommon but serious ocular complication occurring in hypertensive disorders of pregnancy, particularly in cases of severe preeclampsia, eclampsia, and HELLP syndrome [29, 30]. It affects approximately 0.1%–2% of individuals with severe preeclampsia and up to 0.9% of those with HELLP syndrome, with a higher incidence reported in primiparous women, typically during the third trimester or shortly after delivery [31, 32].

SRD presents clinically with visual symptoms such as scotomas, blurred vision, visual obscurations, and occasionally cortical blindness [33]. Fundoscopic findings in these cases may include retinal edema and detachment, typically bilateral and bullous in configuration [33]. In contrast to CSCR or Vogt-Koyanagi-Harada disease, SRD in preeclampsia lacks intraocular inflammation and often involves the macula bilaterally [32].

The underlying pathophysiology of SRD is multifactorial. A central mechanism is choroidal ischemia, thought to result from intense arteriolar vasospasm. The RPE, which relies on choroidal circulation, becomes dysfunctional under ischemic conditions. This impairs the ability of RPE to maintain the outer blood-retinal barrier, leading to fluid leakage into the subretinal space and resultant detachment. In HELLP syndrome the situation may be exacerbated by microthrombi formation and hypoalbuminemia, which increase vascular permeability and reduce oncotic pressure, further promoting fluid accumulation [31, 33].

OCT is the preferred imaging modality in pregnant women as it is noninvasive and safe throughout gestation. OCT provides detailed visualization of retinal layers and can confirm SRD, reveal RPE irregularities, and measure choroidal thickness, which has been found to be significantly increased in patients with SRD. Fluorescein angiography (FA), while informative, is generally avoided or deferred during pregnancy when noninvasive imaging is adequate because fluorescein crosses the placenta and fetal safety data are limited [31, 32].

Management of SRD in the context of preeclampsia is generally conservative, focused on stabilizing blood pressure and determining the timing and mode of delivery according to obstetric indications. Most cases resolve spontaneously postpartum, with minimal anatomical or functional sequelae. Persistent visual loss due to cortical damage or retinal vascular occlusion is rare [31, 32].

Central Serous Chorioretinopathy

CSCR is an uncommon retinal disorder in pregnancy characterized by the accumulation of fluid beneath the central retina [34]. It results from a dysfunction in the outer blood-retinal barrier, specifically at the level of the RPE, leading to detachment of the neurosensory retina. Though CSCR is more frequently observed in men between ages 20 and 50, it may occur in pregnant women, typically during the third trimester [34].

CSCR in pregnancy is believed to be triggered by hormonal fluctuations, particularly elevated levels of endogenous corticosteroids like cortisol, and increased emotional or physiological stress [35]. These factors can contribute to changes in choroidal circulation, leading to capillary congestion and increased choroidal vascular permeability. The disruption of the RPE barrier allows fluid from the choroid to accumulate in the subretinal space, causing localized retinal elevation [35].

Clinically, CSCR presents with unilateral visual symptoms such as decreased central vision and metamorphopsia [35]. On fundus examination a well-defined elevation of the macula may be visible, sometimes associated with subretinal fibrin or subtle exudates. Unlike other causes of SRD in pregnancy, such as those linked to preeclampsia, CSCR typically occurs in normotensive women without systemic findings like proteinuria or edema [32].

OCT and OCT angiography are the preferred imaging modalities during pregnancy due to their safety and high resolution. They can confirm the presence of subretinal fluid and pigment epithelial detachment [36]. While FA is useful in CSCR diagnosis, it is generally avoided or deferred during pregnancy when noninvasive imaging is adequate because fetal safety data are limited [10].

Most cases of pregnancy-associated CSCR resolve spontaneously within weeks after delivery [37]. Visual acuity generally returns to normal, although some patients may have residual RPE changes or mild visual disturbances [37, 38]. In rare cases, especially when subretinal fluid persists beyond several months or in the presence of recurrence, treatment may be considered [34, 35, 37]. Options include focal laser therapy or photodynamic therapy, though these are typically postponed until after delivery [37, 39]. Recurrence in subsequent pregnancies has been documented, and some individuals may experience multiple episodes [37, 40].

Worsening of Diabetic Retinopathy

DR, a frequent microvascular fallout of longstanding diabetes, tends to worsen during pregnancy, largely as a result of various intersecting hormonal shifts, metabolic fluctuations, and circulatory adjustments that destabilize retinal vasculature [7, 41, 42]. Among pregnant women with pre-existing type 1 or type 2 diabetes, approximately 15% of those without DR at baseline may develop DR during pregnancy, while the risk of progression to proliferative stages increases with the severity of pre-existing NPDR. Progression directly to advanced DR is uncommon in women who have no DR at baseline [41, 43–45]. This deterioration is driven largely by elevations in placental growth hormone and VEGF levels, a rise in insulin resistance, and the overall increase in maternal blood volume, all of which act together to promote abnormal new vessel formation and fluid leakage in the retina [7, 42, 46, 47]. DR is the leading cause of blindness in reproductive-age women, and pregnancy itself is a recognized risk factor for its progression [45, 48]. Despite the long-term benefits of improved glycemic control, rapid improvement in blood glucose early in pregnancy can be associated with transient worsening of DR, although the underlying mechanisms remain incompletely understood [49, 50]. Increased retinal permeability leads to hemorrhages, exudates, and diabetic macular edema (DME), a major cause of vision loss. In DME, fluid leaks into the macula, causing thickening and visual distortion [51].

In terms of symptoms, DR often remains asymptomatic until it has significantly progressed, at which point patients might report blurred vision, new floaters, or loss of central vision, especially when DME develops [50, 52, 53].

Fundus examination can reveal a range of retinal abnormalities, including microaneurysms, cotton-wool spots, and scattered intraretinal hemorrhages, which are characteristic of mild or moderate NPDR [54]. When neovascularization is present, it reflects a shift toward the proliferative phase [55].

OCT remains a key imaging modality for assessing retinal architecture, particularly for detecting macular thickening, and is widely regarded as the standard approach for confirming DME [43, 56]. Although FA can provide valuable insight into the retinal vasculature, its use during pregnancy is generally limited to cases in which the expected diagnostic benefit outweighs the potential fetal risk [7]. Noninvasive imaging approaches such as color fundus photography, together with deep learning convolutional neural network (CNN)-based systems, have shown promise in early detection and grading of DR, which may be useful in pregnancy care. These artificial intelligence (AI) platforms have not yet been specifically validated for use in pregnant populations though [7, 57].

Current treatment options for DR include systemic risk-factor control, laser photocoagulation, and, when clinically necessary after individualized maternal–fetal risk assessment, intravitreal therapy [50, 59–67]. The primary aim of treatment is to maintain optimal glycemic and blood pressure control, both of which play central roles in slowing or preventing the progression of DR [59]. Laser photocoagulation is considered safe and remains the first-line treatment for proliferative DR during pregnancy; it can regress neovascular vessels and prevent vision-threatening hemorrhages [50, 60–63]. Anti-VEGF agents are typically avoided owing to insufficient safety data in this population. However, in cases where vision is clearly threatened, ranibizumab, which has a shorter systemic half-life, may be considered with caution, typically later in gestation [7, 64, 65]. For the treatment of DME, focal or grid laser therapy is generally favored, particularly in cases where the fovea remains uninvolved. Intravitreal injections, on the other hand, are typically reserved for cases in which the edema is more advanced or unresponsive to initial treatment [66, 67].

The prognosis is largely determined by the severity of retinopathy at baseline, the degree of glycemic control during pregnancy, and adherence to follow-up care [60, 68]. DR may partially regress postpartum; however, the risk of progression in subsequent pregnancies is influenced by baseline retinopathy severity and systemic risk factors. Individuals with advanced DR at the time of pregnancy are at greater risk of persistent visual impairment [48].

A thorough ophthalmologic assessment should be performed before pregnancy or during the first trimester in patients with pre-existing type 1 or type 2 diabetes, with subsequent follow-up individualized according to baseline DR severity [43]. Monthly evaluations may be needed for more serious cases. Labor and delivery planning should include ophthalmologic consultation in cases of active proliferative DR or recent vitreous hemorrhage; however, the mode of delivery should be

determined by obstetric indications [42]. Close collaboration among ophthalmologists, ophthalmic nurses, endocrinologists, and obstetricians is essential for the effective management of these patients [7, 69].

Emerging AI tools may support early detection and management planning. Newer AI tools such as IDx-DR and EyeArt have demonstrated high diagnostic accuracy in detecting referable DR and could be valuable additions to routine screening protocols [70, 71].

Valsalva Retinopathy (VR)

VR is characterized by a sudden-onset retinal hemorrhagic condition, precipitated by transient elevations in either intrathoracic or intra-abdominal pressure. This abrupt increase in pressure can rupture superficial retinal capillaries, resulting in preretinal hemorrhages, most commonly located beneath the internal limiting membrane or within the subhyaloid space [72–74].

Pregnancy is associated with an increased risk of VR due to multiple physiological changes. As the uterus expands, venous pressure increases, and hormonal alterations may compromise vascular integrity. Moreover, repeated physical strain from activities such as prolonged coughing, forceful vomiting associated with hyperemesis gravidarum, or straining during labor can impose additional stress on fragile retinal vasculature [75, 76]. This physiological stress can lead to acute elevations in intraocular venous pressure, sufficient to rupture the thin-walled capillaries, most commonly in the macular region, where vessels are particularly vulnerable [77, 78].

Clinically, patients commonly report a sudden, painless visual loss, central visual field defects, or floaters; symptoms that in the context of pregnancy may be mistakenly regarded as benign or transient visual disturbances [77, 79, 80]. On ophthalmoscopic examination, the hemorrhages are typically sharply outlined and boat-shaped overlying the macula, sometimes obscuring the underlying deeper retinal structures [80]. OCT is the preferred imaging modality, enabling precise localization of the hemorrhage and assessment of retinal involvement; characteristic features may include hyperreflective dome-shaped elevations and possible disruption of the ellipsoid zone [81]. In most cases, diagnosis is based on clinical findings, with OCT often used to support the diagnosis when appropriate [80].

A watch-and-wait approach is generally sufficient, as the hemorrhage usually clears on its own over the span of a few months. During these recovery phase patients are commonly advised to steer clear of physical strain, especially lifting or bearing down, as added pressure might worsen the bleed [79, 82–84]. In cases where the hemorrhage is particularly dense or slow to resolve, and vision is notably impaired, Nd:YAG laser hyaloidotomy can sometimes speed things along by allowing the blood to drain into the vitreous cavity. If that doesn't work or the hemorrhage continues to linger, the pars plana vitrectomy might be considered, although surgical options are approached with caution during pregnancy because of the inherent risks involved [78].

The prognosis is generally favorable, with most patients recovering near-normal visual acuity (often 20/20 to 20/30) because the neurosensory retina typically remains anatomically intact. Reported outcomes are similar with or without intervention. Recurrence appears uncommon, although the available evidence is limited largely to case reports [77].

Decisions around delivery should be made based on standard obstetric factors, though ophthalmology may have a role when active bleeding or repeat episodes are present. Preventive recommendations typically include controlling emesis, using stool softeners, and avoiding activities that may precipitate a Valsalva response [86].

Although no AI tools have been specifically validated for VR, established imaging modalities such as OCT and fundus photography remain valuable for monitoring structural changes. For patients with limited access or mobility, often the case during pregnancy, smartphone-adapted fundus cameras and teleophthalmology platforms can facilitate remote evaluation. Emerging AI models developed for related retinal hemorrhagic disorders [87–91] may eventually aid in quantifying hemorrhage burden or estimating recurrence risk.

Retinal Vein and Artery Occlusions

RVO and RAO are rare but serious vascular disturbances of the retina that may occur during pregnancy, particularly in the presence of preeclampsia, thrombophilia, hypertension, or other vascular risk factors [92, 93]. RVO tends to occur more often than RAO and includes both central (CRVO) and branch (BRVO) types, while RAO encompasses central (CRAO) and branch (BRAO) types plus cases involving the cilioretinal artery [94, 95].

Pregnancy brings about a physiological tilt toward hypercoagulability, shaped by several interrelated factors including an upsurge in clotting proteins, reduced function of natural anticoagulants such as protein S, and reduced venous return associated with pregnancy-related vascular and mechanical changes. These alterations create a prothrombotic state, although retinal vascular occlusion remains uncommon and should prompt evaluation for additional systemic risk factors [47, 92, 96, 97]. In RVO, pregnancy-related physiological alterations, particularly when compounded by conditions such as preeclampsia or underlying thrombophilic disorders, may increase susceptibility to vein occlusion. RAO, in contrast, typically results from emboli originating from cardiac sources or atherosclerotic plaques within larger vessels [9, 97, 98].

Clinically, patients typically present with sudden-onset, usually unilateral vision loss or visual field defects that correspond to the territory of the affected vessel. In the context of pregnancy, such symptoms can be mistaken for benign or transient visual

disturbances. When preeclampsia is present, additional systemic signs may indicate a more generalized vascular pathology [99–101].

On fundoscopic examination, RVO typically presents with intraretinal hemorrhages, engorged and tortuous retinal veins, cotton-wool spots, and macular edema. In contrast, RAO is characterized by a blanched retinal appearance due to ischemia; in CRAO the fovea remains visible as a cherry-red spot, whereas BRAO produces localized retinal whitening corresponding to the affected vascular territory [100, 102–104]. Imaging modalities such as OCT and OCT angiography play a central role in evaluating both anatomical and vascular alterations of the retina. These imaging techniques enable detection of fluid accumulation in the macula, identification of regions with inadequate capillary perfusion, and visualization of broader disruptions in retinal blood flow. Quantitative analysis of the retinal vasculature can be performed using platforms such as the Singapore I Vessel Assessment (SIVA) and the Vessel Assessment and Measurement Platform for Images of the Retina (VAMPIRE) [105–107]. AI-based models such as PROMPT (Preeclampsia Risk factor + Ophthalmic data + Mean arterial pressure Prediction Test) integrate retinal vascular and clinical features to support prediction of preeclampsia, although their role in routine pregnancy care requires further validation [108].

Diagnostic protocols during pregnancy rely predominantly on noninvasive imaging modalities; namely, fundus photography, OCT, and OCT angiography, given the safety considerations associated with gestation. Although FA provides valuable diagnostic insights, it is generally avoided or deferred during pregnancy when noninvasive imaging is adequate because fetal safety data are limited. OCT-derived biomarkers, including central macular thickness, ellipsoid zone integrity, and the presence of foveal hemorrhage, offer important prognostic information [109–111].

Therapeutic decisions during pregnancy are guided primarily by considerations of maternal and fetal safety. In cases of nonischemic BRVO without macular involvement, a conservative, observational approach is generally appropriate. Management of RVO with macular edema, retinal nonperfusion, or neovascular complications should be individualized; laser photocoagulation is not automatically indicated solely because ischemia or macular involvement is present. Although anti-VEGF therapy is generally avoided during pregnancy due to safety concerns, its use particularly with agents such as ranibizumab, may be cautiously considered when vision is acutely threatened after individualized maternal–fetal risk assessment [10, 100, 109, 112]. The safety profile of intravitreal corticosteroids remains inadequately defined. Acute RAO warrants urgent systemic and stroke evaluation. Systemic anticoagulation is not routine ocular treatment for RVO or RAO but may be indicated for a separately established maternal thrombotic disorder or thrombophilia after multidisciplinary assessment [113–117].

Visual prognosis is variable and depends on both location and extent of the ischemia. Recovery is more likely in BRVO and BRAO when the macula is spared; however, CRVO and CRAO are associated with a greater risk of permanent vision loss [93]. Pregnancy itself does not inherently worsen retinal prognosis [98], although therapeutic options may be limited due to fetal safety concerns. The occurrence of a vascular occlusion during gestation should prompt a comprehensive systemic evaluation to investigate potential coagulopathies, hypertensive disorders, and cardioembolic sources. Close interdisciplinary coordination is essential; though obstetric management typically remains unchanged unless significant visual deterioration occurs in the later stages of pregnancy [114].

From a technological perspective, AI, particularly models integrating OCT angiography-derived data, continues to evolve rapidly. These platforms are increasingly valuable for detecting ischemic alterations and enhancing risk stratification, providing clinicians with noninvasive, safe, and precise tools for longitudinal monitoring and individualized clinical decision-making [109, 118].

Papilledema from Idiopathic Intracranial Hypertension (IIH)

IIH, also known as pseudotumor cerebri, is characterized by elevated intracranial pressure in the absence of a mass lesion or abnormal cerebrospinal fluid (CSF) composition [119]. The condition predominantly affects obese women of reproductive age and may arise de novo during pregnancy or worsen as gestation progresses. Hormonal fluctuations, elevated estrogen levels, fluid retention, and weight gain are believed to contribute to disease onset [97, 120, 121]. Papilledema, the cardinal ocular manifestation, results from impaired axoplasmic flow at the optic nerve head and, if left untreated, can lead to irreversible vision loss [120].

IIH is associated with impaired CSF reabsorption at the arachnoid granulations and elevated venous sinus pressure, frequently linked to transverse sinus stenosis. Obesity may further increase intra-abdominal pressure, thereby impeding cerebral venous outflow. Additionally, adipokines such as leptin have been implicated in stimulating CSF production [97, 122, 123].

Common presenting symptoms include generalized headache, transient visual obscurations, diplopia secondary to sixth nerve palsy, and pulsatile tinnitus. These manifestations may be mistaken for nonspecific pregnancy-related complaints, potentially delaying diagnosis [123–125].

Fundoscopic examination typically reveals bilateral optic disc swelling. OCT serves as a key diagnostic adjunct by quantifying retinal nerve fiber layer and total retinal thickness, both of which correlate with disease severity [126]. Elevated body mass index, polycystic ovary syndrome, and rapid gestational weight gain are recognized risk factors for IIH. Pregnant patients with newly diagnosed IIH tend to exhibit a more rapid increase in total retinal thickness and more pronounced papilledema compared with those who have a pre-existing diagnosis [122, 123, 127, 128].

Detection of papilledema warrants a comprehensive diagnostic evaluation. IIH should be considered only after exclusion of secondary causes. Magnetic resonance imaging (MRI) with magnetic resonance venography (MRV), performed without gadolinium enhancement, is safe during pregnancy and helps rule out space-occupying lesions or cerebral venous thrombosis. MRI may also demonstrate subtle, nonspecific findings such as an empty sella or dilated optic nerve sheaths. Following neuroimaging, lumbar puncture preferably performed in the lateral decubitus position, confirms the diagnosis when the CSF opening pressure exceeds 250 mm H_2O with otherwise normal composition. Serial ophthalmic evaluations incorporating the Frisen grading scale and automated perimetry are essential for monitoring papilledema and visual field changes. OCT provides objective and reproducible quantification of optic nerve head swelling and is increasingly applied in conjunction with machine learning-based analyses. The presence of a relative afferent pupillary defect or impaired color vision indicates optic nerve dysfunction [120, 122, 128].

Management aims to preserve maternal vision while minimizing fetal exposure. Nutritional counseling and avoidance of excessive gestational weight gain constitute important components of management during pregnancy [129]. Acetazolamide, which decreases CSF production, may be considered during pregnancy when clinically necessary after individualized maternal–fetal risk–benefit discussion; although early animal studies raised concerns regarding teratogenicity, available human data have not demonstrated a clear increase in adverse effects, but remain limited [130–132]. In contrast, topiramate is contraindicated due to its association with cleft lip and other congenital malformations [133, 134]. Headache symptoms often improve with reduction in intracranial pressure, although this response can be variable [135]. Nonsteroidal anti-inflammatory drugs should generally be avoided from 20 weeks of gestation unless clinically necessary because of the risk of fetal renal dysfunction and oligohydramnios; if required between 20 and 30 weeks, they should be used at the lowest effective dose for the shortest duration, and they should be avoided after 30 weeks because of additional risks including premature closure of the ductus arteriosus. Opioid analgesics should be avoided because of the potential for neonatal withdrawal [136, 137]. Serial lumbar punctures performed every 10 to 14 days may provide temporary relief when other measures fail, though the procedure is technically challenging and often poorly tolerated during pregnancy [120]. Surgical options, including optic nerve sheath fenestration [138] and ventriculoperitoneal shunting [120, 139, 140], are reserved for severe or refractory cases.

The prognosis for IIH during pregnancy is generally favorable with timely diagnosis and appropriate management. Patients with pre-existing IIH typically remain stable, whereas new-onset cases arising during pregnancy are more likely to experience disease progression. Postpartum improvement is common [120, 122, 123, 130, 141]. Long-term visual outcomes largely depend on baseline optic nerve status and pre-pregnancy body mass index [122]. Close interdisciplinary coordination among neurology, ophthalmology, obstetrics, and anesthesiology is essential for optimal care. Ongoing surveillance with OCT, visual field testing, and weight monitoring assists in disease monitoring and therapeutic decision-making. Neuraxial anesthesia is usually feasible, and the mode of delivery should generally be determined by obstetric indications, with individualized planning according to disease severity and any CSF-diversion procedure [123, 132, 142, 143].

Emerging AI applications, particularly deep learning models utilizing OCT and fundus imaging, signal considerable promise for the detection and longitudinal monitoring of papilledema. These platforms provide safe, noninvasive diagnostic support, which is especially valuable during pregnancy. However, further validation in pregnant populations remains necessary to establish their reliability and clinical utility [144–146]. A comprehensive overview of the etiology, pathophysiology, retinal manifestations, clinical features, diagnostic approaches, management strategies, and pregnancy-specific considerations, including prognosis of each pregnancy-associated retinal disorder, is summarized in Table 1.

Emerging Role of AI in Pregnancy-Related Retinal Diseases

Recent advances in AI show substantial potential in the diagnosis of retinal diseases, particularly in remote or resource-limited settings where access to specialist care is limited [151]. Specific retinal abnormalities including macular edema [152, 153], exudates [153], cotton-wool spots [154], microaneurysms [155], and optic disc neovascularization [156] can be effectively identified using conventional machine-learning techniques. AI-based diagnostic systems represent a significant step forward in the early detection and management of hypertensive retinopathy, offering considerable benefits for both clinicians and patients [157].

AI algorithms applied to retinal fundus photographs evidence promising utility in predicting preeclampsia [158]. AI-based systems also exhibit robust diagnostic performance in detecting DR, with sensitivity and specificity values comparable to, and, in some cases, exceeding those of human experts [159]. For instance, a systematic review and meta-analysis of 21 studies reported pooled sensitivity and specificity values of 0.880 (95% confidence interval [CI], 0.875–0.884) and 0.912 (95% CI, 0.909–0.913), respectively, for AI-based DR detection [160]. To enhance clinical applicability, AI systems must integrate multimodal imaging modalities such as fundus photography, OCT, and OCT angiography, and be trained on large, diverse, and high-quality datasets that capture real-world variations in disease phenotypes, patient populations, and imaging conditions [151, 161].

Table 1. Summary of key features of retinal diseases associated with pregnancy

Condition	Etiology	Pathophysiology	Retinal manifestations	Clinical features	Diagnostic approaches	Management strategies	Pregnancy-specific considerations and prognosis
Hypertensive retinopathy [14–21, 28]	Pregnancy-related hypertension	Systemic hypertension causes vascular changes and endothelial damage	- Arteriolar narrowing - Retinal hemorrhages - Cotton-wool spots - Hard exudates. - Optic disc swelling	- Blurring of vision - Photopsia - Scotomas - Diplopia	- Fundoscopy. - OCT - OCT angiography	- Close monitoring - Treat hypertension.	- Requires frequent monitoring of blood pressure - Can resolve postpartum in some cases
SRD [29–33, 147, 148]	Severe preeclampsia or eclampsia	Choroidal ischemia and retinal pigment epithelium dysfunction	- Subretinal fluid - Retinal detachment	- Blurring of vision -Metamorphopsia - Loss of central vision	- Fundoscopy - OCT	- Monitor for resolution postpartum. - Possible need for interventions in severe cases	- Requires management of preeclampsia - Close follow-up after delivery
CSCR [35–40, 149, 150]	Hormonal and hemodynamic changes	Alterations in choroidal circulation and fluid retention in the retina	- SRD - RPE abnormalities	- Blurring of central vision - Metamorphopsia	- Fundoscopy - OCT - OCT angiography	- Often resolves postpartum. - Sometimes requires focal laser therapy or photodynamic therapy	- Hormonal changes may exacerbate CSCR during pregnancy - Resolution after delivery is common
Worsening of DR [7, 41–43, 50–56, 60–63]	Pregnancy-related hormonal changes	Pregnancy exacerbates preexisting DR	- Diabetic macular edema - Microaneurysms - Cotton-wool spots - Retinal neovascularization	- Blurring of vision - Difficulty seeing at night	- Fundoscopy - OCT	- Tight glycemic control - Frequent ophthalmic monitoring -Laser photocoagulation	- Requires strict control of blood glucose - Increased monitoring during pregnancy
Valsalva retinopathy [72–84]	Increased intrathoracic pressure	Raised pressure ruptures retinal capillaries	- Preretinal hemorrhage	- Sudden vision loss. - Blurring of vision in one eye	- Fundoscopy - OCT	- Observation. - Treatment of underlying cause such as vomiting	- Often triggered during labor or vomiting - Spontaneous resolution in many cases
Retinal vein and artery occlusions [92, 93, 96–111]	Pregnancy-associated hypercoagulability with additional vascular or thrombotic risk factors	Pregnancy-associated coagulation changes may contribute to vascular occlusion in susceptible individuals	- Retinal hemorrhages - Retinal ischemia - Cotton-wool spots	- Sudden loss of vision - Blurring of vision	- Fundoscopy - OCT - OCT angiography	- Urgent systemic and stroke evaluation for RAO - Individualized retinal management for RVO - Anticoagulation only when independently indicated for a maternal thrombotic disorder	- Pregnancy-associated hypercoagulability may contribute when additional vascular or thrombotic risk factors are present - Requires evaluation for preeclampsia, thrombophilia, hypertension, and cardioembolic disease
Papilledema from IIH [97, 119–130, 141-143]	Increased ICP	Raised ICP leads to optic disc swelling	- Optic disc edema - Peripapillary hemorrhages - Enlarged blind spot	- Headaches - Transient visual obscurations - Diplopia - Nausea	- Fundoscopy - OCT - MRI of the brain	- Avoid excessive gestational weight gain - Manage ICP - Ophthalmologic monitoring - Continue monitoring during pregnancy and postpartum because the disease course is variable	- May require close monitoring of both ICP and vision

Abbreviations: OCT, optical coherence tomography; SRD, serous retinal detachment; CSCR, central serous chorioretinopathy; RPE, retinal pigment epithelium; DR, diabetic retinopathy; IIH, idiopathic intracranial hypertension; ICP, intracranial pressure; MRI, magnetic resonance imaging.

This review provides a broad and integrative overview of retinal diseases induced or aggravated by pregnancy, synthesizing evidence from diverse study designs and highlighting emerging diagnostic and AI-based approaches. Its strength lies in the comprehensive synthesis of the literature and the detailed clinical and pathophysiologic insights that enhance clinical relevance. However, as a narrative rather than a systematic review it may not encompass all pertinent studies, introducing potential selection bias. The heterogeneity of available evidence and the predominance of case-based reports further limit generalizability. Overall, pregnancy can trigger or exacerbate a spectrum of retinal disorders, including hypertensive retinopathy, SRD, and CSCR, particularly in preeclampsia or eclampsia, where ocular findings may serve as early indicators of disease severity. Pre-existing DR often worsens, necessitating stringent metabolic and blood pressure control, while less common conditions such as retinal vascular occlusions and papilledema secondary to IIH may pose substantial visual and systemic risks. Diagnosis relies on safe, noninvasive imaging modalities such as fundus photography, OCT, and OCT angiography, and many pregnancy-associated retinal changes improve postpartum with timely, multidisciplinary management, although some conditions may cause persistent visual impairment. Emerging AI-based tools show promise for screening and risk prediction but require validation in pregnant populations. Future systematic reviews, meta-analyses, and longitudinal studies are warranted to develop evidence-based screening and management protocols that integrate ocular findings into comprehensive maternal care and improve both visual and systemic outcomes.

CONCLUSIONS

Pregnancy can precipitate or exacerbate a range of retinal disorders, reflecting the complex vascular, hormonal, and metabolic changes of gestation. Early recognition of ocular manifestations is critical, as they often parallel systemic disease severity and may inform timely obstetric management. Noninvasive imaging, interdisciplinary collaboration, and vigilant monitoring are essential to optimizing maternal and fetal outcomes. Although many pregnancy-associated retinal changes improve postpartum, some conditions can cause persistent visual impairment, making continued awareness and prompt management necessary. Future research should prioritize longitudinal studies and AI-driven tools to refine screening, diagnosis, and personalized care in pregnant populations.

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