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Original article

Berger's space[☆]

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ABSTRACT

Introduction and Objective: The Berger's space (BS) is a space located between the posterior capsule of the lens and the anterior hyaloid of the vitreous, structures that adhere in a circular manner by means of the Wieger ligament, for which the outer limit is defined by Egger's line. The aim of this article is to perform a review of the BS, as well as to present three cases in which this BS could be demonstrated by optical coherence tomography (OCT).

Material and Method: A total of 90 patients from a general ophthalmology clinic were studied, on whom an anterior pole OCT was performed (Cirrus Lumera 700 Carl Zeiss Meditec, Dublin, California, United States). All patients were included consecutively, with an analysis being performed on the cornea, anterior chamber, iris, lens, and anterior vitreous, but excluding those in which the test could not be performed.

Results: The posterior lens capsule, the anterior hyaloid, and the BS between both structures were observed in three patients. This is the first time in the current literature that three cases have been described, together with their characteristics (one phakic –case 1- and two pseudophakic, one of them vitreous de structuring –case 2- and the other with opacification of the posterior capsule of the lens –case 3-), using this previous pole OCT technique.

Conclusions: Knowledge of the BS is essential to understand the vitreo-lenticular junction and any complications in some cataract surgeries, as well as to also understand the pathological origin of pigment dispersion syndrome.

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Espacio de Berger

RESUMEN

Introducción y Objetivo: El espacio de Berger (EB) es un espacio situado entre la cápsula posterior del cristalino y la hialoides anterior del humor vítreo, estructuras que se adhieren de forma circular mediante el ligamento de Wieger cuyo límite exterior está delimitado por la línea de Egger. El objetivo es realizar una revisión del EB así como presentar tres casos en los que se ha podido evidenciar este EB mediante tomografía de coherencia óptica (OCT).

Palabras clave:

Berger

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Wieger
Egger

Material y Método: Se han estudiado 90 pacientes de una consulta general de oftalmología, a los que se ha realizado una OCT de polo anterior (Cirrus Lumera 700 Carl Zeiss Meditec, Dublin, California, Estados Unidos). Se han incluido todos los pacientes de forma consecutiva analizando córnea, cámara anterior, iris, cristalino y el vítreo anterior, excluyendo a aquellos en los que no pudo realizarse la prueba.

Resultados: En tres pacientes se ha podido evidenciar la cápsula posterior del cristalino, la hialoides anterior y el EB entre ambas estructuras. Describimos por primera vez en la literatura actual los tres casos en conjunto y con las características que presentan (un fáquico –caso 1- y dos pseudofáquicos, uno de ellos con desestructuración vítreo –caso 2- y otro con opacificación de la cápsula posterior del cristalino –caso 3-) mediante esta técnica de OCT de polo anterior.

Conclusiones: El conocimiento del EB es fundamental para comprender la unión vitreolenticular y las posibles complicaciones en algunas cirugías de catarata así como para entender además la etiopatogenia del síndrome de dispersión pigmentaria.

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Introduction and objective

The vitreous-lens join is developed through circular adherence of the vitreous to the lens posterior capsule, constituting the Wieger ligament, the outer circumference limit being Egger's line, leaving a central virtual space known as the Berger space (BS).¹⁻⁴ Said space is not found in all patients as in many cases the lens posterior capsule adheres throughout its extension to the anterior hyaloid of the vitreous, with repercussions in cataract surgery such as lens posterior capsule rupture with vitreorrhagia, among others.

Optical coherence tomography (OCT) and the anterior pole module (Cirrus Lumera 700 Carl Zeiss Meditec, Dublin, California, United States) enables a visualization of the lens, posterior lens capsule and adhered vitreous which, in the majority of patients, extends throughout its surface without showing BS. However, some patients exhibit a space between both structures behind the lens posterior capsule and in front of the anterior hyaloids of the vitreous, which corresponds to the BS.

The objective of the present paper is to review the BS and research its presence in a sample of general consultation patients that were studied with said OCT.

Material and methods

The study included 90 patients who consecutively visited the general practice, without exclusion criteria with the exception of patients that did not produce a successful OCT due to ocular pathology involving medium opacity or systemic, neurological or osteoarticular pathology that prevented image capture.

Out of the 90 patients included in the study, 3 cases are presented evidencing BS between the posterior lens capsule and the anterior hyaloids of the vitreous humor. For the first time, the BS is described with the characteristics of the present sample, i.e., one phakic—case 1— and 2 pseudophakics, one with vitreous destructuring—case 2—, and one with lens posterior capsule opacification —case 3—, applying said technique for

the first time since the BS was described by Émile Berger in 1887.

Results

The BS is located between the lens posterior capsule and the anterior hyaloid of the vitreous (Fig. 1), although in most patients it cannot be seen with OCT, which shows both structures (anterior hyaloid and lens posterior capsule) joined as a single structure (Fig. 2).

Case 1

Male, 54, phakic, emmetropic, without relevant general or ophthalmological history or known allergies. Examination produced a visual acuity (VA) of one in both eyes (BE) and

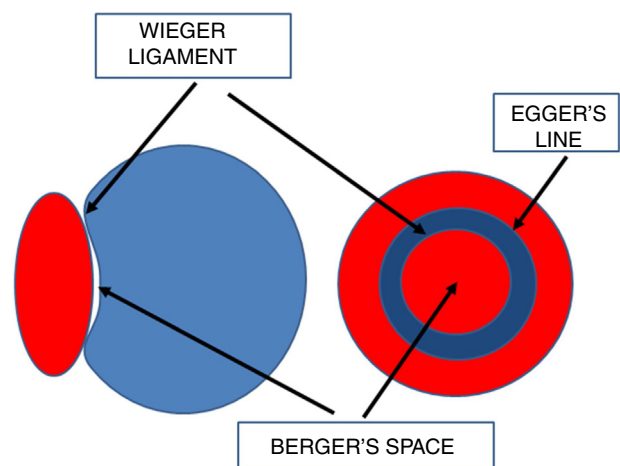


Fig. 1 – Schema of the vitreous-lens join by means of the Wieger ligament (blue circle), Egger's line (outer line of Wieger ligament) and Berger's space. The lens is shown in red and the vitreous humor in blue (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article).

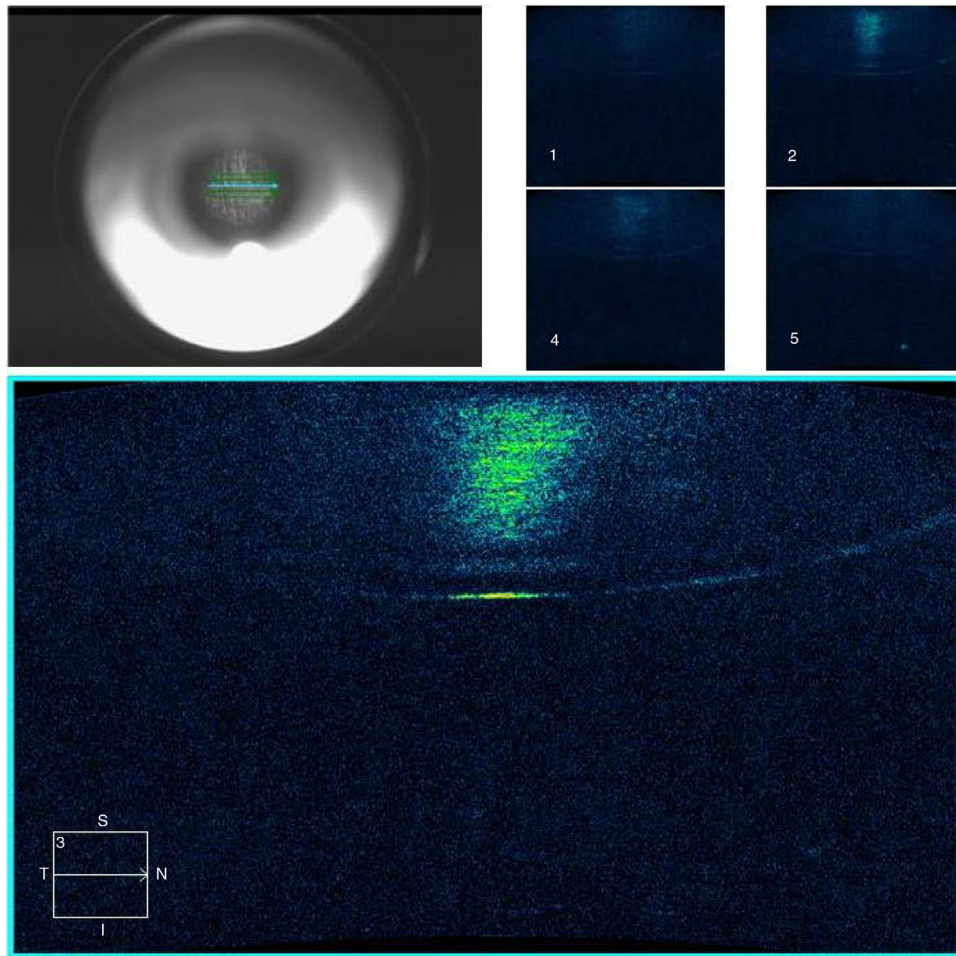


Fig. 2 – Optical coherence tomography showing the lens and posterior capsule with vitreous adhered through the anterior hyaloids throughout its extension, without Berger's space.

intraocular pressure (IOP) of 16 mmHg in BE. Biomicroscopy showed nuclear cataract in development in BE with normal ocular fundus (OF) in BE. OCT revealed a space between the anterior hyaloid and the lens posterior capsule, corresponding to BS (Fig. 3).

Case 2

Male, 70, pseudophakic, with -2.00 previous diopters (PD) before cataract surgery, without remarkable general or ophthalmological history or any known allergy. Examination produced VA of 0.8 in BE and IOP of 16 mmHg in BE. Biomicroscopy showed stable pseudophakia in BE and normal OF in BE. OCT revealed a space between the hyaloids and the lens posterior capsule corresponding to BS (Fig. 4).

Case 3

Female, 74, pseudophakic with -8.00 PD diopters before cataract surgery, without remarkable general or ophthalmological history or any known allergies. Examination produced VA of 0.4 in BE and IOP of 16 mmHg in BE. Biomicroscopy showed stable pseudophakia in BE with lens posterior cap-

sule opacification in BE awaiting YAG laser capsulotomy and normal OF in BE. OCT showed a space between the anterior hyaloid and the lens posterior capsule corresponding to BS (Fig. 5).

Discussion

BS was described by Émile Berger, an Austrian ophthalmologist (1825–1926) in 1887 as a space between the lens posterior capsule and the anterior hyaloids contained at its outer limit by Wieger's ligaments and Egger's line (Fig. 1). Said BS could continue along the Erggelet space located in the anterior section of the Cloquet canal or the Stilling duct that traverses the thickness of the vitreous towards the Martegiani space located in front of the optic papilla.^{1–3}

The prevalence of BS identified by means of OCT is unknown. The present paper described BS in 3 patients out of a sample of 90 analyzed patients. However, it is a small sample that should be confirmed by other larger studies and with the progressive development of OCT technology. Similarly, it is not known either whether the development of BS is facilitated by changes in the vitreous caused by aging¹ including liquefaction and syneresis occurring in the vitreous structure, taking

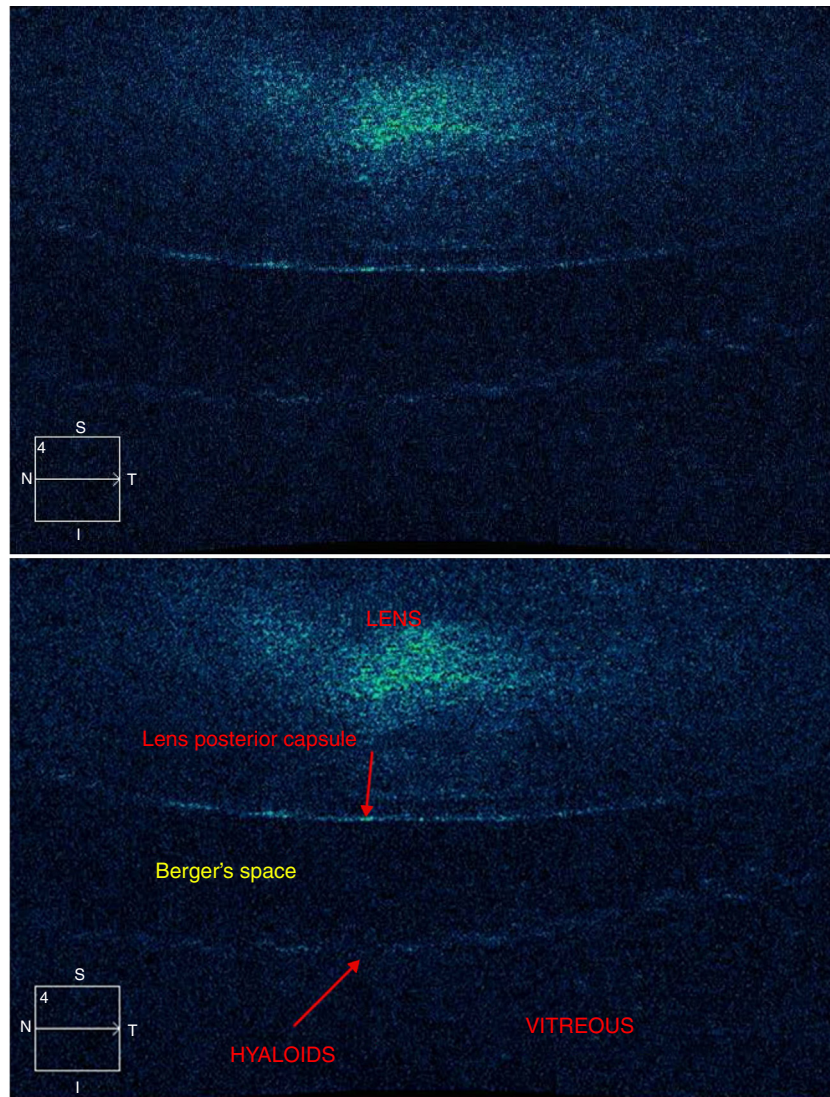


Fig. 3 – (left and right). Optical coherence tomography in phakic patient showing Berger's space between the lens posterior capsule and anterior hyaloid.

into account that 2 of the 3 patients were 70 and 74 years old respectively and that one had -8.00 diopter myopia (case 3).

In 2016, Tassignon and Ni Dhubghaill⁴ described 3 cases in which BS could be seen in real time during cataract surgery by means of an OCT device connected to the microscope (Zeiss Opmi Lumera 700 / Rescan 700 system; Zeiss Ltd., Jena, Germany). List et al.⁵ described hemorrhage in the BS of a 4-year-old child, secondary to traumatism who probably had ruptured Wieger's ligament, with blood accumulation in the BS. Kim et al.⁶ discussed one case of dislocation of a posterior chamber phakic intraocular lens in the BS secondary to closed traumatism. Debrulle et al.⁷ described the case of a patient treated with dexamethasone implant that remained confined in the BS.

The implications of said BS in daily practice are numerous and greater knowledge about it is essential to understand the performance of some cataract surgery types among other things.

The vitreous-lens interface through Wieger's ligament would explain the presence of vitreorrhagia in cataract surgery by means of the intracapsular extraction technique.⁸ The adherence of Wieger's ligament would have the secondary effect of dragging the anterior hyaloids when pulling the cataract, giving rise to vitreorrhagia that could reach massive proportions. In less intense or age-degeneration adherence cases, the active traction of the cataract would rupture the Wieger ligament without giving rise to vitreorrhagia.

The BS that can be appreciated in the cases discussed herein is it essential to explain in the absence of vitreorrhagia in phacoemulsification complications that course with lens posterior capsule rupture. When the lens posterior capsule is adhered to the anterior hyaloids, said ruptures can extend to both structures with secondary vitreorrhagia due to being closely related. In patients with evidence of BS, lens posterior capsule ruptures do not necessarily extend to the anterior hyaloids because BS is between both structures, thus avoiding

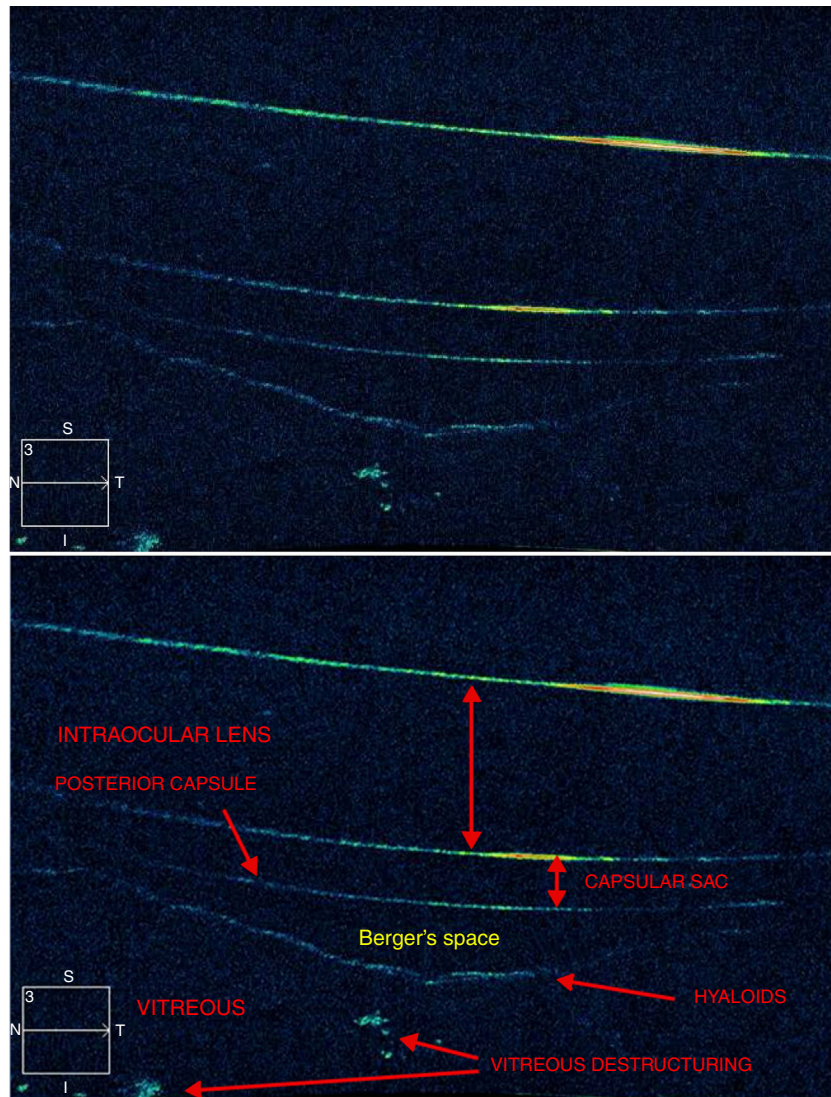


Fig. 4 – (left and right). Optical coherence tomography in pseudophakic patient showing Berger's space between the lens posterior capsule and anterior hyaloids.

vitreorrhagia if the traumatism produced by the phacoemulsifier is not very intense.

In addition, BS could account for the lens posterior capsule oscillations in some cataract surgeries with hard cores, particularly in phacoemulsification of the last quadrant. The saline solution would pass through the anterior surface of the iris, the zonule and the Petit space (a virtual space between the zonule and the anterior hyaloids which is circumscribed by the Wieger ligament and the base of the vitreous),¹⁻³ passing through dehiscence of the Wieger ligaments towards the BS, raising the lens posterior capsule in waves and approximating the phacoemulsification terminal, with the possibility of exposing the latter with secondary rupture of said posterior capsule. In these cases, capsule rupture could be avoided filling in the capsular sac with viscoelastic to extract the last quadrant, thus avoiding capsule oscillation.

In addition, in some phacoemulsification cases some remains of a cataract could pass through the zonule and the

Petit canal towards said BS. These remains can be seen at the end of the phacoemulsification procedure apparently in the vitreous without producing lens posterior capsule ruptures. Due to gravity, said remains precipitate to the inferior part of the BS, beyond the visual axis, without producing intra- or postoperative complications such as ocular hypertension, hydration or post-surgery uveitis in the short as well as in the long-term.

Finally, Wieger's ligament and BS are fundamental elements in the etiopathogeny of the pigment dispersion syndrome. The pigment proceeding from iris-lens friction could also precipitate in the form of the Krukenberg spindle, in the cornea, passing through the zonule in retrograde movement towards the Egger line and linearly precipitating along the edge of Wieger's ligament, constituting Scheie's line. In some cases, said pigment can circularly surround the entire Wieger ligament, constituting the Zentmayer ring.⁹⁻¹¹

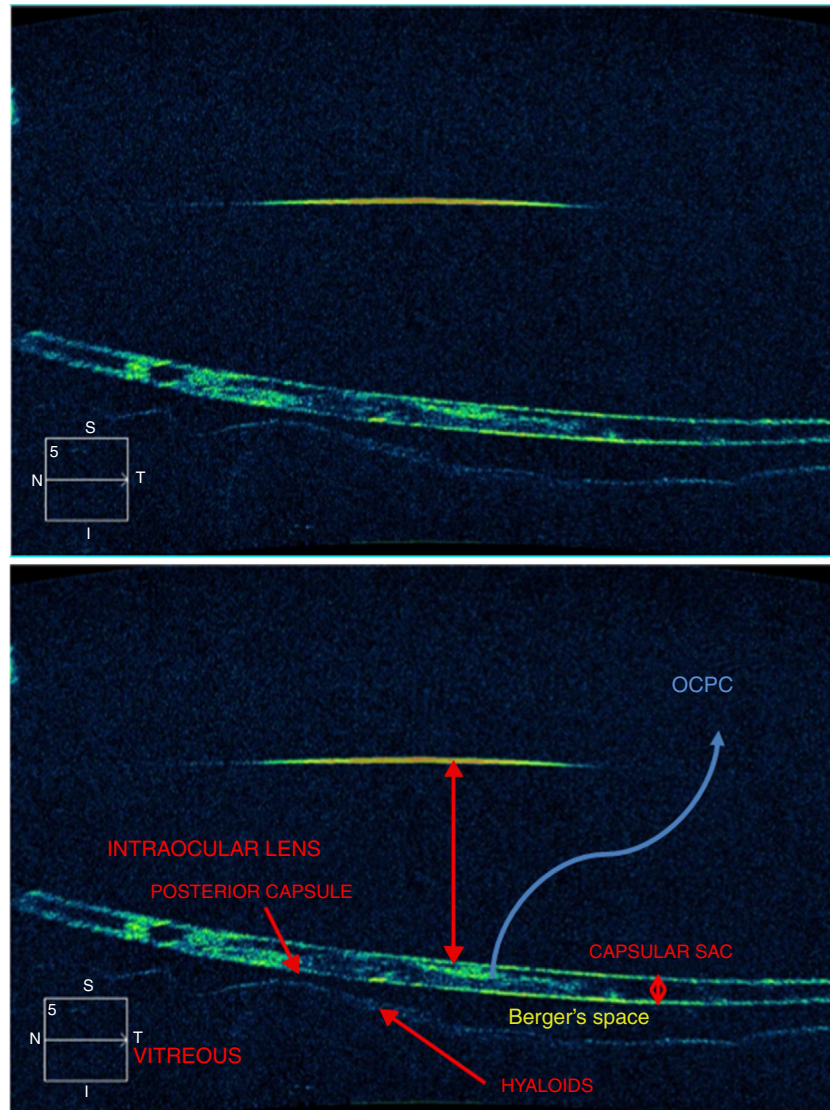


Fig. 5 – (left and right). Optical coherence tomography IN pseudophakic patient with lens posterior capsule opacification showing Berger's space between the lens posterior capsule and anterior hyaloid.

Conclusions

BS can be observed in some patients by means of OCT (Cirrus Lumera 700 Carl Zeiss Meditec, Dublin, California, United States) between the posterior capsule of the lens and the anterior hyaloids of the vitreous humor. The present study is the first to observe and describe said BS in the literature in 3 patients exhibiting completely different characteristics since its discovery by Émile Berger in the 19th century. However, the authors were unable to describe Wieger's ligament, Egger's line or Erggelet's space. The present study emphasizes the OCT images and the anterior pole module with resolution to access the vitreous-lens join after penetrating the lens and its posterior capsule (case 1) or in the intraocular lens, capsular sac with or without lens posterior capsule opacification (cases 3 and 2, respectively).

Additional studies are necessary with future OCT technology developments in order to understand the vitreous-lens

join, the prevalence of these invisible structures in the general population as well as the rest of structures that constitute this join of the vitreous to the lens posterior capsule.

Knowledge of the vitreous-lens join and its characteristics is essential to understand the development of specific cataract surgery complications as well as to understand the etiopathogeny of the pigments dispersion syndrome.

Conflicts of interest

No conflict of interest was declared by the authors.

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