

# Adapting Kuhnian Theories to the Field of Retinal Pathologies Crisis or Revolution

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## ABSTRACT

**Purpose:** Reviewing the state of medical retinal knowledge according to the theories of Thomas Kuhn

**Methods:** We have reviewed the medical literature on various pathologies in retina, comparing them with Thomas Kuhn's theories as written in *The Structure of Scientific Revolutions*.

**Results:** It seems that in AMD, neovascular forms but also geographic atrophy more recently, and retinal dystrophies reach a state of normal science, while myopia, pachychoroid diseases are in crisis. For vascular retinal disorders, we couldn't conclude.

**Conclusion:** Each retina specialty now evolves independently, alternating between normal science and crisis. It seems that the crisis experienced by myopia and pachychoroid specialists can be resolved.

## Keywords

Retina, Crisis, Revolution, Epistemology.

## Introduction

There are several milestones on the road to scientific knowledge and problem-solving. Thomas Kuhn, the eminent 20th-century philosopher of science, theorized about relativistic science in his major work, *The Structure of Scientific Revolutions*, published in 1962 [1]. He theorized the following two phases of science: the "normal" phase of confirming the scientific theories of the day (known as a paradigm), and the phases of refounding knowledge.

Although the existence of this paradigm is well-supported by Kuhn, its consequences are ambivalent. This serves as a framework for research, enabling us to deepen the knowledge that would otherwise be uninterpretable. However, it also defends the fluid appearance of new theories, modifying scientists' appreciation of facts guided by the expectation of a result validating the paradigm.

In "normal" science, there are three types of discoveries: those that confirm that the paradigm works, those that confirm the results derived from the paradigm, and those that correct ambiguities in the paradigm (an updated classification).

When a problem resists understanding, there is significant awareness of the anomaly and the emergence of its recognition, which leads to a change in paradigmatic mechanisms. In addition to the resistance of the majority to the breach in the paradigm, there is a relaxation of the rules of problem-solving, which Kuhn describes as the only characteristic that bears the beginnings of its demise. The rest of the time, he noted, the more rigid the paradigm, the more visible the problems, and therefore, the more open it is to discover.

When awareness of an anomaly persists without a solution emerging, we speak of a growing crisis. This is highly frustrating for scientists who are stuck using a paradigm in which obsolescence has already been programmed. Outside this framework, a crisis is desirable as

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it is a condition for revolution. It can come from normal science in the face of a challenge that arises more frequently through an application that does not work or through a combination.

Kuhn's theories are old, and the examples he uses come more often from physics and chemistry than that from medicine; however, his grid for reading the state of knowledge in a specific field is generalizable to any scientific discipline. Therefore, we focused on the Kuhnian scientific phase of various retinal pathologies. Every field could have been studied for an entire article, reporting all the steps of its development. For clarity, we chose to focus on actual problems.

## Methods

In this study, we applied Thomas Kuhn's theoretical framework on the structure of scientific revolutions to the field of retinal diseases, including age-related macular degeneration (AMD), myopia, retinal dystrophies, pachychoroid spectrum disorders, and vascular retinal diseases. The analysis was conducted through a qualitative review of historical and contemporary literature to identify paradigmatic shifts in understanding, diagnosis, and treatment approaches. Key phases of scientific progression—normal science, anomaly recognition, crisis, and paradigm shift—were mapped to advancements in retinal disease research. This interdisciplinary approach aimed to reveal how paradigm changes have shaped current clinical and research practices in ophthalmology.

## Results

### Age-related macular degeneration

Age-related macular degeneration corresponds to aging of the retina in a pathological mode, with the accumulation of deposits resulting from photoreceptor regeneration. The two complications, neovascularization and atrophy, have different clinical histories and treatments [2]. While targeted anti-VEGF treatment of the neovascular complication has, solved rare therapeutic problems over the past 15 years, geographic atrophy has not been completely comprehended. A breakthrough came with genetics and histology, which identified complement factors as the keystone of pathophysiology, reversing the degenerative paradigm in favor of an inflammatory interpretation [3]. Since this decades-long crisis, the prospect of a normal scientific explanation for geographic atrophy seems to be dawning, with new tools for describing the retinal pigment epithelium that is to be preserved, either using anti-complement factors, stem cell transplants, or subretinal implants [4].

### Myopia

Myopia, the incidence of which is increasing in the developed world, is linked to inappropriate near-vision habits. Although the scleral extracellular matrix is modified, the mechanism through which repeated defocusing induces these changes is not understood [5]. Consequently, corrective lenses slowing down myopia's progression in children have been developed, whose mechanism of action is imperfectly understood; however, they show significant myopia-braking results [6]. The pitfall here

is to indulge in promising effective solutions, sometimes to the detriment of the energy devoted to a holistic understanding of the myopia phenomenon. As a result, scientists are stuck with empirical treatments associated with a poor comprehension of the underlying physiopathology creating a growing crisis. As Kuhn describes the frustration of scientists in a growing crisis; clinicians must be aware of the anomaly, even as empirical solutions emerge.

### Pachychoroid

Recently, central serous chorioretinopathy and retinal serosal elevations of unknown causes have been integrated into a new classification system, linking them to a variety of phenotypes whose choroidal genesis has served as an association revealer [7]. Apart from the pleasing coherence resulting from this classification, some consequential associations have rather added vagueness to the borderline forms. CRSC now has borderline forms with AMD, and the polyps are cut in half between the two [8]. The pathophysiology of pachychoroid (whose strict definition is hard to come by, in that the choroid is sometimes no thicker) remains misunderstood. The hormonal theory has lost some feathers on the altar of antiandrogens, the various vascular theories are organized in a labyrinthine cycle with no real point of entry (watershed zones of choroidal veins leading to pachyvessels, which cause ischemia of the choriocapillaris, thus creating an epitheliopathy), and the infectious theories are not unanimously accepted [9]. Overall, it is a crisis. One of the signs of the crisis is this attempt at pachychoroid classification, which once again, helps bring a empirical organization without improving our understanding of the pathology. We could add frustrating elements for the clinician to support the state of crisis, such as the absence of treatments other than PDT, focal laser, and anti-VEGF, which are derivatives of other understandings, and the absence of any form of continuity between diffuse retinal epitheliopathy and CRSC.

### Vascular Diseases

The pathophysiology of retinal vein occlusions does not correspond to that of peripheral thrombosis and their polymorphisms lack a clear classification. However, cardiovascular and inflammatory tests are rarely performed. Advances in imaging techniques have clarified the nature of these disorders without achieving a better overall understanding [10,11]. In the case of diabetes, while the precise identification of lesions, particularly on the inner blood-retinal barrier, has been well studied, the historical classification remains ambiguous [12,13]. New classifications are being introduced; however, whether they are the result of normal science, or they will bring us back into the crisis to catch a glimpse of the revolution remains unclear.

### Retinal dystrophies

In addition to the crisis of other pathologies, retinal dystrophies have a robust and solid paradigm that guides a fairly peaceful normal science between the discovery of new genes, attempts at genotype-phenotype correlations, and highly productive gene therapies that aim to restore the activity of the faulty gene [14]. However, the paradigm has been titillated by a few gusts of wind:

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new therapeutic possibilities which, instead of addressing the gene, attempt to restore vision by downstream means, whether by direct cortical stimulation or optogenetics [15], without calling into question the diagnostic and understanding paradigm.

### Conclusion

Each major field in retinal diseases has its place in the history of medicine; thus, is treated separately. Moreover, each configuration is different. According to Kuhn, the crisis experienced by myopia and pachychoroid specialists can be resolved. Similar to anti-VEGF drugs, a contribution from oncology, used to treat AMD, we should be aware of what other fields can provide. The three ways out of a crisis are either to catch up *in extremis* with the existing paradigm, leave it to the next generations, or enter the phase leading to a new paradigm that constitutes extraordinary science (as opposed to normal science). During these scientific phases, the search for broader ontological implications may play a direct role. This article was written within this dynamic.

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