



International Consensus and Guidelines on Diagnosing and Managing Coats Disease by the Academia Retina Internationalis (ARI), the Asia-Pacific Vitreo-retina Society (APVRS), and the Academy of the Asia-Pacific Professors of Ophthalmology (AAPPO)

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This invited article was submitted as part of the Medical and Surgical Retina Update Joint Virtual Special Issue with the Asia-Pacific Journal of Ophthalmology (APJO).

Accepted for publication October 12, 2025.

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• **PURPOSE:** Coats disease is a rare, retinal vascular disorder characterized by telangiectasias, aneurysmal dilations, and progressive exudative retinal detachment. Limited understanding of the disease warranted the need to identify controversial issues through an extensive literature search and a debate and discussion among international panels of experts.

• **METHODS:** Extensive literature search was done on multiple aspects of the disease-classification patterns, disease, Coats-plus, and Coats-like response. Other key factors included the etiology, possible genetic patterns, relationship with other vascular disorders, the role of inflammatory factors and vascular endothelial growth factor (VEGF) in the pathogenesis, diagnostic features, and complications. Considering the varying treatment patterns followed, imaging modalities, clinical findings, differential diagnosis, treatment options, prognostic factors, and emerging concepts in management were all covered in the search. Eighteen experts were included to opine on questions spanning classification, pathogenesis, diagnostic and treatment methods, prognostic controversies, and newer concepts in disease management.

• **RESULTS:** Of the 52 questions in 7 sections, the experts arrived at a consensus for 48 (92.3%) statements (with 75% voted as strong agreement or agreement). Most experts agreed on the suggested classification, diagnosis, and prognosis. The controversy, however, remained in questions regarding association with other vascular disorders,

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treatment of stages 3 and 4, possible benefits of newer anti-VEGF agents, and the role of artificial intelligence.

• **CONCLUSIONS:** These debates reflect the rarity of the condition, complex pathophysiology, and the challenges of treating a progressive blinding disease primarily affecting children. Hence, further studies are warranted, especially in areas that have not reached a consensus. (Am J Ophthalmol 2026;282: 162–186. © 2025 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>))

COATS DISEASE IS A RARE, IDIOPATHIC RETINAL vascular disorder characterized by retinal telangiectasias, aneurysmal dilations, and progressive exudative retinal detachment. First described by George Coats in 1908, this condition primarily affects young males and remains a challenging diagnosis with numerous controversies surrounding its etiology, classification, diagnosis, and management.

This document explores the major areas of debate and uncertainty in understanding and treating Coats disease.

Key unique aspects of Coats disease controversies include the following:

- The critical importance of differentiating from retinoblastoma in young children
- Debates over treatment aggressiveness in a condition that primarily affects children
- Challenges in conducting clinical trials for a rare pediatric condition
- Questions about the role of newer therapies such as anti-vascular endothelial growth factor (anti-VEGF) agents in pediatric populations

METHODOLOGY

Following the appointment of 2 coordinators, the Academia Retina Internationalis (ARI), the Asia-Pacific Vitreo-retina Society (APVRS), and the Academy of the Asia-Pacific Professors of Ophthalmology (AAPPO) convened an international expert panel comprising 21 panelists from 14 countries and territories. The panelists were invited based on their expertise, relevant publications, and geographic location to ensure a good representation of leading experts from around the world. A core group of 4 members (D.S.C.L., M.S., M.M., and N.V.R.), selected from the panelists, was established to conduct an extensive literature review on Coats disease and draft the initial consensus statements with explanatory elaborations. English-only articles were included for literature review from PubMed using the terminologies: *Coats' disease*, *laser*, *cryotherapy*, *intravitreal steroid*, *anti-VEGF*, *subretinal fluid*

drainage, *management*, and *complications*. Duplicates were screened manually and removed. Cross-references were studied from references wherever relevant and included as well. Because the primary focus of the literature review was to identify common controversies and generate a consensus, a literature review in the line of systematic review or meta-analysis was not strictly followed. Instead, whenever common or existing controversies or consensus points were identified, they were noted down and refined as necessary for the voting exercise.

Each panelist independently and anonymously reviewed the draft statements and provided feedback to the core group. The core group evaluated the comments, revised the statements accordingly, and circulated a second draft for further input. This iterative process continued until consensus was achieved.

For final approval, panelists anonymously voted on each statement using a 5-point Likert scale (ie, strongly agree, agree, neutral, disagree, and strongly disagree). A statement was considered consensus-approved if $\geq 75\%$ of experts voted either agree or strongly agree as per the methodology described in a previous consensus paper.¹

OUTLINE

• **DEFINITION AND CLASSIFICATION CONTROVERSIES:** Coats disease is most often unilateral, and the occurrence of bilateral cases is considered controversial as of this writing. Coats may rarely be seen in infants and adults, but more commonly in boys >8 years old. It is 3 times more common in males than females. Although bilateral cases in females have been reported,² the evidence for truly bilateral cases of Coats disease is contentious, and in the absence of genetic evaluation, these cases could possibly reflect Coats plus or Coats-like diseases. Shields and associates reported female prevalence of 24%, with a higher occurrence of advanced disease in females,¹⁰⁶ but Daruich et al.¹⁴ failed to identify any difference of Coats disease presentation between genders. Younger age at presentation has been found to be associated with advanced disease with poor prognosis.^{4,16}

Leber miliary aneurysm is considered as a milder form of Coats disease with no hemorrhage, massive subretinal exudation, or retinal detachment.^{5,6} Type 1 macular telangiectasia is considered as a milder form of Coats disease.⁵

Coats plus syndrome refers to a heterogenous group of Mendelian disorders linked to defects of telomere maintenance or Telomere biology disorders (TBD) characterized by bilateral telangiectasias, incomplete vascularization, exudative retinopathy, neovascularization, and retinal detachments.¹⁰⁹ The recessive disorder known as cerebroretinal microangiopathy with calcifications and cysts caused by CTC1 mutations is emblematic of TBD with intracerebral calcifications, leukodystrophy, and brain cysts.⁷ Patients present with spasticity, dystonia, seizures, ataxia, and

TABLE 1. Comparative Description of Different Classification Systems.

Stage/Group	Gómez-Morales ¹²	Sigelman ¹²	Shields et al ¹¹	Daruich et al ¹³
1	Focal exudates	Only telangiectasia	Stage 1: Retinal telangiectasia only	Stage 1: Retinal telangiectasia only
2	Massive exudation	Focal exudates	Stage 2: Telangiectasia with exudation: • 2A: Extrafoveal exudation • 2B: Foveal exudation	Group 2: Macular exudation without retinal detachment Stage 2: Telangiectasia with exudation: • 2A: Extrafoveal exudation • 2B: Foveal exudation – 2B1 without subfoveal nodule – 2B2 with subfoveal nodule
3	Partial exudative retinal detachment	Partial exudative retinal detachment	Stage 3: Exudative retinal detachment: • 3A1: Subtotal, extrafoveal • 3A2: Subtotal, foveal Stage 3B: Total exudative retinal detachment	Stage 3: Exudative retinal detachment: • 3A1: Subtotal, extrafoveal • 3A2: Subtotal, foveal Stage 3B: Total exudative retinal detachment
4	Total retinal detachment	Total retinal detachment	Stage 4: Total retinal detachment with glaucoma	Group 4: Total retinal detachment with glaucoma:
5	Complications (eg, chronic retinal detachment, glaucoma)	Complications	Stage 5: Advanced end-stage disease (eg, phthisis, no light perception)	Stage 5: Advanced end-stage disease (e.g., phthisis, no light perception)

TABLE 2. Key Differences in the Shields and Daruich Systems.

Feature	Shields	Daruich
Emphasis	Extent of exudation/detachment	Macular involvement (key for vision prognosis)
Usefulness	Standard for staging and treatment planning	Better for predicting visual outcomes
Clinical use	All age groups	Primarily for pediatric Coats disease
Limitations	Stages 2A vs 2B do not reflect macular damage well	New system, needs broader validation

cognitive decline. Vascular malformations may involve the stomach, small intestine, and liver; osteopenia and poor bone healing may also occur.⁸

Coats-like response is a widely used term that describes the fundus changes seen in cases of exudative retinopathies, of multiple etiology including the group of familial exudative vitreoretinopathies linked to defects of the Wnt pathway.^{9,10}

Coats presents between the third and seventh decades, progresses more slowly, and has a better visual outcome. In a study by Hansraj and associates, the mean age at presentation was found to be 50 years—72% being men, with 90% unilateral presentation. They found stage 2A and 2B to be the most common stages of the disease.⁴

The Shields system encompasses all stages of the disease, allowing every stage of the disease from only telangiectasia to advanced end-stage disease to be categorized and subclassified and hence allow prognosis (in contrast to other staging systems that are not as elaborate) (Table 1).

Stages along with the fundus findings are as follows¹¹:

1. Retinal telangiectasia only
2. Telangiectasia with exudation
 - 2A. Extrafoveal exudation
 - 2B. Foveal exudation
3. Exudative retinal detachment
 - 3A. Subtotal detachment-
 - 3A1. Extrafoveal
 - 3A2. Foveal
 - 3B. Total retinal detachment
4. Total retinal detachment with glaucoma
5. Advanced end-stage disease

The classification by Daruich and associates further suggested subdivision of stage 2B into stage 2B1, without subfoveal nodule, and stage 2B2, with subfoveal nodule, the presence of which affects the final visual outcome.¹³ The Shields and the Daruich are the most followed classification systems. Table 2 describes the key differences between the two.

CONTROVERSIES AND CONSENSUS STATEMENTS

SECTION 1: DEFINITION AND CLASSIFICATION CONTROVERSIES

- **COATS DISEASE VS COATS SYNDROME VS LEBER MILIARY ANEURYSMS:** Coats disease is a rare, unilateral, idiopathic retinal vascular disorder characterized by retinal telangiectasias, aneurysmal dilations, and progressive exudative retinal detachment. Coats plus syndrome is Coats disease with extraocular manifestations such as cerebroretinal microangiopathy with calcifications and cysts. Leber miliary aneurysms is considered as a milder form of Coats disease. Coats plus and other conditions with similar exudative retinopathy as seen in Coats with a Coats-like response are now-a-days described as Coats-like phenotype instead of referring to them as a spectrum of Coats disease which is an older term usually reserved only for the unilateral pediatric cases.

Consensus Statement 1.1: Coats disease, Coats syndrome, and Leber miliary aneurysms represent different spectra of Coats-like phenotype. (Consensus score: 100% [strongly agree: 29.41%; agree: 70.59%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

- **UNILATERAL VS BILATERAL INVOLVEMENT CLASSIFICATION:** Coats disease is a unilateral disease, and the bilateral forms reported most likely represent other conditions from the Coats-like phenotype as noted earlier.¹⁴ In a study evaluating the normal fellow eye of patients with unilateral Coats disease, ultrawide-field imaging revealed presence of more microvascular anomalies than in the group where both eyes were normal. However, the occurrence of these anomalies was similar to the normal eye peripheral anomalies in patients with other retinal vascular anomalies.¹⁵ Another study evaluating Coats disease in female population reported that bilateral Coats disease tends to be more common in females than in males. However, in this study, of the 11 bilateral patients (7 females), genetic testing was done only in 3 and found to be Coats-plus instead of true Coats disease.²

Consensus Statement 1.2: Bilateral Coats disease is more likely to be a part of the spectrum of conditions from Coats-like phenotypes rather than true Coats disease, and such bilateral Coats-like phenotypes may be more common in females. (Consensus score: 76.47% [strongly agree: 29.41%; agree: 52.94%; neutral: 11.76%; disagree: 5.88%; strongly disagree: 0%])

- **IS EXUDATION REQUIRED FOR DIAGNOSIS:** The presence of telangiectasia is enough to make a diagnosis of the disease.¹¹ The question of whether presence of exudation is a requisite has been well explained in the

classification by Shields and associates,¹¹ where they add it in stage 2. Although the emphasis of that classification is on extent and location of exudation, the presence of the precursor telangiectatic lesions is definitive of diagnosis.

Consensus Statement 1.3: Telangiectasias are requisite to making the diagnosis of Coats disease and presence, and knowing the extent of exudation helps in staging. (Consensus score: 100% [strongly agree: 60%; agree: 40%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

- **ADULT-ONSET COATS DISEASE: IS IT DIFFERENT FROM CHILDHOOD COATS?:** Adult-onset Coats presents between the third and seventh decades, progresses more slowly, and has a better visual outcome. A study of 98 children with Coats disease found that younger age at diagnosis is linked to more severe stage, worse visual prognosis, and higher complication risk. It revealed a highly significant inverse correlation between age and severity of the disease at diagnosis. Disease stage, rather than age itself, independently determined final visual outcome.¹⁶

Consensus Statement 1.4: Adult-onset Coats is generally milder and has a better prognosis. (Consensus score: 100% [strongly agree: 47.06%; agree: 52.94%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

- **CLASSIFICATION SYSTEMS:** The Shields system encompasses all stages of the disease, allowing every stage of the disease from only telangiectasia to advanced end-stage disease to be categorized and subclassified and hence allow prognosis (in contrast to other staging systems that are not as elaborate).¹¹ The visual outcome influence of the subfoveal nodule incorporated in the Daruich classification is an important functional parameter.¹³ The classification systems are not separate. Daruich's proposal is to split the Shields 2B stage into 2B1 (without a nodule) and 2B2 (with a nodule).

Consensus Statement 1.5: Shields classification system is more complete, encompassing all stages of the disease, and is the preferred staging system. A composite Shields-Daruich classification could be helpful. (Consensus score: 100% [strongly agree: 29.41%; agree: 70.59%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

SECTION 2: ETIOLOGY AND PATHOGENESIS CONTROVERSIES

- **GENETIC VS SPORADIC NATURE: RARE FAMILIAL CASES VS PREDOMINANTLY SPORADIC OCCURRENCE:** Coats disease is an exclusively sporadic and nonhereditary condition. Reports of bilateral or familial occurrence are better explained by Coats-like phenotypes within other genetic entities (such as familial exudative vitreoretinopathies or telomeropathies), rather than true Coats disease. However, structural instabilities in chromosome 3 and 13 have been found in Coats disease. Mutations in retinal proteins such as

CRB1 and NDP have been linked to Coats-like exudative vasculopathy, a distinct entity that mimics Coats disease in appearance but arises in the context of syndromic or non-syndromic retinitis pigmentosa, and should not be conflated with classic Coats disease.¹⁷

Cremers and associates suggested that CRB1 gene (which was found in retinitis pigmentosa with secondary exudative vasculopathy), could be causative in Coats disease.¹⁸ Mutations in Norrie disease gene, namely, somatic mutations in mosaicism NDP^{19,20} and PANK2^{5,21} also have been described in Coats disease.

Consensus Statement 2.1: Molecular screening in Coats disease is unnecessary but is mandatory in case of syndromic or bilateral presentation. (Consensus score: 92.3% [strongly agree: 15.38%; agree: 76.92%; neutral: 7.69%; disagree: 0%; strongly disagree: 0%])

• **ASSOCIATED SYNDROMES: COATS PLUS SYNDROME, AS DESCRIBED EARLIER:** Coats-like responses also can be seen in familial scapulohumeral dystrophy (FSHD; seen in females with bilateral involvement)²² telomeropathies or telomere biology disorders and osteoporosis pseudoglioma syndrome, linked to the Wnt signaling pathway.^{23,109} Coats-like responses are seen in multiple conditions leading to exudative retinopathies such as retinitis pigmentosa,^{24,25} ocular toxoplasmosis,²⁶ and vasoproliferative tumors (VPTs).³

Systemic syndromes showing Coats-like retinal findings include CRB1-related retinopathy (Leber, autosomal recessive RP),²⁷ Senior-Loken syndrome,²⁸ Turner syndrome,²⁹ and Parry-Romberg.³⁰

Consensus Statement 2.2: Coats-like responses can be seen in various diseases but are usually milder and need a less aggressive treatment approach. (Consensus score: 76.47% [strongly agree: 5.88%; agree: 70.59%; neutral: 23.53%; disagree: 0%; strongly disagree: 0%])

• **SYSTEMIC SCREENING REQUIREMENTS:** No systemic screening guideline of patients with Coats disease has been put forward.

Consensus Statement 2.3: Systemic screening is not routinely advised in Coats disease except in atypical presentations such as bilateral disease in a young female. (Consensus score: 100% [strongly agree: 41.18%; agree: 58.82%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

• **DEBATE OVER SUBSTAGE CLASSIFICATIONS WITHIN EACH STAGE:** The Gomez-Morales staging^{12,31} and Sigelman staging¹² focused on the clinical features of the disease but did not categorize them based on the importance of the location of the features, hence helping to prognosticate the disease. The Shields group, however, divided the stages further into substages according to the location of the disease,¹¹ hence helping the treating physician to understand the prognosis because of sites of the exudates or detachment. The addition of presence of subfoveal nodule

to the Daruich classification was crucial in helping prognosticate visual outcomes.¹³

Brockmann et al.³² proposed a subclassification of stage 2B Coats disease in 2B1 and 2B2 based on the presence of “typical foveal Coats vascular abnormalities” found in a adult-onset group of patients (mean age of 17 y), in complete ignorance of previous evidence-based definition of 2B1 (without sub-foveal nodule) and 2B2 (with sub-foveal nodule) stages and its impact on the visual prognosis (see Daruich¹³). In addition the so-called “typical foveal Coats vascular abnormalities” are virtually inexistent in pediatric Coats’ disease (<1%; see Shields³). It makes no sense to modify a classification based on less than 1% of the cases.

Consensus Statement 2.4: The substage classifications in the Shields and Daruich classification systems help in disease prognostication and treatment planning. (Consensus score: 86.66% [strongly agree: 13.33%; agree: 73.33%; neutral: 13.33%; disagree: 0%; strongly disagree: 0%])

• **SEVERITY-BASED VS LOCATION-BASED CLASSIFICATIONS:** In a study on 117 patients, to classify and manage Coats disease by the Shields group,¹¹ they emphasized that the risk factors to predict poor outcomes include postequatorial location, diffuse involvement, superior location of the telangiectasias with exudation, incomplete resolution of subretinal fluid after treatment, and lack of retinal macrocysts, thus validating the importance of subcategorization of the stages according to the location of the disease.

Based on the classification, the treatment options varied, with options such as observation or laser for stage 1 and surgical repair in stage 3B. Hence, a severity-based classification can help to plan the appropriate line of management and prognosticate the disease. However, symptomatic cases with stage 4 may need enucleation, whereas many eyes with stage 5 can be observed.^{3,11,33}

Hence, a comprehensive classification along with a thorough examination and understanding of the patient’s symptoms is essential to treat and provide prognosis of the disease.

Consensus Statement 2.5: Severity-based classification with subcategorization of the disease such as Shields classification allows treatment decisions and helps to prognosticate. (Consensus score: 93.33% [strongly agree: 13.33%; agree: 80%; neutral: 6.67%; disagree: 0%; strongly disagree: 0%])

• **DEBATE OVER INCORPORATING VISUAL POTENTIAL IN STAGING:** In the study by Shields,³³ more advanced stages of the disease indicated a probable need for enucleation and poorer visual prognosis. However, visual acuity, even in earlier stages of the disease, may be poor because of numerous factors such as site and extent of exudation, fovea involving retinal detachment, presence of subfoveal nodule, adverse effects of raised intraocular pressure, corneal edema, cataract, subfoveal gliosis or scarring, vitreous hemorrhage, strabismus, and amblyopia.

Consensus Statement 2.6: Establishing a staging system that incorporates visual potential is challenging because of factors like chronicity and amblyopia, although certain clinical features such as subfoveal involvement may strongly influence the outcomes. (Consensus score: 92.86% [strongly agree: 21.43%; agree: 71.43%; neutral: 0%; disagree: 7.14%; strongly disagree: 0%])

- **RELATIONSHIP TO OTHER RETINAL VASCULAR DISORDERS:** Coats-like response has been described in exudative retinopathies, secondary to retinal vascular disorders such as retinal vein occlusion,³⁴ retinal macroaneurysms, capillary hemangiomas, VPT, and familial exudative retinopathy.³ Eyes with Coats disease can also develop secondary VPT.

Consensus Statement 2.7: A relationship between Coats-like response in various other retinal vascular disorders is well known and described. (Consensus score: 64.71% [strongly agree: 23.53%; agree: 41.78%; neutral: 17.65%; disagree: 11.76%; strongly disagree: 5.88%])

- **PRESENCE OF AN INFLAMMATORY COMPONENT IN THE PATHOGENESIS OF COATS DISEASE:** Eucleated specimens of Coats disease showed prominent infiltration by inflammatory cells within and adjacent to the retinal cells. On immunohistochemical staining, macrophages were identified with perivascular T lymphocyte infiltration.³⁵

Further, cytokines such as interleukin 8 (IL-8), monocyte chemoattractant protein 1 (MCP-1), and macrophage inflammatory protein 1 alpha (MIP-1 α) have been identified in the aqueous humor of patients with Coats disease; the authors suggested the same for patients with refractory macular edema, to find an ideal treatment modality.³⁶

This may also further validate the usage and response noted with steroid agents in Coats disease.

Consensus Statement 2.8: There is a significant inflammatory component involved in the pathogenesis of Coats disease. (Consensus score: 84.61% [strongly agree: 15.38%; agree: 69.23%; neutral: 7.69%; disagree: 7.69%; strongly disagree: 0%])

- **VEGF IN COATS DISEASE:** In a comparative study done to estimate intraocular VEGF levels in Coats disease and rhegmatogenous retinal detachment, samples of subretinal fluid, aqueous humor, and vitreous were compared. In eyes with Coats disease, the VEGF level was 2394.5 pg/mL, compared with 15.3 pg/mL in eyes with rhegmatogenous retinal detachment.³⁷

In a study by Mano and associates, significant elevation of VEGF levels were seen in the subretinal fluid drained from eyes with Coats disease, compared with the vitreous.³⁸

In the study by Zhao and associates, not only was the VEGF concentration in the aqueous humor noted to be higher in Coats disease eyes as compared to controls, it was also noted to show significant increase with progression of the stage of the disease, from stage 2 to 3B.³⁹

This explains the beneficial use of anti-VEGF agents in management of the disease. Improved vascular density on OCTA following the use of anti-VEGF agents has been identified.^{40,41}

However, a study also compared the levels of VEGF in different stages of Coats disease stagewise with a control group and found that the mean aqueous levels of VEGF in Coats stage 1 and 2 were not significantly different from the control group.³⁹ They also showed that the levels of VEGF increase with increasing stage.³⁹ As a result, whether raised VEGF levels are a cause or consequence is not precisely known. But the role and efficacy of anti-VEGF agents as an adjuvant has been validated by several groups as mentioned above.

Consensus Statement 2.9: VEGF molecules play a role in the pathogenesis of Coats disease. However, whether they are the trigger or a consequence is not precisely known. (Consensus score: 92.31% [strongly agree: 23.08%; agree: 69.23%; neutral: 0%; disagree: 7.69%; strongly disagree: 0%])

- **HISTOPATHOLOGY IN COATS:** The main histopathologic abnormality in Coats is breakdown of the blood-retina barrier at the level of the vascular endothelium and loss of pericytes and endothelial cells. Following this, leakage and exudation occur.

Consensus Statement 2.10: Disruption of the pericytes and endothelial cells is seen on histopathology in Coats disease. (Consensus score: 100% [strongly agree: 15.38%; agree: 84.62%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

- **LIPID ABNORMALITIES:** In a study by Woods and associates,⁴² no lipid abnormalities were noted in children with Coats disease. However, the adult cases showed elevated serum cholesterol, probably suggesting the difference between the 2 entities.

Consensus Statement 2.11: Lipid metabolism abnormality may be seen in adult-onset Coats; however, it is not related to the juvenile form in which the pathology is exudative in nature. (Consensus score: 75% [strongly agree: 16.67%; agree: 58.33%; neutral: 16.67%; disagree: 0%; strongly disagree: 8.33%])

SECTION 3: DIAGNOSTIC CONTROVERSIES

Clinical diagnosis: Standardization of diagnostic criteria and early disease recognition

Patients may complain of vision loss, yellow reflex pain, nystagmus, and strabismus.

The anterior segment findings include megalocornea, corneal edema, cholesterol deposition in the anterior chamber, shallow anterior chamber, cataract, neovascularization of the iris and heterochromia.

The posterior segment findings on indirect ophthalmoscopy mainly include the following:

- Retinal telangiectasias or light bulb telangiectasia,⁴³ fusiform appearance, usually in the periphery, with an in-

creased chance of temporal or inferior quadrant involvement³

- Occasional presence of macular or paramacular telangiectasia
- Widespread intraretinal exudation, including sites away from the telangiectasia
- Migration of the exudation toward the macula^{44,45}
- Presence of fibroglial nodules with a predilection for subfoveal location
- Exudative retinal detachment
- Retinal hemorrhage
- Long-standing retinal detachment can lead to macrocysts, VPT, and vitreous hemorrhage
- Extramacular fibrosis and associated retinal traction in the long term⁴⁶

Complications

Iris and angle neovascularization can lead to neovascular glaucoma. Ciliary nonperfusion areas are seen, around the telangiectatic vessels. Neovascularization of the disc and elsewhere are rarely seen; hence, vitreous hemorrhage is also a rare complication. Retinal macrocysts and VPT can be seen in long-standing detachments.

The classic triad to look out for in Coats disease, so as to identify at an early stage include irregularly dilated telangiectatic vessels, peripheral nonperfusion areas, and exudative retinal detachment.^{47,48}

Imaging approaches: Role of fluorescein angiography, optical coherence tomography (OCT), and multimodal imaging

1. Fundus fluorescein angiography³³: Common findings include (a) hyperfluorescence of the telangiectatic vessels in the venous phase; (b) capillary nonperfusion areas; (c) hypofluorescence along the areas of exudation, with late staining; (d) leakage of dye from the abnormal vessels; (e) macular edema hyperfluorescence around the foveal avascular zone; and (f) rarely, leaky neovascularization of the iris and disc.
2. Ultrasound B scan shows the exudative retinal detachment and subretinal exudation often noted in the form of subretinal dotlike echoes.
3. OCT helps in identification of macular edema, subretinal or intraretinal fluid, presence of vitreomacular traction, or epiretinal membranes. It can also help to document the subfoveal choroidal thickness and central macular thickness.³³
4. OCT angiography can be helpful in disease monitoring. The features that have been described include chorioretinal anastomoses, abnormal foveal vascular loops, and choroidal flow voids.⁴⁰ Some studies have also reported foveal avascular zone abnormalities in the fellow eye⁴⁹; however, these cases were most likely Coats-like conditions.
5. Magnetic resonance imaging (MRI) is rarely used for Coats diagnosis but can help in differentiating it from

retinoblastoma. The exudates appear hyperintense in both T1- and T2-weighted images, whereas the tumor shows hypointensity in T2 in case of retinoblastoma.

6. Computed tomography (CT) can be used to differentiate the presence of calcification in retinoblastoma, as opposed to the absence of the same in Coats disease. However, approximately 20% of eyes with Coats disease can show calcification due to bone formation along the vessel walls and calcification of the submacular nodule.⁵⁰⁻⁵²

Differential diagnosis: Critical distinction from retinoblastoma and other simulators

The most important differential for Coats disease remains retinoblastoma, and is crucial for differentiating the two before beginning the treatment.

The other conditions that can mimic Coats disease include causes of leukocoria such as stage V retinopathy of prematurity, persistent fetal vasculature, Toxocara infection, endophthalmitis, and conditions arising from the Norrin/ β -catenin signaling pathway, for example, familial exudative vitreoretinopathy and Norrie disease. Table 3 shows some distinguishing features between Coats disease and retinoblastoma.

Stage V retinopathy of prematurity can be differentiated by the history of prematurity. It is usually a bilateral disease and characteristically shows the presence of a tractional retinal detachment instead of exudative retinal detachment.

Familial exudative vitreoretinopathy is a genetically heterogeneous inherited disorder, with variable penetrance. It is typically bilateral with extensive neovascularization, leading to vitreoretinal traction, folds, and tractional retinal detachment. It can occasionally present with exudative retinal detachment as well. Extensive avascular peripheral retina is noted, with dragged retinal vessels and macula.

Persistent fetal vasculature is a sporadic and unilateral disease. Small-sized eye with the presence of a retrolental fibrous tissue is a determinant feature.⁵¹ A stalk that arises from the disc toward the inferonasal part of the lens is seen. The ciliary processes are elongated, behind the lens, as the fibrous tissue exerts centripetal traction over it.

In toxocariasis, the patient presents with a history of exposure to pets, unilateral disease, and a quiet appearing eye. A peripheral granuloma is noted with extension of fibrous tissue from the granuloma to the optic disc. It may be associated with tractional retinal detachment, and can have an associated central nervous system involvement.

For endophthalmitis, usually there is a history of trauma, surgery, or sepsis. Patients present with pain, redness, eyelid edema, and watering. Circumcorneal and conjunctival congestion are classically seen.

The hallmarks of Norrie disease are the presence of microphthalmia and corneal opacification. It is associated with developmental delay and deafness.^{52,53}

TABLE 3. Distinguishing Features Between Coats Disease and Retinoblastoma.

Category	Retinoblastoma	Coats disease
Age group, y	0-5	2-10
Laterality	Unilateral/bilateral	Unilateral
Vitreous seeds	Present	Absent
Fundus reflex	White (leukocoria)	Yellowish (xanthocoria)
Vascular malformation	+/-	+++ Hallmark feature
Mass	Intraretinal/subretinal/vitreous with white lesions within the retina, obscuring the vessels	Clump exudates causing subretinal mass-like appearance
Calcium	+++ (masslike)	+/- (plaquelike)
Exudative RD	+	+++
USG	Mass lesion	Can see all layers
	Highly reflective calcium blocking, sclera may not be seen	Exudative RD with subretinal exudation
CT	Calcification	Ground-glass appearance
MRI	Mass lesion: hyper on T1, hypo on T2	Exudation remains hyper on T1 and T2

+++ Probability of occurrence.
CT = computed tomography, MRI = magnetic resonance imaging, RD = retinal detachment, USG = ultrasonography.

• CONTROVERSY OVER ATYPICAL PRESENTATION INCLUSION: PEDIATRIC VS ADULT DIAGNOSTIC CRITERIA DIFFERENCES:

Features of adult-onset Coats disease (AOCD)

The typical distinguishing features include an increased macular involvement, and the most common clinical feature identified was hard exudates.⁵⁴⁻⁶⁰ Microaneurysm, cystoid macular edema, and subretinal fluid were also noted.⁵⁴⁻⁶⁰ On OCT, intraretinal fluid, hard exudates, and disorganization of the inner retinal layers were seen. Irregularity of the foveal avascular zone was noted on angiography, with microaneurysms and capillary nonperfusion areas.⁶⁰ The authors also noted a lower incidence of retinal detachment and neovascular glaucoma compared with the pediatric population.^{4,54} Surgical intervention and enucleation were very rarely needed, and most eyes had a good prognosis, with better visual acuity compared with the pediatric disease.⁵⁹

Table 4 shows a summary of findings from some studies on Coats disease.

Consensus Statement 3.1: *Adult-onset Coats is usually mild and does not require subretinal fluid drainage but can be treated with intravitreal steroids, anti-VEGF agents, and laser photocoagulation.* (Consensus score: 100% [strongly agree: 23.53%; agree: 76.47%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

• IMAGING CONTROVERSIES:

Fluorescein Angiography: Necessity in all suspected cases vs selective use

Considering the young age at presentation, and difficulty in performing a fundus fluorescein angiography (FFA) without

the usage of sedation or general anesthesia, FFA can be reserved for cases where there remains a diagnostic dilemma after thorough fundus evaluation, with equivocal results on noninvasive investigation modalities such as ultrasound B scan and MRI.

Consensus Statement 3.2: *Angiography is strongly recommended in every single case of Coats to identify leaking vascular anomalies and delineate the extent of the affected retina including nonperfusion to aid treatment.* (Consensus score: 92.85% [strongly agree: 57.14%; agree: 35.71%; neutral: 0%; disagree: 7.14%; strongly disagree: 0%])

Pediatric angiography safety and cooperation issues

As discussed above, most children will need to be sedated or anesthetized to perform the angiography. Option of intravenous versus oral FFA can be considered, the latter being relatively safer.⁶¹ The rare adverse effects of oral FFA include discoloration of skin and temporary staining of teeth. The risks involved in intravenous angiography include anaphylaxis, which needs prompt management. Anesthetic risks remain in both types of angiography. Procedural difficulties may be overcome under anesthesia using the angiography module of a handheld fundus camera.

Consensus Statement 3.3: *Angiography is difficult in children but should be strongly recommended to be performed under general anesthesia if the facility of handheld fundus camera with angiography module is available.* (Consensus score: 92.85% [strongly agree: 35.71%; agree: 57.14%; neutral: 7.14%; disagree: 0%; strongly disagree: 0%])

Wide-field imaging necessity debate

Ultrawide-field imaging and angiography is important in identifying peripheral telangiectasias, aneurysms and peripheral capillary nonperfusion or leakage.⁶² This can help

TABLE 4. Summary of Findings From Some studies of adult-onset Coats disease.

Study (Year)	Sample	Age Range / Mean	Key Clinical Features	Visual Outcomes
Rishi et al, 2016 ⁶⁰	48 eyes	Mean 47 y	Localized (<6 h), unilateral (83%); hypertension (22%); presenting vision loss (83%); telangiectasia, exudation	35% improved, 48% stabilized, 12% worsened
Smithen et al, 2005 ⁵⁶	13 eyes	36-79 y (mean 50 y)	Unilateral, male predominance (12/13); telangiectasia, lipid exudation, macular edema, hemorrhage; limited (<6 h) involvement	Average -2.1 lines vision loss; stable or improved in many
Otani et al, 2012 ⁵⁷	2 case studies (>10-y follow-up)	71 and 76 y	Subretinal exudation; treated with laser ± cryotherapy	VA improved to 20/20 and 20/200 and remained stable
Sakurada et al, 2018 ⁶⁰	Case report	~Middle-aged adults	Multimodal imaging: FA, OCT findings detailed; telangiectasia, exudates	Not specified
Stephen et al, 2024 (review) ⁵⁵	N/A	Adults aged ≥35 y	Telangiectasia, exudation; slower progression; less neovascular glaucoma	Discusses management but no raw VA data
Banerjee et al, 2023 (review) ⁵⁸	N/A	Adults	Imaging characteristics, staging into 4 categories, localized exudation	—

FA = fluorescein angiography, OCT = optical coherence tomography, VA = visual acuity.

to establish diagnosis, and more importantly aid in appropriate laser treatment and follow-up. In bilateral cases, the asymmetry of the disease between the 2 eyes can be identified. However, considering the difficulty in performing the same because of the younger children's lack of cooperation, it will need to be performed under sedation or under anesthesia.

Consensus Statement 3.4: *Wherever available, wide-field angiography should be performed in adults and in cooperative children to identify peripheral leaking vascular anomalies. (Consensus score: 100% [strongly agree: 64.29%; agree: 35.71%; neutral: 0%; disagree: 0%; strongly disagree: 0%])*

B-scan ultrasonographic evaluation

B-scan ultrasonography is particularly relevant to differentiate from retinoblastoma, which shows irregular mass lesion with high intralesional echogenicity, suggestive of calcification, with orbital shadowing. It may be associated with a retinal detachment. In addition, the sclera may be blocked because of the calcification.

In Coats disease, all the layers can be seen clearly, with presence of an exudative retinal detachment and subretinal exudative material. The movements of the subretinal cholesterol crystals under the bullous exudative retinal detachment are seen in Coats disease but never seen in retinoblastoma.

Consensus Statement 3.5: *Although ultrasonography may aid in differentiating between Coats disease and retinoblastoma, it is not conclusive, particularly in differentiating anterior diffuse infiltrating retinoblastoma. Often neuroimaging such as MRI and clinical acumen is required for differentiation. (Consensus*

score: 100% [strongly agree: 52.94%; agree: 47.06%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

SECTION 4: TREATMENT CONTROVERSIES

Laser photocoagulation: Technique variations and technology selection

Laser photocoagulation is an effective method to treat the telangiectatic vessels, enlarged aneurysms, and avascular retina to control the exudation and prevent neovascularization. Green laser (double-frequency Nd-YAG laser 532-nm) or yellow laser (577-nm) can be used. Low power, large spot size, and longer-duration burns are suggested. Laser is usually indicated in early stages of the disease, stage 1-3a usually, with no retinal detachment.⁶³

In adult patients, laser to the focal leaks threatening the fovea can be performed, along with laser to the telangiectatic vessels with active exudation and peripheral non-perfusion areas. Focal leaks away from the fovea need not be treated. Multiple sittings of laser are often needed to control the disease. In such cases, an interval of at least 3 months should be allowed between the episodes. [Figure 1](#) shows reduction in hard exudation and resolution of CMO after the first sitting of focal laser with adjuvant anti-VEGF injection at the 3-month follow-up, and [Figure 2](#) shows sequential resolution after focal laser to telangiectasias in another case of Coats disease.

In cases with extensive retinal detachment, double freeze-thaw cryotherapy can be performed to treat peripheral vascular malformations instead of laser. A transient increase in exudation and subretinal fluid can be seen after cryotherapy. The safe recommendation includes cryotherapy up to 2 quadrants, with a gap of 4 weeks between the 2

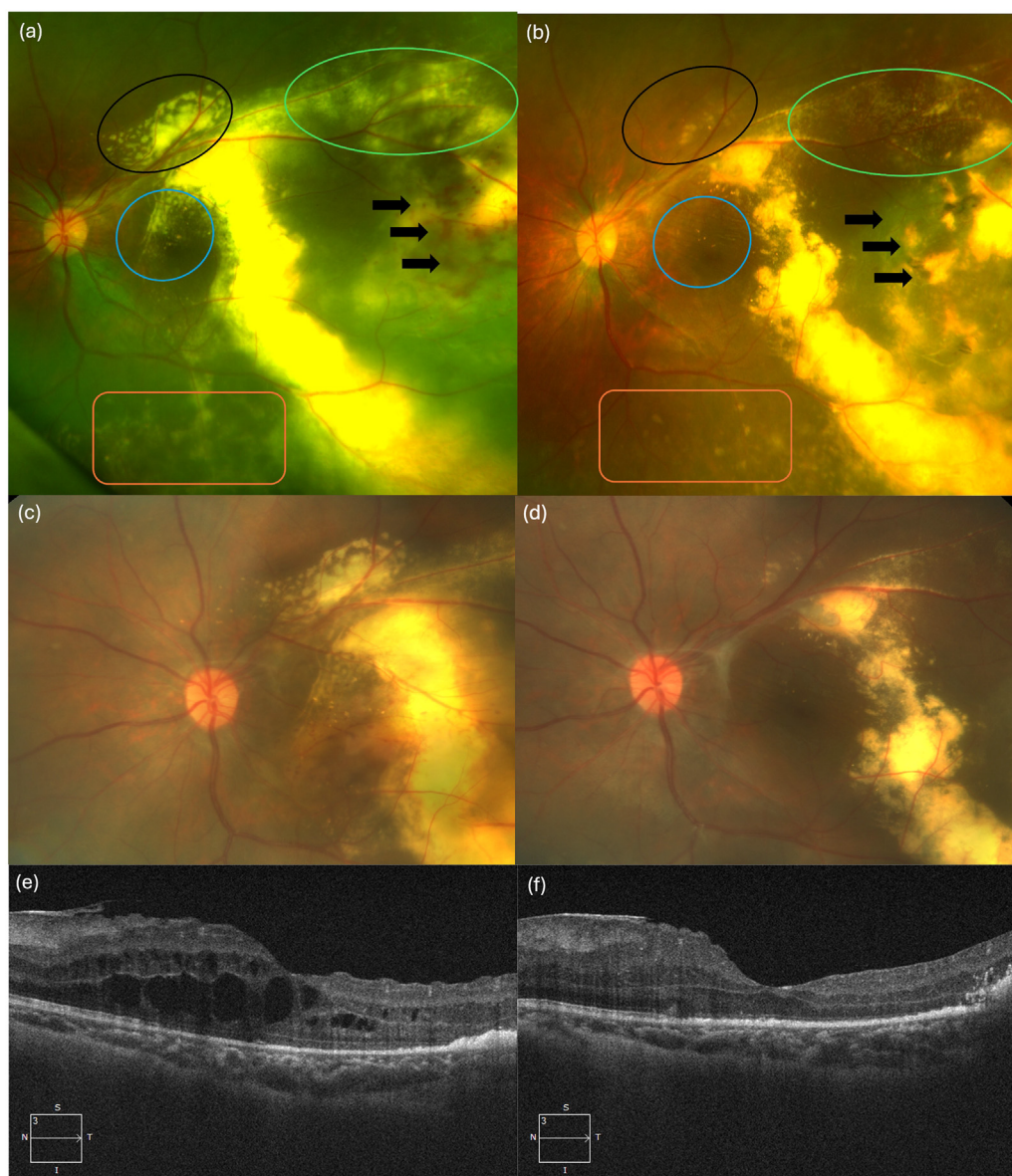


FIGURE 1. Wide-field SLO images of a 16-year-old boy with Coats disease OS. A. Top left: pre-laser first sitting. B. Top right: follow-up 3 months post-laser and 1 injection of anti-VEGF. Marked locations in corresponding areas of (A) and (B)—black and green ovals, maroon rectangle, and blue circle over macula—show reduction in hard exudates. Black solid arrows in (A) and (B) show the corresponding reduction in telangiectasias and hemorrhages post laser. C. Color fundus montage showing pretreatment picture. D. Color fundus montage post laser treatment showing reduction in hard exudates similar to the SLO image above. E. OCT image shows ERM with nasal IRF and CMO with discontinuity in the outer retinal layers. F. OCT image shows decreased IRF and CMO post 1 anti-VEGF injection at 3-month follow-up. anti-VEGF = anti-vascular endothelial growth factor, CMO = cystoid macular edema, ERM = epiretinal membrane, IRF = intraretinal fluid, OCT = optical coherence tomography, OS = oculus sinister (left eye), SLO = scanning laser ophthalmoscopy. (Figure 1 was contributed by D.S.C.L., original author.)

cycles. In case of application over the same area, a gap of 3 months is warranted.¹¹

Consensus Statement 4.1: The aim of laser treatment is to ablate the avascular retina and occlusion of the telangiectatic vessels, and hence the preferred wavelength is 532 nm or 577 nm. (Consensus score: 100% [strongly agree: 46.67%; agree: 53.33%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

Anti-VEGF therapy: Role in treatment algorithm and agent selection

Anti-VEGF agents are useful in treating macular edema, regression of abnormal vessels, and stabilization of the telangiectatic vessels and aid in stabilization of vision.⁵² However, although VEGF levels are found to be increased in Coats disease, it is not involved in the pathogenesis of

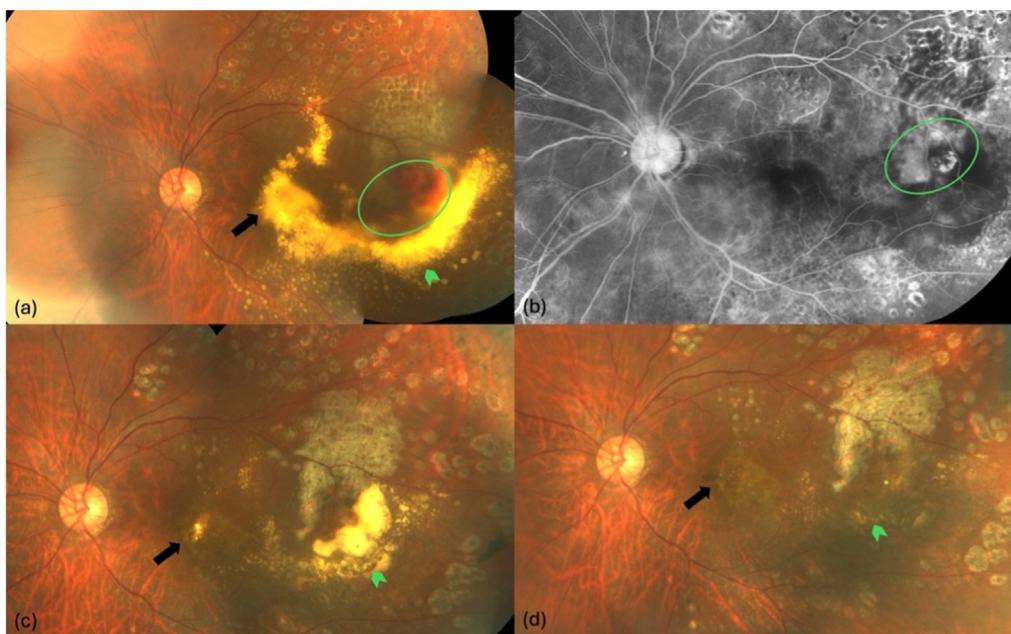


FIGURE 2. Case of OS Coats disease. **A.** Top left: Color fundus montage showing extensive hard exudates involving the fovea (black solid arrow), extrafoveal hard exudates (green chevron), and abnormal telangiectatic vessels (green oval marked area). **B.** Top right: FA montage revealing lightbulb telangiectasias (green oval marked area). **C.** Bottom left: 4 months post laser significantly reduced foveal and extrafoveal exudation (solid black arrow and green chevron); note no visible telangiectasia. **D.** Bottom right: 8 months post laser, the foveal and extrafoveal hard exudates are completely resolved (solid black arrow and green chevron). FA = fluorescein angiography, OS = oculus sinister (left eye). (Figure 2 was contributed by N.V.S., original author.)

the disease. The increase in mean aqueous levels of VEGF in Coats disease seems to be stage dependent, leaving open the question of cause or effect. Therefore anti-VEGF agents are used as an additional modality of treatment, not primarily.

There have been reports that suggest the possibility of occurrence of choroidal neovascularization and macular scarring.^{64,65} This maybe an indication for the effective usage of anti-VEGF agents.

Some authors have also noted the downsides of using anti-VEGF agents in Coats disease. One study discussed 8 patients who underwent intravitreal bevacizumab along with cryotherapy or laser. Half the patients developed vitreoretinal fibrosis and approximately 27% developed tractional retinal detachment,⁶⁶ whereas extramacular fibrosis in the long run is well reported by another group.⁴⁶ Further, hyaloid contraction, leading to a traction retinal detachment, is another complication associated with anti-VEGF injection administration.⁶⁷ Hence, careful and judicious use of anti-VEGF agents is advised. Safety for the child must also be ensured.

Consensus Statement 4.2: Anti-VEGF agents may aid in treatment of Coats disease but is not the primary agent of choice. (Consensus score: 100% [strongly agree: 46.67%; agree: 53.33%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

Surgical management: Vitrectomy indications and retinal detachment approaches

The indications for vitrectomy include complex retinal detachment and extensive exudation. In a study by Schmidt-Erfurth and Lucke, they reported successful management of complications of Coats disease with scleral buckling, pars plana vitrectomy, internal drainage of the subretinal fluid, and tamponade with silicone oil.⁶⁸ They reported good visual outcomes in all eyes. In another study of 5 patients who underwent vitrectomy, internal drainage of subretinal fluid, and silicone oil tamponade, all patients noted improvement in vision, with no secondary complications.⁶⁹ In a study on 23 eyes that underwent vitrectomy with tamponade, 7 eyes needed revision surgery. Eight eyes had improved vision, 3 remained stable, and 6 showed decline in vision. None needed enucleation, or progressed to neovascular glaucoma.⁷⁰

However, extensive proliferative retinopathy can occur with internal drainage of subretinal fluid. Rishi and associates suggested the benefit of external drainage to combat this issue, along with cryotherapy, and showed promising results.⁶³ The technique of subretinal fluid drainage employed was transconjunctival tangential entry into the subretinal space at the point of highest bulgosity, approximately 7 to 10 mm from the corneoscleral limbus gener-

ally in the inferotemporal or inferonasal quadrant, by using a 26-G needle connected to a 2-mL syringe without plunger and bevel of the needle facing the retinal pigment epithelium while simultaneously injecting saline solution using a 30-G needle through the pars plana, 3.5 mm from the corneoscleral limbus, to compensate for the hypotony during subretinal fluid drainage.⁷¹ This simple technique achieves reattachment of the retina or at least decreases the bullous detachment sufficiently enough to allow laser treatment of vascular malformations. Another method of drainage includes lamellar scleral dissection. This can be combined with placement of an encircling band, depending on the case and the surgeon's discretion.

Scleral buckling with external drainage of subretinal fluid using a scleral cut-down technique and cryotherapy has also shown promising results.⁶³

Consensus Statement 4.3: *Where possible, it is preferable to perform external drainage of subretinal fluid and reattach the retina rather than perform vitrectomy.* (Consensus score: 100% [strongly agree: 47.06%; agree: 52.94%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

Enucleation considerations: Indications and alternative approaches

The rates of enucleation for Coats are on a decline over the years. The indication includes advanced disease with a painful blind eye, or neovascular glaucoma with advanced disease.⁷² Other clinical features that predict the need for enucleation include iris neovascularization and extensive extent of light bulb aneurysms.⁷³ Alternative approaches could be symptomatic management of pain and intraocular pressure management if needed by a cyclophotocoagulation.

Consensus Statement 4.4: *It is better to enucleate a blind eye than perform biopsy, wherein one is unable to rule out retinoblastoma.* (Consensus score: 80% [strongly agree: 33.33%; agree: 46.67%; neutral: 13.33%; disagree: 6.67%; strongly disagree: 0%])

Controversy over enucleation vs observation in ambiguous cases

In ambiguous cases, where it is near impossible to rule out retinoblastoma with noninvasive tests, biopsy techniques are not advised.⁷² Considering the extensive nature of the disease and poor prognosis, leading to the diagnostic dilemma, enucleation is recommended, so as to avoid life-threatening complications because of missed diagnosis of retinoblastoma.

Consensus Statement 4.5: *Enucleation is seldom performed as a treatment option in Coats disease and is limited to eyes wherein one cannot rule out retinoblastoma with certainty or in unsightly, painful blind eyes.* (Consensus score: 100% [strongly agree: 47.06%; agree: 52.94%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

Treatment timing and indications: Early intervention vs observation

Mild cases with retinal telangiectasias alone (Shields stage 1) with no exudation or imminent risk of vision loss can be observed periodically. If exudation is noted, laser photocoagulation is warranted. Additionally, more severe stages of the disease that are asymptomatic can be observed.

Consensus Statement 4.6: *Mild cases of the disease, not involving the posterior pole or vision threatening, can be observed.* (Consensus score: 82.35% [strongly agree: 23.53%; agree: 58.82%; neutral: 5.88%; disagree: 5.88%; strongly disagree: 5.88%])

Minimal disease treatment thresholds: Controversy over asymptomatic disease management

Focal leaks that are not involving the posterior pole, need not be treated. They can be periodically followed up and observed. The leaks that are threatening the fovea and advanced stages of the disease should be treated, even if the patient remains asymptomatic. Possibility of ablatio fugax or drop in vision after laser to posterior lesions needs to be discussed as macular edema may increase post laser. Sometimes foveal migration of hard exudates and resultant plaque formation also causes drop in vision in the long term.

Consensus Statement 4.7: *Asymptomatic diseases may still warrant treatment, especially if threatening the fovea.* (Consensus score: 100% [strongly agree: 47.06%; agree: 52.94%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

Controversy over treatment continuation in poor-prognosis cases: Quality of life vs anatomical success

considerations—resource allocation in developing countries

Maintaining globe and anatomical integrity, despite poor prognosis and advanced disease with a probable blind eye, is important. It not only maintains the appearance but becomes important in the overall development of the physical and mental status of the child. Laser, cryotherapy, or surgery may not be warranted in advanced asymptomatic cases. However, the option of enucleation should be considered in those with a painful blind eye, who need multiple treatment modalities to control the disease and maintain intraocular pressure.

Consensus Statement 4.8: *The risks and benefits should be weighed up before continuing treatment in poor-prognosis cases, especially in low-resource countries.* (Consensus score: 88.24% [strongly agree: 47.06%; agree: 41.18%; neutral: 11.76%; disagree: 0%; strongly disagree: 0%])

Laser photocoagulation: Treatment technique

variations—direct photocoagulation vs scatter approaches

Direct laser photocoagulation to the abnormal vessels is usually done. Scatter laser can be used in the thickened areas of the retina. Focal leaks threatening the fovea are treated directly with laser. A conventional green or yellow laser with a relatively long duration (0.1-0.5 seconds) is preferred to produce effective closure of the vessels.⁷⁴ Laser

photocoagulation also has been a traditional mainstay in treating Coats disease, used to obliterate aberrant retinal vessels and halt the progression of vascular leakage.^{75,76} The procedure can be guided by fluorescein angiography to accurately target areas of abnormal blood vessel growth while minimizing collateral damage to healthy tissues.^{77,78} It is crucial to acknowledge, however, that laser photocoagulation is not devoid of limitations, as it can lead to inflammatory responses that create traction on the retina, potentially resulting in epiretinal membrane formation and complications such as retinal detachment.⁷⁹

Consensus Statement 4.9: Direct treatment of aneurysmal lesions as well as dilated, telangiectatic vessels is recommended, with the hemoglobin being the pigment absorbing the laser energy. (Consensus score: 100% [strongly agree: 47.06%; agree: 52.94%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

Controversy over treatment extent beyond visible disease: treat CNP areas as well or treat only vascular malformations
Most authors advise FFA-guided treatment of the capillary nonperfusion areas, with laser, along with the treatment of the vascular malformations.

Consensus Statement 4.10: Laser treatment may be directed at areas of capillary nonperfusion once the retina is attached, in addition to treating the vascular malformations. (Consensus score: 100% [strongly agree: 35.29%; agree: 64.71%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

Cryotherapy: Indications, contraindications, and technical considerations

Cryotherapy is chosen over laser to treat peripheral vascular malformations, or over sites of exudative retinal detachment with vascular abnormalities where laser is not feasible.^{11,74} This method effectively targets abnormal peripheral retinal vasculature, promoting structural changes that can prevent further exudative complications. Localized freezing helps to significantly reduce vascular leakage, thereby facilitating the resolution of subretinal fluid and enhancing the chances of retinal reattachment.^{74,80,81} In cases of retinal detachment where laser treatment is not feasible, but where the cryoprobe can still be positioned close to the telangiectatic vessels using scleral indentation, double freeze-thaw cryotherapy offers a viable alternative. This approach is particularly suitable for peripheral lesions, including stage 3A and 3B disease.¹¹ Cryotherapy can, however, increase the exudative detachment, or cause macular edema because of the transient rise in inflammatory factors and may temporarily worsen subretinal exudation or exacerbate retinal detachment—a phenomenon known as ablatio fugax.^{11,72} Cryotherapy often requires multiple sessions. To minimize risks, it is generally recommended to limit cryotherapy to no more than 2 quadrants per session, with a 4-week interval between treatments. If retreatment in the same area is necessary, it should be delayed for at least 3 months, similar to laser therapy protocols, to allow sufficient time for exudation to resolve.¹¹ It is also conveniently

practiced in combination with anti-VEGF or intravitreal steroid agent, along with subretinal fluid drainage. A double freeze-thaw cryotherapy is recommended in Coats disease.

Consensus Statement 4.11a: Cryotherapy is indicated in peripheral vascular malformations, and to treat such malformations in areas of exudative retinal detachment where laser treatment is not feasible. (Consensus score: 76.47% [strongly agree: 29.41%; agree: 47.06%; neutral: 5.88%; disagree: 17.65%; strongly disagree: 0%])

Consensus Statement 4.11b: A double freeze-thaw cryotherapy is recommended in Coats disease. (Consensus score: 88.23% [strongly agree: 11.76%; agree: 76.47%; neutral: 11.76%; disagree: 0%; strongly disagree: 0%])

Cryotherapy vs laser photocoagulation selection criteria

It is preferable to use laser photocoagulation than cryotherapy wherever possible. Laser causes less inflammation post treatment. Cryotherapy can transiently worsen the subretinal fluid and detachments.

Consensus Statement 4.12: It is preferable to use laser photocoagulation than cryotherapy wherever possible. (Consensus score: 100% [strongly agree: 52.94%; agree: 47.06%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

Role of intravitreal steroids

Intravitreal steroids such as triamcinolone acetate or dexamethasone implant is used as an adjuvant therapy. The use of intraocular and periocular corticosteroids represents another strategic approach aimed at reducing intraocular inflammation, resolution of exudates, and edema associated with Coats disease.^{79,82,83} Corticosteroids, such as triamcinolone acetonide or dexamethasone implant administered locally, have demonstrated efficacy in decreasing subretinal fluid accumulation, thus facilitating an environment conducive to the healing of retinal structures.^{82,83} Combining these agents with anti-VEGF therapy may yield synergistic benefits, particularly in cases of extensive macular edema and persistent exudation where standalone treatments fall short.^{79,82,83}

They also can be used to combat the inflammatory side effects of therapeutic agents such as laser or cryotherapy. The adverse effects of steroids include cataract formation and glaucoma.

Consensus Statement 4.13: Intravitreal steroids may be combined with anti-VEGF agents in Coats disease for a synergistic effect as adjuvants to laser treatment. (Consensus score: 94.12% [strongly agree: 17.65%; agree: 76.47%; neutral: 0%; disagree: 5.88%; strongly disagree: 0%])

Combination Approaches: Anti-VEGF plus laser/cryotherapy sequencing

The introduction of anti-VEGF agents into the therapeutic arsenal has notably revolutionized the management of Coats disease, especially in recurrent or severe cases that do not respond adequately to standard therapies.⁸⁴⁻⁸⁶ These agents work by inhibiting the proliferative effects of VEGF,

which is frequently elevated in Coats disease because of abnormal vasculature and retinal ischemia. Studies have shown that combination therapies involving anti-VEGF injections are particularly beneficial when used alongside cryotherapy or laser treatments, leading to improved anatomical and functional outcomes.^{86,87} Such approaches may augment the resolution of exudative complications and ultimately contribute to visual recovery. To combat the risk of tractional retinal detachment secondary to anti-VEGF injection, a study was conducted to understand the combined treatment of anti-VEGF with laser.⁶⁷ It was found that laser combined with anti-VEGF was protective against vitreoretinal fibrosis, and tractional retinal detachment as compared to cryotherapy with anti-VEGF.

Consensus Statement 4.14: Combination of anti-VEGF with laser is preferred over anti-VEGF with cryotherapy. (Consensus score: 100% [strongly agree: 47.06%; agree: 52.94%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

Techniques of subretinal fluid drainage: combination with laser and intravitreal steroid

Usually the telangiectatic vessels are treated with laser, after subretinal fluid drainage, or cryotherapy. It is often combined with an intravitreal steroid agent to reduce the exudation and macular edema, if any. The post-cryotherapy inflammation also can be controlled by using an intravitreal steroid agent. Subretinal fluid drainage can be aided by using an anterior chamber maintainer in select cases. Cryotherapy and laser also can be performed with the aid of an endoilluminator.

Consensus Statement 4.15a: Subretinal fluid drainage through external approach is often combined with laser ablation and/or intravitreal steroid injection. (Consensus score: 94.11% [strongly agree: 35.29%; agree: 58.82%; neutral: 5.88%; disagree: 0%; strongly disagree: 0%])

Consensus Statement 4.15b: It is best to avoid internal subretinal fluid drainage through a small retinotomy as it carries a high risk of subsequent nonclosure. (Consensus score: 100% [strongly agree: 52.94%; agree: 47.06%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

Use of anterior chamber maintainer to aid subretinal fluid drainage or inject in to the vitreous cavity

An anterior chamber (AC) maintainer can be used to avoid sudden hypotony, during subretinal fluid drainage. However it should be well secured, and should not be mobile. In which case, an inadvertent lens touch can occur. Infusion in the anterior chamber is in general safer than injecting into the vitreous as it avoids inadvertent retinal injury (Figure 3).⁷⁴

Consensus Statement 4.16: An anterior chamber maintainer is safer to avoid hypotony over needle injection into the vitreous cavity during subretinal fluid drainage. (Consensus score: 82.36% [strongly agree: 41.18%; agree: 41.18%; neutral: 11.76%; disagree: 5.88%; strongly disagree: 0%])

Need for tamponade and role of silicone oil

Pars plana vitrectomy with or without transscleral drainage and silicone oil tamponade has been reported as an alternative treatment for Coats disease with retinal detachment.^{69,88,89} Although vitreoretinal surgery with silicone oil tamponade is associated with several disadvantages, particularly in children, such as cataract formation necessitating lensectomy, it remains a widely accepted practice.

Silicone oil may be preferred in certain complex cases on a case-by-case basis, as it can provide additional stability and support in challenging surgical situations.

Consensus Statement 4.17: Long-term silicone oil tamponade may be preferred in some cases following vitrectomy in Coats disease. (Consensus score: 88.23% [strongly agree: 5.88%; agree: 82.35%; neutral: 11.76%; disagree: 0%; strongly disagree: 0%])

Do all cases of stage 3 and 4 warrant surgery?

It remains patient specific, with adequate surgeon discretion. Surgery is usually planned for detachments that are amenable to treatment and can be settled. Posterior pole status, presence of fibrosis, scarring, extent of exudation and detachment, intraocular pressure, and the other eye status also play an important role in management. In cases with subretinal fluid, in which the laser does not take effect and cryotherapy may worsen the anatomic structure, the endolaser photocoagulation performed via a 2-port pars plana no-vitrectomy approach may take effect. Zhao and associates reported that the approach combined with external drainage of subretinal fluid and intravitreal injection of anti-VEGF is an effective treatment for advanced Coats disease with serous retinal detachment.⁹⁰⁻⁹³ Still, it is more invasive than regular laser photocoagulation and should be performed with caution.

Consensus Statement 4.18: All cases of stage 3 and 4 of Coats disease do not warrant surgery: it should be a patient-specific decision. (Consensus score: 70.59% [strongly agree: 17.65%; agree: 52.94%; neutral: 5.88%; disagree: 17.65%; strongly disagree: 5.88%])

Indications for enucleation in stage 5

Enucleation can be considered in cases of painful blind eye and for appearance purposes.

Consensus Statement 4.19: Painful blind eye and appearance are the indications of enucleation in stage 5 disease. (Consensus score: 94.12% [strongly agree: 23.53%; agree: 70.59%; neutral: 5.88%; disagree: 0%; strongly disagree: 0%])

SECTION 5: SPECIAL POPULATION CONTROVERSIES

Adult-onset disease: Different characteristics and treatment approaches

Difference in the features seen in Coats among adults, as compared to the pediatric population, is as mentioned above. In the study by Hansraj and associates on Coats,⁵⁴

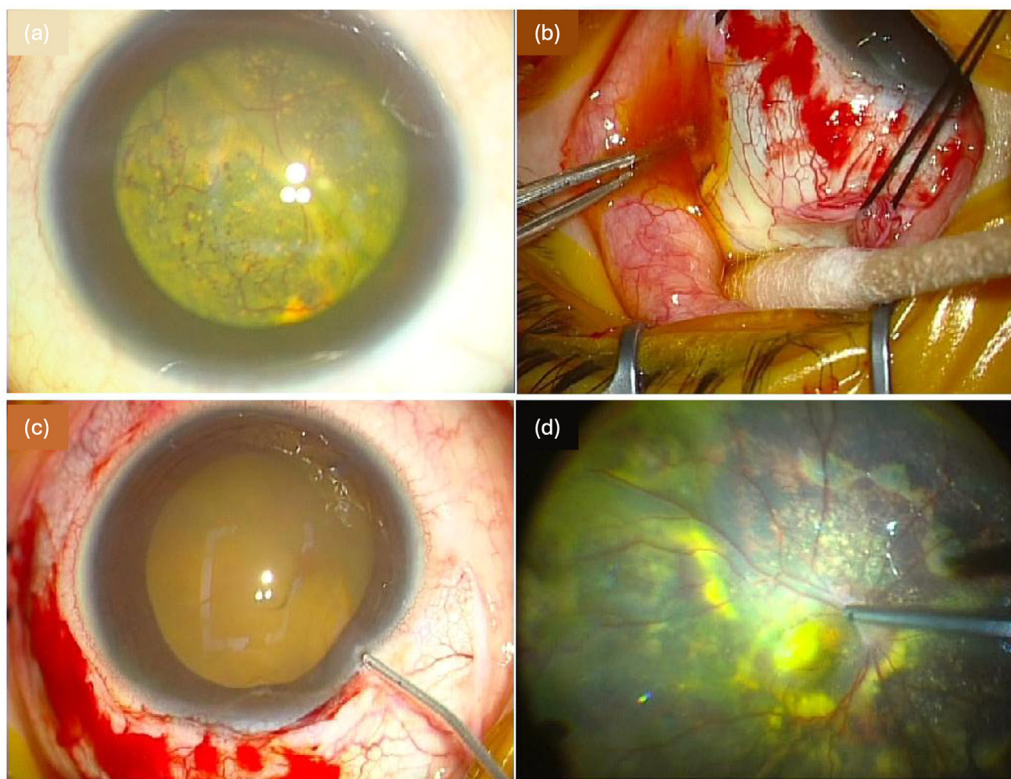


FIGURE 3. Surgery for stage 3B Coats disease in an 8-year-old boy. **A.** Total exudative retinal detachment before the surgery. **B.** External subretinal fluid drainage. **C.** Infusion of balanced salt solution enriched with bicarbonate, dextrose, and glutathione (BSS PLUS) through an ACM is a good alternative method. Intraocular pressure can also readily be maintained by BSS PLUS infusion through an ACM (points added by authors of this paper). **D.** During vitrectomy, the retina is reattached after external subretinal fluid drainage. ACM = anterior chamber maintainer. (Adapted from Kusaka.⁷⁴)

the most common stages were 2A and 2B. Of the 58 patients who remained on periodic follow-up, 2 were observed, 53 underwent treatment, and only 3 were identified to be better left alone. Almost 43% eyes underwent laser application alone, about 2% cryotherapy alone, and 38% were advised combination of anti-VEGF and steroid with ablation. None of the eyes needed enucleation, and only 2 eyes underwent cyclo-destructive measures to reduce the intraocular pressure. A mean of just 1.7 sessions of laser were needed for disease stabilization. In case of combination therapy, mean of 2 sessions of ablative treatment and 2.7 intravitreal injections were needed. None underwent surgical intervention. Hence, the treatment requirement and extent of the disease were less severe compared with the pediatric population. The outcomes were much better: almost 45% remained stable, 40% had resolution of the disease, 5% showed improvement, and only 10% worsened. In addition, 24 eyes maintained vision between 20/20 and 20/70. The complications included 0 subfoveal nodule formation, 4 cases that developed neovascular glaucoma, and only 1 painful blind eye. Hence treatment for Coats disease remains less aggressive, and focal, as compared to pediatric cases.

Consensus Statement 5.1: Adult-onset Coats is less severe than pediatric disease and warrants less invasive methods of in-

tervention. (Consensus score: 100% [strongly agree: 17.65%; agree: 82.35%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

Bilateral disease: Management strategies and prognosis

Bilateral involvement of the disease is actually a Coats-like phenotype that has been reported by a few authors. They have, however, established the gross asymmetry of the disease between both eyes.⁹⁴ A careful peripheral retinal examination of the other eye with periodic follow-up is of utmost importance to not miss a quiescent disease. Treatment strategies and plan remain almost similar to unilateral Coats, where ablative therapy is advised as soon as exudation and fluid leakage are noted. In doubtful cases, a wide-field angiography is essential to establish the diagnosis. There are reports of cases that were left untreated, which progressed to neovascular glaucoma.^{45,95}

Consensus Statement 5.2: Bilateral cases of Coats-like disease with asymmetric presentation have been reported. Hence, periodic evaluation of the other eye can help in early diagnosis and timely intervention in such cases as well. (Consensus score: 100% [strongly agree: 47.06%; agree: 52.94%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

SECTION 6: PROGNOSTIC CONTROVERSIES

Disease extent at diagnosis correlation with outcomes: advanced stage of disease or extent of retinal detachment and involving the macula

It is suggested that patients who present with stages 1 to 3 of Coats disease have better visual prognosis and outcomes than those with more advanced stages.¹¹ More advanced disease may also correlate with the need for surgical intervention or sometimes even enucleation, whereas early stages of the disease can be managed with ablative modalities or intravitreal agents. More advanced stages showed poor outcomes because of persistent retinal detachment, extensive exudation, and macular scarring.³

Advanced stage at presentation (stage 3B and above), development of vitreoretinal fibrosis (preretinal and subretinal), extent of involvement of the disease, vitreous hemorrhage, cataract, tractional or combined retinal detachment, and anterior hyaloid proliferation are poor prognostic factors for globe salvage in advanced disease.⁷¹

The presence of subretinal gliotic nodule or scar suggests poor functional outcomes.⁷¹

Consensus Statement 6.1: *There exists a significant correlation between extent of the disease at diagnosis and outcomes post treatment. (Consensus score: 100% [strongly agree: 41.18%; agree: 58.82%; neutral: 0%; disagree: 0%; strongly disagree: 0%])*

Controversy over anatomical vs functional success definitions

Anatomical success and globe salvage need not always equate with good functional outcomes. This is especially true in advanced stages of the disease. With better local treatments and combination therapy, the rates of enucleation for Coats disease have reduced over the years. However, significant improvement in functional outcomes may not be seen.

According to our study, factors associated with anatomical improvement included localized extent of the disease, clear lens at presentation and at subsequent follow-ups, complete regression of telangiectatic vessels, absence of vitreoretinal fibrosis, eyes requiring less number of ablative treatment sessions, vitreous hemorrhage. Tractional or combined retinal detachment and subretinal gliosis.⁷¹

Structural factors for poor prognosis and vision salvage include cataract formation and subfoveal pigmentary scar or gliotic nodule. The functional factors were poor adherence to patching and amblyopia management or lack of adequate visual rehabilitation.⁷¹

Consensus Statement 6.2: *Successful anatomical outcomes do not necessarily imply good functional outcomes. (Consensus score: 100% [strongly agree: 52.94%; agree: 47.06%; neutral: 0%; disagree: 0%; strongly disagree: 0%])*

Retreatment indications

The indications for retreatment include recurrence of exudation, development of new telangiectatic vessels, and

worsening of the subretinal fluid or exudative retinal detachment.

Ong and associates suggested that aggressive early repeat treatment can help in early anatomic control of the disease progression and better outcomes.⁹⁶

Consensus Statement 6.3: *The indications for retreatment include recurrence of exudation, development of new telangiectatic vessels, and worsening of the subretinal fluid or exudative retinal detachment. (Consensus score: 100% [strongly agree: 47.06%; agree: 52.94%; neutral: 0%; disagree: 0%; strongly disagree: 0%])*

Monitoring for secondary glaucoma and cataract and recurrence of exudation

The dreaded complication, leading to a painful blind eye and enucleation, is neovascular glaucoma in Coats. A study by Daruich and associates found that the presence of exudative retinal detachment at the time of diagnosis was also an independent risk factor for the development of cataract.⁹⁷ They also concluded that cataract progression is a marker for poor functional outcomes and prognosis.⁹⁷ Hence, periodic follow-up until the disease has regressed completely is of utmost importance to ensure adequate control of the disease, and to identify any secondary complications, at the earliest so that timely intervention can be provided.

Consensus Statement 6.4: *A close follow-up and monitoring for identifying recurrence or development of cataract and glaucoma is essential in cases of Coats disease. (Consensus score: 100% [strongly agree: 64.71%; agree: 35.29%; neutral: 0%; disagree: 0%; strongly disagree: 0%])*

SECTION 7: EMERGING CONCEPTS

Newer treatment modalities

The newer upcoming anti-VEGF agents may prove to be beneficial in Coats disease. They may offer a longer duration of action within the eye, and hence can reduce the burden of recurrent injections. Depot drug delivery and sustained drug delivery systems are being developed for various retinal conditions that require longer intravitreal activity of the drug. There are no depot agents except for the dexamethasone implant that is commonly used as of now, for Coats disease, which has shown to be relatively safe.

Consensus Statement 7.1: *Newer anti-VEGF agents may prove to be more beneficial, safer, and a longer-lasting option in the management of Coats disease, especially in pediatric cases. (Consensus score: 64.7% [strongly agree: 29.41%; agree: 35.29%; neutral: 29.41%; disagree: 5.88%; strongly disagree: 0%])*

Artificial intelligence in retinal disease

Artificial intelligence (AI) is actively being developed and used to diagnose and follow up multiple disorders in the eye, including those involving the retina.^{98,99,100,101} Although no such tool has been developed for Coats disease as yet, an integration of machine learning with investigative

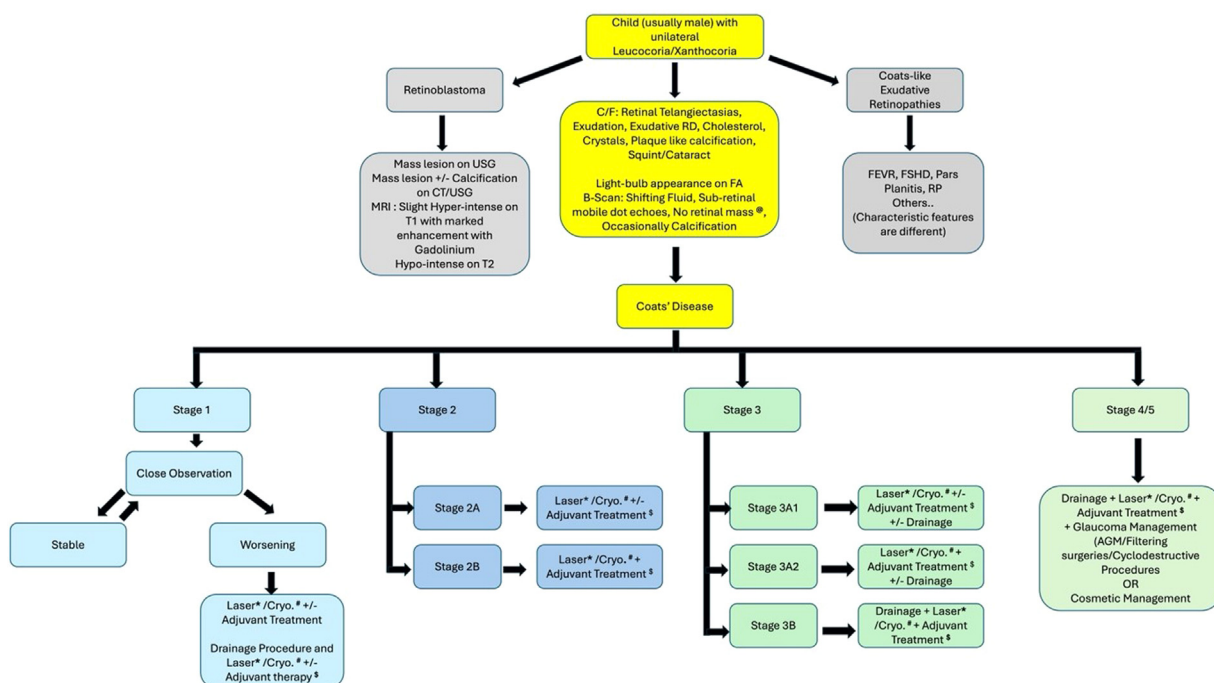


FIGURE 4. Suggested management algorithm of Coats disease. ^aPreferred approach over cryotherapy. ^bWherever laser is not possible. ^cIntravitreal anti-VEGF injection or intravitreal/subtenon steroid injection. ^dNo retinal mass lesion but subretinal clumped exudates may present like a mass. AGM = antiglaucoma medications, anti-VEGF = anti-vascular endothelial growth factor, C/F = clinical features, CT = computed tomography, FA = fluorescein angiography, FEVR = familial exudative vitreoretinopathy, FSHD = fascioscapulohumeral dystrophy, MRI = magnetic resonance imaging, RD = retinal detachment, RP = retinitis pigmentosa, USG = ultrasonography.

modalities can help in prompt and correct diagnosis, to aid in appropriate management of Coats disease in the future. Further development of prognostication tools with specific markers may add value in management of the disease, in the future.

Consensus Statement 7.2: AI-based tools for diagnosis and prognostication of the disease will add a great advantage in the uniform management of Coats disease. (Consensus score: 52.94% [strongly agree: 0%; agree: 52.94%; neutral: 47.06%; disagree: 0%; strongly disagree: 0%])

Options in resource-limited settings

The cost-effective options to manage Coats disease in these settings include laser and intravitreal steroid agents like triamcinolone acetonide (TA), as compared to vitrectomy or repeated anti-VEGF injections. Studies have evaluated the beneficial role of IVTA in the resolution of exudative retinal detachment, macular hard exudates, and subretinal fluid in patients with Coats disease.¹⁰²⁻¹⁰⁵ Bergstrom and associates, however, cautioned against the use of combining cryotherapy and IVTA in the management of Coats disease after they reported a higher incidence of rhegmatogenous retinal detachment and proliferative vitreoretinopathy.¹⁰⁵ TA is more economical than dexamethasone implants and can be used as an option where cost constraints are at play. Some authors have

used subtenon steroids as an adjunct in stages 2A and above.¹⁰⁶

Consensus Statement 7.3: Laser and intravitreal steroids (IVTA) are cost-effective options in managing Coats disease in low-resource settings. (Consensus score: 88.24% [strongly agree: 23.53%; agree: 64.71%; neutral: 11.76%; disagree: 0%; strongly disagree: 0%])

Lack of high-quality evidence for treatment decisions

Considering the not so common nature of the disease, pediatric population involvement, along with the varied presentations and difficulties in diagnosis, it becomes challenging to conduct large-scale trials that could aid in appropriate diagnosis, decision making on management, and to develop a consensus on the management. However, there is a need for standardization of protocols for the disease across centers, so as to bring in uniformity in management and to develop an algorithmic approach to achieve the best anatomical and functional outcomes in majority of the cases.

Consensus Statement 7.4: There is a lack of high-quality evidence for treatment decisions, and standardization of treatment protocols in Coats disease is essential. (Consensus score: 100% [strongly agree: 35.29%; agree: 64.71%; neutral: 0%; disagree: 0%; strongly disagree: 0%])

Figure 4 shows a suggested management algorithm of Coats disease.

RESULTS OF VOTING AND DISCUSSION

Table 5 summarizes the outcomes of the voting on the consensus statements.

With respect to definition and classification, a consensus was achieved on most controversies. As reported earlier,⁴ Coats syndrome and Leber miliary aneurysms were considered part of the spectrum of Coats-like disease (Consensus statement 1.1), with a 100% consensus on the requirement of telangiectasias to make a diagnosis, and exudation to help in staging (Consensus statement 1.3). As previously described, Coats was understood to be milder, with better prognosis (Consensus statement 1.4). The expert panel agreed that the Shields classification was comprehensive, and that it was the preferred grading system (Consensus statement 1.5).

Similar consensus was obtained in most scenarios concerning etiology and pathogenesis of the disease. The majority (92.3%) expressed the need for molecular screening in syndromic or bilateral cases (Consensus statement 2.1), and 76.5% (Consensus statement 2.2) stated that Coats-like response was usually milder, warranting less aggressive treatment in most cases. All (100%) agreed that systemic screening was not routinely advised, and was reserved for bilateral cases (Consensus statement 2.3). The use of Shields-Daruich substage classification to prognosticate the disease was recommended (Consensus statement 2.4 and 2.5) on the same lines as previous literature.^{11,13} The panel, however, accepted that establishing a staging system using visual potential was challenging because of multiple variable factors (Consensus statement 2.6). Contrary to earlier reports,^{3,33} there remained some inconsistency regarding the relationship between Coats-like response and other retinal vascular disorders, with only 64.7% consensus (Consensus statement 2.7). In addition, 84.6% and 92% acknowledged the significance of an inflammatory component and role of VEGF in the pathogenesis of the disease, respectively (Consensus statements 2.8 and 2.9). A unanimous consensus was achieved with regard to the histopathology (Consensus statement 2.10).

The expert panel conceded entirely on statements regarding the mild presentation of Coats (Consensus statement 3.1), the need for wide-field angiography (Consensus statement 3.4), and inadequacy of ultrasonography in differentiating Coats from retinoblastoma (Consensus statement 3.5). Although the recommendation was angiography in all cases (Consensus statement 3.2), the panel agreed on the probable challenges, and need for general anesthesia in children (Consensus statement 3.3).

As widely accepted,⁶¹ the panel unanimously agreed on the preferred wavelength of laser being 532 nm or 577 nm (Consensus statement 4.1), direct treatment targeting the aneurysms (Consensus statement 4.9), and benefit of laser to the capillary nonperfusion areas after retinal reattach-

ment (Consensus statement 4.10). As reported in literature,⁸⁹⁻⁹¹ anti-VEGF was considered only as an adjuvant and not as the sole modality of treatment (Consensus statement 4.2). Most of the experts suggested that although enucleation is seldom performed, it can be considered in painful blind eyes, for appearance (Consensus statement 4.5), or in situations when retinoblastoma is strongly suspected (Consensus statement 4.4). In advanced cases in low-resource settings, the need for and modality of treatment should be identified, weighing the risks and benefits (Consensus statement 4.8). Along the lines of previous reports,^{11,73} the panel suggested cryotherapy in peripheral vascular malformations or in cases with exudative retinal detachment (Consensus statement 4.11), with double freeze-thaw being preferred (Consensus statement 4.12). The panel was undivided with laser being favored over cryotherapy (Consensus statement 4.13), along with an anti-VEGF (Consensus statement 4.15). In addition, 94% agreed that a combination of anti-VEGF with intravitreal steroids may provide a synergistic effect (Consensus statement 4.14). The panel was in complete accord regarding external subretinal fluid drainage over vitrectomy with drainage retinotomy (Consensus statements 4.3 and 4.16b), and advocated use of an anterior chamber maintainer for the same (Consensus statement 4.17). Subretinal fluid drainage was to be combined with laser ablation or with intravitreal steroid (Consensus statement 4.16a). A variable response (70%) was noted with regard to surgical management of stage 3 and 4 disease (Consensus statement 4.19).

The panel was in complete agreement regarding Coats being less severe compared with pediatric cases (Consensus statement 5.1) and described the need for periodic evaluation of the unaffected eye for early diagnosis and management of bilateral disease (Consensus statement 5.2).

A unanimous response was noted with respect to prognostic controversies such as importance of extent of the disease (Consensus statement 6.1), discrepancy between successful anatomical and functional outcomes (Consensus statement 6.2), indications of retreatment such as development of new telangiectatic vessels or worsening of exudative retinal detachment (Consensus statement 6.3), and the need for close follow-up to identify early recurrence (Consensus statement 6.4).

However, a varied consensus was noted with regard to the possible benefits of newer anti-VEGF agents (Consensus statement 7.1) and the benefit of AI-based tools for either diagnosis or prognostication (Consensus statement 7.2): 64.7% and 52.9%, respectively. Most experts conceded the importance of IVTA with laser in low-resource settings (Consensus statement 7.3) and the need for standardization of protocols in management of the disease (Consensus statement 7.4).

Many of the results of the consensus statements are also reflected in a recently published large study involving >600 eyes, which found unilateral Coats disease to predominantly affect males, laser photocoagulation to be the main-

TABLE 5. Results of Voting of the Key Consensus Statements of Coats Disease.

Section	Consensus Statements	Final Score	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. Definition and Classification Controversies							
1.1	Coats disease, Coats syndrome, and Leber miliary aneurysms represent different spectra of Coats-like phenotype.	100	29.41	70.59	0	0	0
1.2	Bilateral Coats disease is more likely to be a part of the spectrum of conditions from Coats-like phenotypes rather than true Coats disease and such bilateral Coats-like phenotypes may be more common in females.	76.47	29.41	52.94	11.76	5.88	0
1.3	Telangiectasias are requisite to making the diagnosis of Coats disease and presence, and knowing the extent of exudation helps in staging.	100	60	40	0	0	0
1.4	Adult-onset Coats is generally milder and has a better prognosis.	100	47.06	52.94	0	0	0
1.5	Shields classification system is more complete, encompassing all stages of the disease, and is the preferred staging system. A composite Shields-Daruich classification could be helpful.	100	29.41	70.59	0	0	0
2. Etiology and Pathogenesis Controversies							
2.1	Molecular screening in Coats disease is unnecessary but is mandatory in case of syndromic or bilateral presentation.	92.3	15.38	76.92	7.69	0	0
2.2	Coats-like responses can be seen in various diseases but are usually milder and need a less aggressive treatment approach.	76.47	5.88	70.59	23.53	0	0
2.3	Systemic screening is not routinely advised in Coats disease except in atypical presentations such as bilateral disease in a young female.	100	41.18	58.82	0	0	0
2.4	The substage classifications in the Shields and Daruich classification systems help in disease prognostication and treatment planning.	86.66	13.33	73.33	13.33	0	0
2.5	Severity-based classification with subcategorization of the disease such as the Shields classification allows treatment decisions and helps to prognosticate.	93.33	13.33	80	6.67	0	0
2.6	Establishing a staging system that incorporates visual potential is challenging because of factors like chronicity and amblyopia, although certain clinical features such as subfoveal involvement may strongly influence the outcomes.	92.86	21.43	71.43	0	7.14	0
2.7	A relationship between Coats-like response in various other retinal vascular disorders is well known and described.	<u>64.71</u>	23.53	41.78	17.65	11.76	5.88
2.8	There is a significant inflammatory component involved in the pathogenesis of Coats disease.	84.61	15.38	69.23	7.69	7.69	0
2.9	VEGF molecules play a role in the pathogenesis of Coats disease. However, whether they are the trigger or a consequence is not precisely known.	92.31	23.08	69.23	0	7.69	0
2.10	Disruption of the pericytes and endothelial cells is seen on histopathology in Coats disease.	100	15.38	84.62	0	0	0
2.11	Lipid metabolism abnormality may be seen in adult-onset Coats; however, it is not related to the juvenile form in which the pathology is exudative in nature.	75	16.67	58.33	16.67	0	8.33
3. Diagnostic Controversies							
3.1	Adult-onset Coats is usually mild and does not require subretinal fluid drainage but can be treated with intravitreal steroids or anti-VEGF agents and laser photocoagulation.	100	23.53	76.47	0	0	0

(continued on next page)

TABLE 5. (continued)

Section	Consensus Statements	Final Score	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
3.2	Angiography is strongly recommended in every single case of Coats to identify leaking vascular anomalies and delineate the extent of the affected retina including nonperfusion to aid treatment.	92.85	57.14	35.71	0	7.14	0
3.3	Angiography is difficult in children but should be strongly recommended to be performed under general anesthesia if the facility of handheld fundus camera with angiography module is available.	92.85	35.71	57.14	7.14	0	0
3.4	Wherever available, wide-field angiography should be performed in adults and in cooperative children to identify peripheral leaking vascular anomalies.	100	64.29	35.71	0	0	0
3.5	Although ultrasonography may aid in differentiating between Coats disease and retinoblastoma, it is not conclusive, particularly in differentiating anterior diffuse infiltrating retinoblastoma. Often neuroimaging such as MRI and clinical acumen is required for differentiation.	100	52.94	47.06	0	0	0
4. Treatment Controversies							
4.1	The aim of laser treatment is to ablate the avascular retina and occlusion of the telangiectatic vessels, and hence the preferred wavelength is 532 nm or 577 nm.	100	46.67	53.33	0	0	0
4.2	Anti-VEGF agents may aid in treatment of Coats disease but is not the primary agent of choice.	100	46.67	53.33	0	0	0
4.3	Where possible, it is preferable to perform external drainage of subretinal fluid and reattach the retina rather than perform vitrectomy.	100	47.06	52.94	0	0	0
4.4	It is better to enucleate a blind eye than perform biopsy, wherein one is unable to rule out retinoblastoma.	80	33.33	46.67	13.33	6.67	0
4.5	Enucleation is seldom performed as treatment option in Coats disease and is limited to eyes wherein one cannot rule out retinoblastoma with certainty or in unsightly, painful blind eyes.	100	52.94	47.06	0	0	0
4.6	Mild cases of the disease, not involving the posterior pole or vision threatening, can be observed.	82.35	23.53	58.82	5.88	5.88	5.88
4.7	Asymptomatic diseases may still warrant treatment, especially if threatening the fovea.	100	47.06	52.94	0	0	0
4.8	The risks and benefits should be weighed up before continuing treatment in poor-prognosis cases, especially in low-resource countries.	88.24	47.06	41.18	11.76	0	0
4.9	Direct treatment of aneurysmal lesions and dilated, telangiectatic vessels is recommended, with the hemoglobin being the pigment absorbing the laser energy.	100	47.06	52.94	0	0	0
4.10	Laser treatment may be directed at areas of capillary nonperfusion once the retina is attached, in addition to treat the vascular malformations.	100	35.29	64.71	0	0	0
4.11a	Cryotherapy is indicated in peripheral vascular malformations, and to treat such malformations in areas of exudative retinal detachment where laser treatment is not feasible.	76.47	29.41	47.06	5.88	17.65	0
4.11b	A double freeze-thaw cryotherapy is recommended in Coats disease.	88.23	11.76	76.47	11.76	0	0
4.12	It is preferable to use laser photocoagulation than cryotherapy wherever possible.	100	52.94	47.06	0	0	0
4.13	Intravitreal steroids may be combined with anti-VEGF agents in Coats disease for a synergistic effect as adjuvants to laser treatment.	94.12	17.65	76.47	0	5.88	0

(continued on next page)

TABLE 5. (continued)

Section	Consensus Statements	Final Score	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
4.14	Combination of anti-VEGF with laser is preferred over anti-VEGF with Cryotherapy.	100	47.06	52.94	0	0	0
4.15a	Subretinal fluid drainage through external approach is often combined with laser ablation and/or intravitreal steroid injection.	94.11	35.29	58.82	5.88	0	0
4.15b	It is best to avoid internal subretinal fluid drainage through a small retinotomy as it carries a high risk of subsequent nonclosure.	100	52.94	47.06	0	0	0
4.16	An anterior chamber maintainer is safer to avoid hypotony over needle injection into the vitreous cavity during subretinal fluid drainage.	82.36	41.18	41.18	11.76	5.88	0
4.17	Long-term silicone oil tamponade may be preferred in some cases following vitrectomy in Coats disease.	88.23	5.88	82.35	11.76	0	0
4.18	All cases of stage 3 and 4 of Coats disease do not warrant surgery: it should be a patient-specific decision.	<u>70.59</u>	17.65	52.94	5.88	17.65	5.88
4.19	Painful blind eye and appearance are the indications of enucleation in stage 5 disease.	94.12	23.53	70.59	5.88	0	0
5. Special Population Controversies							
5.1	Adult-onset Coats is less severe than pediatric disease and warrants less invasive methods of intervention.	100	17.65	82.35	0	0	0
5.2	Bilateral cases of Coats-like disease with asymmetric presentation have been reported. Hence, periodic evaluation of the other eye can help in early diagnosis and timely intervention in such cases as well.	100	47.06	52.94	0	0	0
6. Prognostic Controversies							
6.1	There exists a significant correlation between extent of the disease at diagnosis, and outcomes post treatment.	100	41.18	58.82	0	0	0
6.2	Successful anatomical outcomes do not necessarily imply good functional outcomes.	100	52.94	47.06	0	0	0
6.3	The indications for retreatment include recurrence of exudation, development of new telangiectatic vessels and worsening of the subretinal fluid or exudative retinal detachment.	100	47.06	52.94	0	0	0
6.4	A close follow-up and monitoring for identifying recurrence or development of cataract and glaucoma is essential in cases of Coats disease.	100	64.71	35.29	0	0	0
7. Emerging Concepts							
7.1	Newer anti-VEGF agents may prove to be more beneficial, safer, and a longer-lasting option in the management of Coats disease, especially in pediatric cases.	<u>64.7</u>	29.41	35.29	29.41	5.88	0
7.2	AI based tools for diagnosis and prognostication of the disease will add a great advantage in the uniform management of Coats disease.	<u>52.94</u>	0	52.94	47.06	0	0
7.3	Laser and intravitreal steroids (IVTA) are cost-effective options in managing Coats disease in low-resource settings.	88.24	23.53	64.71	11.76	0	0
7.4	There is a lack of high-quality evidence for treatment decisions, and standardization of treatment protocols in Coats disease is essential.	100	35.29	64.71	0	0	0

anti-VEGF = anti-vascular endothelial growth factor, IVTA = intravitreal triamcinolone acetonide, MRI = magnetic resonance imaging.

All values are expressed as percentages.

Consensus Score (C Score) was defined as the value of the summation of the "strongly agree" and "agree" percentages. C Score $\geq 75\%$ was considered "consensus achieved" and C Score $< 75\%$ was "consensus not reached." Only 4 statements were "consensus not achieved" (nonbold and underlined).

stay of treatment, subfoveal nodule as indicating poor visual prognosis, and that anti-VEGF may help prevent enucleation in advanced cases.^{107,108}

In conclusion, Coats disease presents numerous controversies across its definition, pathogenesis, diagnosis, and management spectrum. These debates reflect the rarity of the condition, its complex pathophysiology, and the challenges of treating a progressive blinding disease primarily affecting children. The lack of randomized controlled trials and the reliance on case series and expert opinion contribute to ongoing controversies in management approaches. In our study, most experts agreed on the suggested classification, diagnosis, and prognosis. The controversy, however, remained in questions regarding association

with other vascular disorders, treatment of stages 3 and 4, possible benefits of newer anti-VEGFs, and the role of AI. These debates reflect the rarity of the condition, complex pathophysiology, and the challenges of treating a progressive blinding disease primarily affecting children. Hence further studies are warranted, especially in areas that have not reached a consensus. Resolution of these controversies requires international collaboration, standardized diagnostic criteria, outcome measures, and well-designed clinical trials adapted to the unique challenges of rare pediatric retinal diseases. As our understanding of the molecular mechanisms improves and novel therapeutic approaches emerge, more evidence-based and personalized treatment strategies for Coats disease will likely develop.

Funding/Support: This work was supported by Ms. May Lam Research and Education Fund of The Primasia International Eye Research Institute (PIERI) of the Chinese University of Hong Kong (Shenzhen); Shun Hing Education and Charity Fund; Bright Future Charitable Foundation Postgraduate Education Fund; and Daniel & Co Scholarship. **Financial Disclosures:** The sponsor had no role in the design or conduct of the research. All authors attest that they meet the current ICMJE criteria for authorship.

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