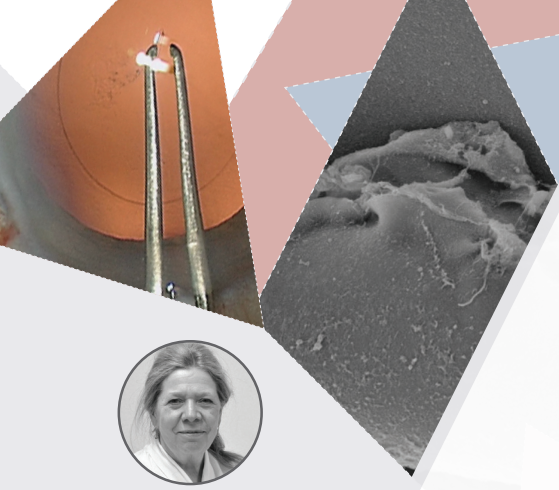
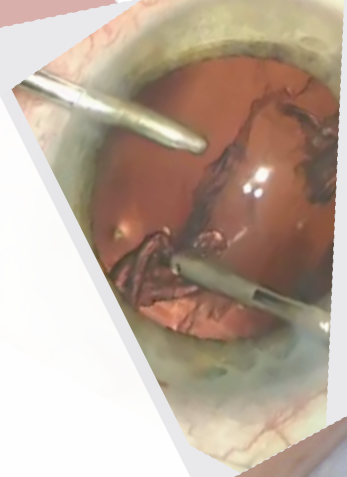


BY MARIE-JOSÉ TASSIGNON, MD, PHD, FEBO

ANATOMY OF THE RETROLENTICULAR SPACE



New insights into a long-neglected part of the eye are emerging.

My interest in the retrolenticular space started in the early 1990s. At that time, I was more involved in the posterior segment. My mentor was Jan Worst, MD, of the Netherlands, who fascinated the world with his beautiful images of the vitreous cisternae. While I was helping him in his lab in Groningen, we were able to color the Berger space in a young adult's postmortem eye.

This was, for me, the start of a new journey. I became convinced that this space was big enough to accommodate a new lens design, and I filed the idea and concept of that new lens design with the US Patent Office in October 1997. The lens was named the *double-rhexis lens* to accentuate the fact that both an anterior and posterior capsulorhexis were required to implant the lens properly. Another name for the concept that was mentioned in the original patent application was the *bag-in-the-lens*, and that is the name used for the lens as it exists today (Bag-In-The-Lens, or BIL, Morcher).

The BIL design was originally manufactured by PhysIOL in PMMA and later by Morcher in foldable hydrophilic versions. It was first used in a clinical study in 1999 and was approved by the Belgian National Social Security in 2004. Only one draft was drawn for the original lens, and the result is now used in the clinic in adult and pediatric cases. Modifications have since been developed to provide the lens in a toric version and a version for use with a loose, torn, or nearly absent capsule.

In 1990, the ophthalmologic world was convinced that the posterior capsule was the most precious structure in the eye. Behind that membrane, the vitreous was considered a black box, eagerly waiting to prolapse and cause macular edema, retinal detachment, etc.

It was hard to convince the ophthalmic community that this was not true, but I had the help of giants such as Howard Gimbel, MD, MPH, FRCSC, who invented the posterior capsulorhexis and who used the optic capture technique to place the optic in the retrolenticular interface. Later, other individuals, including Robert Stegmann, MD; Albert Galand, MD, PhD; Lisa Brothers Arbisser, MD; and Rupert Menapace, MD, FEBO, promoted the idea of the primary posterior continuous circular capsulorhexis (PPCCC) to be used alone or with the optic capture technique.

Albert Galand was convinced that use of the PPCCC alone, without optic capture, would prevent posterior capsular opacification (PCO). We showed, however, that reclosure of the PPCCC occurred in about one-third of cases in which PPCCC was used in combination with a regular BIL IOL, and this occurred within the first 2 postoperative years.[1] The reason was that lens epithelial cells were able to grow either on the anterior vitreous hyaloid or on the posterior surface of the IOL.[2]

ANSWERING THE SKEPTICS

As my colleagues and I developed the concept of the BIL, animal models showed excellent results. This encouraged us to proceed to using the

"THE POSTERIOR CAPSULE CAN BE SAFELY REMOVED WITHOUT RISK OF LEAKAGE. ... HOWEVER, IN THE EVENT OF RUPTURE OF THE ANTERIOR HYALOID, LEAKAGE WAS EXTREMELY HIGH."

BIL in the clinic.[3] This was all good news in favor of my approach, but skeptics continued to question me about the safety of systematically performing PPCCC. My response was threefold, and I committed myself to proving three points:

- **Point No. 1.** The posterior capsule is *not* the most important membrane defining the anterior and posterior segments of the eye; the anterior hyaloid *is*;
- **Point No. 2.** The incidence of cystoid macular edema (CME) is not increased after PPCCC; and
- **Point No. 3.** The incidence of retinal detachment is not increased after PPCCC.

To prove Point No. 1, we used an ocular flurophotometer to measure the leakage of fluorescein, a very small molecule, into the anterior vitreous space after PPCCC and after inadvertent vitreous loss during cataract surgery. The results were absolutely convincing. The posterior capsule can be safely removed without risk of leakage. Conversely, however, in the event of rupture of the anterior hyaloid, leakage was extremely high.[4]

In an effort to prove Point No. 2, we participated in the PREMED study run by the ESCRS. In that large multicenter study, CME was not increased after PPCCC and BIL implantation.[5]

Regarding Point No. 3, retinal detachment after PPCCC was studied by Menapace after optic capture, and he did not find an increased risk of postoperative retinal detachment.[6] We also studied retinal detachment after PPCCC and BIL implantation. We found that the incidence of retinal detachment after BIL implantation was comparable to that after in-the-bag implantation, if not slightly lower.[7] Long-term postoperative follow-up (not yet published) shows a small advantage for the BIL technique compared with in-the-bag implantation.

Based on these findings, we concluded that there is no inferiority of the BIL technique compared with the traditional implantation technique regarding the postoperative incidence of CME and retinal detachment.

ANTERIOR VERSUS POSTERIOR HYALOID

Why do we still have an increased risk of retinal detachment after cataract surgery? Although small, the risk is elevated in patients after cataract surgery compared to the population without surgery. What is the cause? Is it the anterior hyaloid or the posterior hyaloid that plays a role?

In order to answer this question regarding the role of the posterior hyaloid, we have participated in the MYOPRED study, a multicenter study run by the ESCRS that is enrolling high myopes (axial length >25 mm) with or without posterior hyaloid detachment prior to surgery.[8] No results have been posted from this study, so we cannot yet disclose details.

However, we already know that anterior hyaloid detachment can occur; it can be present preoperatively or can occur after cataract surgery. We have used intraoperative OCT, incorporated into an operating microscope, to observe the Berger space, the anterior hyaloid, and the ligament of Wieger—structures that have not been visible until the advent of these new imaging technologies.[9] We will have to wait for more studies and publications on this topic in the coming years in order to know more about the incidence of anterior hyaloid detachment and the risk for retinal detachment. What we surely know is that the anterior hyaloid detaches with age and that the prevalence of its detachment is highest after cataract surgery in patients 60 years of age or older and in myopes. In the presence of a detached ligament of Wieger, we can no longer use the term *Berger space* but rather *retrolenticular interface*. The retrolenticular interface is still not fully unraveled.

By using the BIL in children and infants, Van Looveren and colleagues were able to describe a new subgroup of congenital cataract based on the presence of anterior interface dysgenesis.[10] This is another amazing new description made possible by intraoperative OCT. Not only can the anterior interface present a dysgenesis, these authors concluded, but, due to the extremely bad condition of this dysgenesis, the eye will not be able to fulfill the reflex of emmetropization as programmed.

MATERIAL NOT RESPONSIBLE FOR PCO

One thing we surely know is that the biomaterial of an IOL is not responsible for the rate of PCO. We studied this by implanting lenses of two different designs made with the same biomaterial. We found that, when using the lens-in-the-bag technique, the incidence of PCO was much higher than using the BIL design.[11]

PCO development is a result of the foreign body reaction of the eye against the IOL, which is initiated by lens epithelial cells. These cells, however, can have very little impact when the biomaterial is implanted using the BIL implantation technique.

COMING SOON

In order to understand the anterior interface, also called the *retrolenticular space* or *space of Berger* (when the Wieger ligament is still attached), I invite you all to read a book on the BIL that is soon to be published by Springer Publishing. The editors of this book, Sorcha Ni Dhubhghaill, MB, PhD, MRCSI(Ophth), FEBOS-CR; Luc Van Os, MD; and I, in collaboration with a large international panel, will describe in detail the anterior interface and the named structures of this interface. In our research for the book, we went back to history books to learn how our colleagues of previous centuries described these structures and concepts that have since remained dormant for so many years. The novel technologies of today have now allowed us to visualize them and confirm their existence.

The coming years will be dedicated to learning why these structures are present and what their precise roles are within the eye. They may also help us to develop a better understanding of accommodation. ■

1. van Tenten Y, De Groot V, Wuyts FL, Tassignon MJ. Quantitative measurement of PCCC area in the postoperative period. *Br J Ophthalmol*. 2003:84(10):1117–1120.
2. De Groot V, Vrensen GF, Willekens B, et al. In vitro study on the closure of posterior capsulorrhexis in the human eye. *Invest Ophthalmol Vis Sci*. 2003;44(5):2076-2083.
3. De Groot V, Tassignon MJ, Vrensen GF. Effect of bag-in-the-lens implantation on posterior capsule opacification in human donor eyes and rabbit eyes. *J Cataract Refract Surg*. 2005;31(2):398–405.
4. De Groot V, Hubert M, Van Best JA, et al. Lack of fluorophotometric evidence of aqueous–vitreous barrier disruption after posterior capsulorhexis. *J Cataract Refract Surg*. 2003;29(12):2330-2338.
5. Wielders LHP, Schouten JSAG, Winkens B, et al; ESCRS PREMED study group. Randomized controlled European multicenter trial on the prevention of cystoid macular edema after cataract surgery in diabetics: ESCRS PREMED Study Report 2. *J Cataract Refract Surg*. 2018;44(7):836-847.
6. Menapace R. Posterior capsulorhexis combined with optic buttonholing: an alternative to standard in-the-bag implantation of sharp-edged intraocular lenses? A critical analysis of 1000 consecutive cases. *Graefes Arch Clin Exp Ophthalmol*. 2008;246(6):787–801.
7. Tassignon MJ, Van den Heurck JJ, Boven KB, et al. Incidence of rhegmatogenous retinal detachment after bag-in-the-lens intraocular lens implantation. *J Cataract Refract Surg*. 2015;41(11):2430-2437.
8. Influence of posterior vitreous detachment on retinal detachment after lens surgery in myopic eyes (MYOPRED). clinicaltrials.gov. NCT03152747. https://clinicaltrials.gov/ct2/show/NCT03152747. Accessed November 27, 2018.
9. Tassignon MJ, Ní Dhubhghaill S. Real-time intraoperative optical coherence tomography imaging confirms older concepts about the Berger space. *Ophthalmic Res*. 2016;56(4):222-226.
10. Van Looveren J, Van Gerwen V, Timmermans J-P, Tassignon MJ. Immunohistochemical characteristics of the vitreolenticular interface in congenital unilateral posterior cataract. *J Cataract Refract Surg*. 2016;42(7):1037–1045.
11. Leysen I, Coeckelbergh T, Gobin L, et al. Cumulative neodymium:YAG laser rates after bag-in-the-lens and lens-in-the-bag intraocular lens implantation: comparative study. *J Cataract Refract Surg*. 2006;32(12):2085–2090.

MARIE-JOSÉ TASSIGNON, MD, PHD, FEBO
- Past Chair and Chief, Department of Ophthalmology, Antwerp University Hospital, Antwerp, Belgium.
- marie-jose.tassignon@uza.be
- Financial disclosure: Patent ownership (Morcher)