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ODS Pseudophakia + Posterior Capsular Opacification (PCO): Case Report

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ABSTRACT

Posterior capsular opacity (PCO), also known as after cataract, is a complication of cataract surgery that manifests as an opacity that persists or develops after extracapsular lens extraction. 1 The incidence of PCO varies widely in the literature, influenced by the type of intraocular lens (IOL) and patient risk factors. The standard treatment for PCO-related visual impairment is posterior capsulotomy using a neodymium-doped yttrium-aluminum-garnet (Nd: YAG) laser. Although PCO recurrence after initial treatment with YAG capsulotomy is more common in children, it is rare in adults. The underlying pathophysiologic mechanism is analogous to primary PCO, involving proliferation, migration, and/or clustering of lens epithelial cells (LECs), resulting in posterior aperture re-closure. A comprehensive review of recent literature has identified several potential risk factors for PCO recurrence, including younger age, female gender, high myopia, diabetes, vitrectomy status, uveitis, low diopter IOLs, and certain types of IOLs with higher water content.2A 69-year A 69-year-old male with a history of cataract surgery four years ago, a physical examination showing results within normal limits, and an ophthalmologic physical examination showing ODS virus 0.2, PH - NC, arcus senilis +/+, fibrosis type posterior lens opacity +/+, and IOL +/+ was identified. Funduscopic examination revealed a fundus reflex (+/+), diminished due to posterior lens opacities, with a macular reflex that was difficult to assess (+/+) and retinal degeneration (+/+). The diagnosis of ODS pseudophakia + PCO was established based on the patient's history, physical examination results, and supporting examinations of the mother and baby that had been carried out. According to the diagnosis, the patient was administered the primary pharmacological therapy of P Pred ED 6x1 drops in both eyes and the non-pharmacological therapy of Nd: YAG laser treatment in both eyes.

Introduction

Posterior capsular opacity (PCO), or "secondary cataract," is a prevalent and recognized complication that can ensue after cataract surgery, potentially resulting in considerable visual impairment. Alarmingly, PCO can develop as early as six months post-surgery, with incidence rates continuing to rise at one, three, five, and even nine years after the procedure. This progressive risk underscores the urgent need for ongoing research and clinical strategies to prevent and manage PCO effectively. The rate of PCO formation exhibits significant variability, contingent on the type of intraocular lens (IOL) utilized and patient-specific risk factors (Donachie et al., 2023), further emphasizing the importance of personalized approaches in postoperative care.

PCO has been categorized into two main types: fibrous and pearly. The fibrous type is caused by the proliferation and migration of lens epithelial cells (LECs) that have undergone epithelial-to-mesenchymal transition (EMT), leading to folds and wrinkles in the posterior capsule. The pearly type is caused by residual LECs from the equatorial lens region clustering

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together and forming Elschnig pearls, easily visible under retro illumination. Notably, both types of PCO have the potential to cause deterioration or obstruction of the visual axis. Treatment for visually significant PCO, irrespective of its type, is typically neodymium-doped yttrium-aluminum-garnet (Nd: YAG) laser capsulotomy[4]. Risk factors for PCO include patient-related factors, such as young age, due to a more significant number of lens epithelial cells in the anterior capsule. The proliferation of lens epithelial cells is contingent on age; patients under the age of 40 exhibit a proliferation rate that is three times faster than patients over the age of 60. Surgery-related risk factors resulting from cataract surgery may influence the predisposition to PCO development. Studies have identified several factors associated with recurrence, including intraocular lenses (IOLs) with higher water content, female gender, diabetes, vitrectomy status, and uveitis (Wu et al., 2018). One of the key population-related challenges in PCO research and clinical management is the high incidence among younger patients, who are more prone to rapid lens epithelial cell (LEC) proliferation post-cataract surgery. This age-related biological response leads to a higher risk and faster onset of PCO in individuals under 40 years of age, compared to older populations. Additionally, certain subgroups, such as diabetic patients, females, and those with a history of uveitis or vitrectomy, are also disproportionately affected due to their increased susceptibility to LEC proliferation and capsular changes. Understanding the impact of these population-specific risk factors is crucial for tailoring preventive strategies, selecting appropriate intraocular lenses (IOLs), and optimizing postoperative care. Failure to account for these variations can lead to suboptimal outcomes, especially in high-risk populations, and may contribute to a higher recurrence rate of PCO even after Nd:YAG laser capsulotomy. Therefore, research that stratifies patients based on age, systemic disease, and surgical history is essential to develop personalized management approaches and improve long-term visual outcomes.

In PCO, characterized by the disruption of the visual axis, the utilization of a neodymium-doped yttrium aluminum garnet (Nd: YAG) laser engenders an aperture within the posterior capsule. This procedure, designated as a posterior capsulotomy, employs the laser's capacity to emit a low divergence focal wavelength at 1064 nm due to its 1% Nd doping—light refraction prompts ionization and plasma formation within the ocular tissue. The formation of plasma, a process initiated by acoustic waves and shock waves, can potentially cause tissue destruction. The Nd:YAG laser operates on the principle of photodisruption, utilizing high-energy light in a concentrated spot for a brief duration. This characteristic allows it to be highly concentrated, resulting in a localized temperature increase of up to 15,000 degrees Celsius. The acoustic shockwave produced by the laser penetrates the tissue, and the laser is focused directly behind the capsule (250–350 µm offset) using a helium-neon aiming beam (Karahan & Kaynak, 2014). The aim of this research is to evaluate the efficacy and safety of Nd:YAG laser capsulotomy by examining its mechanism of action, energy parameters, and tissue interaction, particularly in the context of posterior capsule opacification treatment.

Method

Research on PCO after cataract surgery usually involves clinical studies, with a prospective or retrospective design, which may observe patients before and after treatment with the Nd: YAG laser. The population is patients who have undergone cataract surgery and have a diagnosis of postoperative PCO. A sample of patients who meet the inclusion criteria, such as being of a certain age (adult), having PCO after cataract surgery, and willing to undergo treatment with Nd: YAG laser. Data Collection: a) Patient Medical History, Patient medical history data, including age, gender, history of cataract surgery, presence of comorbidities such as diabetes, and general health condition, were recorded. b) Physical Examination: An initial visual examination is performed to assess visual acuity (e.g., using the Snellen table or other methods), as well as check for other

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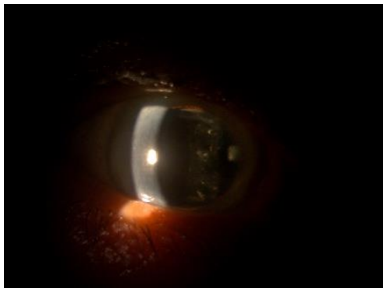
signs, such as the presence of posterior capsule opacity, and fundus evaluation. c) Funduscopic examination: To look for any fundus abnormalities such as retinal degeneration or other disorders that may be associated with vision. Outcome Measurement and Evaluation: a) Visual Acuity: After the Nd: YAG procedure, visual acuity is measured again to evaluate the success of the procedure. b) Fundus Examination: Performed to monitor whether posterior opacity is reduced and whether there are any changes in the retina or other fundus conditions after treatment. c) Observation of Side Effects: Side effects of laser or drug treatment, such as increased intraocular pressure, inflammation, or other complications, are monitored periodically.

Result and Discussion

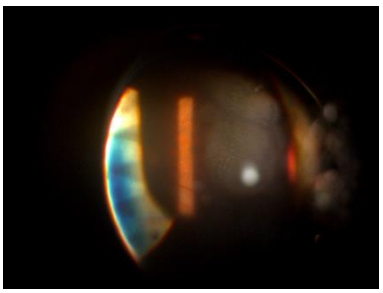
Result

A 69-year-old male patient with a history of cataract surgery four years prior presented at the eye clinic of Bhayangkara Semarang Hospital with a complaint of visual impairment in both eyes, characterized by a blurry, foggy appearance, which had persisted for two years. The patient reported using reading glasses purchased without a physician's prescription to mitigate the symptoms, yet these did not provide adequate relief. The patient reports that his current complaints are the same as the complaints he had 4 years ago before he underwent cataract surgery. He continues to experience these complaints, which persist and cause him to feel glare when looking at light, both during the day and at night, thus interfering with his daily activities. The patient has a documented medical history of diabetes mellitus (DM) that has been in remission for two years, for which he continues to receive medication. He also has a history of hypertension (HT) that has been in remission for two years, for which he continues to receive medication. The patient has a history of coronary heart disease, and he underwent a cardiac implant two years ago. He reports no history of allergies or eye disorders.

The patient exhibited compos mentis consciousness (GCS 15 [E4V5M6]). The vital signs were as follows: blood pressure 116/69 mmHg, pulse frequency 67x/minute (regular), respiratory frequency 20x/minute (regular), and abdominotorakal breathing 20x/minute (regular). The patient's temperature was 36.7 °C. The anthropometric data obtained included a body weight of 70 kg, height of 170 cm, and BMI of 24.2 kg/m2, indicating a good nutritional status. The results of the system examination were within normal limits. The ophthalmologic physical examination revealed a distant virus of 0.2 PH - NC in both right and left eyes, arcus senilis +/+, fibrosis-type posterior lens opacities +/+, and IOL +/+.



Picture 1 (a). Pco Tipe Fibrosis



Picture 1 (b) Funduskopi, Oculi Dextra

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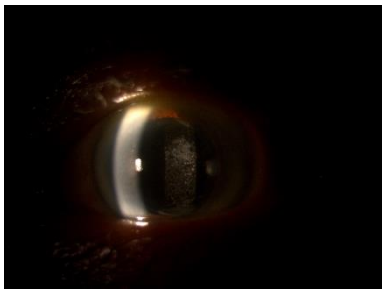

Picture 2: Pco Tipe Fibrosis Oculi Sinistra

The results of the funduscopic examination revealed decreased fundus reflexes (+/+), with macular reflexes of both right and left eyes proving challenging to assess, as well as retinal degeneration (+/+). The diagnosis of ODS pseudophakia + posterior capsular opacity (PCO) was established through clinical symptoms and corroborated by findings from physical examination and supporting examinations. The therapeutic regimen consisted of pharmacotherapy, specifically P Pred ED 6x1 drops administered in both eyes, and non-pharmacological therapy, employing the Nd: YAG laser in both eyes.

Discussion

Posterior capsular opacity (PCO), or "secondary cataract," is the most prevalent postoperative complication associated with cataract extraction. The development of PCO is characterized by the migration, proliferation, and differentiation of lens epithelial cells (LECs), resulting in opacities within the posterior capsule. This condition can manifest significant visual symptoms, mainly involving the central visual axis.PCO has been classified into two primary types: fibrous and pearly. The fibrous type is characterized by the proliferation and migration of lens epithelial cells (LECs) that have undergone an epithelial-to-mesenchymal transition (EMT), resulting in folds and wrinkles in the posterior capsule. In contrast, the pearly type is caused by residual LECs from the equatorial lens region clustering together and forming Elschnig pearls, which are easily visible under retro illumination. Both types of PCO can lead to deterioration or obstruction of the visual axis (Cooksley et al., 2021); (Wu et al, 2018).

In this case, the recurrent PCO (posterior capsular opacification) observed was most consistent with the fibrosis type. The mechanism behind the proliferation and migration of LECs (lens-related cells) over the posterior aperture, despite the absence of the posterior capsule as a scaffold, is still under investigation. In vitro studies investigating the cause of posterior capsulorhexis closure may provide a possible explanation. These studies revealed the proliferation and migration of residual LECs on the vitreous-derived basal lamina, which is believed to be the anterior hyaloid membrane. This membrane provides a surface for LECs to occlude the posterior aperture.

Research has indicated that the incidence of PCO in Indonesia is 20% of cases within a year after cataract surgery, with a reported increase to 50% over 5 years following surgery. A 2014 Brazilian study, which examined 58 samples, found that 67% of cases exhibited PCO after four years of phacoemulsification and IOL implantation, with 41.3% of cases experiencing decreased visual acuity due to glaucoma, IOL opacities, or age-related macular degeneration. The study also noted that 12 patients exhibited mild PCO with unchanged visual acuity and 45% of patients with systemic arterial hypertension. It is noteworthy that children and infants exhibit a significantly higher incidence and earlier onset of PCO, often accompanied by the potential development of amblyopia.6 According to estimates by the Royal National Institute of Blind People (RNIB), by 2020, the number of individuals living with cataracts in the UK is projected to reach 695,000,

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representing a 30% increase from 2020 to 2030. In the UK, the annual number of cataract operations is approximately 330,000 (Roberts et al., 2017).

Risk factors for PCO include patient-related factors, such as young age, due to a more significant number of lens epithelial cells in the anterior capsule. The growth of lens epithelial cells is age-dependent; patients younger than 40 exhibit three times more rapid growth compared to patients older than 60. Lens opacities gradually increase with age, which may affect surgery. Diabetic patients have a high risk of developing PCO. Other risk factors include uveitis, myotonic dystrophy, retinitis pigmentosa, and traumatic cataracts. Furthermore, surgical interventions such as enhanced cortical clearance with hydrodistention, which involves the removal of lens substance, and in-bag fixation, which aims to ensure intraocular lens (IOL) centralization for optimal barrier effect, have been shown to reduce the incidence of PCO. However, studies have identified that several factors may be associated with recurrence, including IOLs with higher water content, female gender, diabetes, vitrectomy status, and uveitis (Wu et al., 2018).

The pathophysiology of PCO is multifactorial. During routine phacoemulsification surgery, the surgeon removes a portion of the anterior capsule (capsulorhexis), removes the cataract lens material, and then implants a synthetic lens into the intact capsular bag.PCO occurs when the residual LEC in the anterior capsule undergoes three phenomena: proliferation, migration to the posterior capsule, and normal and abnormal differentiation. The accumulation of LECs results in opacification of the intact posterior lens capsule, with consequent adverse effects on vision. Several cytokines and growth factors, including transforming growth factor β (TGF-β), fibroblast growth factor 2 (FGF-2), hepatocyte growth factor (HFG), and matrix metalloproteinases (MMPs), have been implicated in the pathogenesis of PCO. Exogenous hyaluronic acid (HA), a component of some viscoelastic agents used during cataract surgery, may increase PCO levels ex vivo (Cooksley et al., 2021); (Sinha et al., 2013).

When it involves the visual axis, PCO generally results in a decrease in visual acuity. A slit lamp examination reveals an opaque membrane with varying degrees of fibrosis formed on the posterior capsule. Other significant signs include (Cooksley et al., 2021):

1. Elschnig pearls are a distinctive manifestation observed in pearl-type PCO. These pearls, clusters of residual LECs, exhibit a round, clear appearance under retro light. When these pearls accumulate on the visual axis, they can result in a decline in visual acuity.
2. The Sommering ring is a distinctive radiological finding characterized by a ring-shaped accumulation of residual LEC and cortical fibres. This ring is often located peripherally, typically between the posterior capsule and the residual edge of the anterior capsule. While it frequently does not manifest as a cause of visual symptoms, it can result in glare and vision loss in cases of severe manifestation.
3. Capsule wrinkles

Nd: YAG laser capsulotomy is a prevalent treatment modality for adult PCO, though pediatric cataract surgeons often opt for posterior capsulotomy, with or without anterior vitrectomy, in young children or those with developmental delays. This preference is attributed to the fact that these patients cannot frequently maintain stillness during the procedure. The associated PCO is generally denser than adult PCO. 9 The incidence of Nd: YAG capsulotomy following cataract surgery ranges from 2.4% to 12.6% at 3 years and 5.8% to 19.3% at 5 years. The Nd: YAG capsulotomy procedure is performed under ophthalmic anesthesia, with a surface contact lens being placed over the patient's eye during the procedure. The patient is then positioned in the slit lamp, and the physician delivers multiple laser pulses in a circular, cruciate, horseshoe, or spiral pattern, targeting the central posterior capsule. It creates an opening in the visual axis, enabling the patient to regain clear vision. The potential complications of this

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procedure include increased intraocular pressure, anterior uveitis (iritis), pitting of the intraocular lens (IOL), cystoid macular edema (CME), retinal detachment, disrupted anterior hyaloid surface, and IOL dislocation. Although this procedure is relatively straightforward and expeditious, it can potentially result in complications such as increased intraocular pressure (IOP), glaucoma, CME, and retinal detachment (Ursell et al., 2020).

Conclusion

PCO is a prevalent complication that arises after cataract surgery, despite the implementation of intraoperative preventive measures aimed at mitigating its occurrence. Contemporary research endeavors about PCO prevention hold considerable promise; however, their practical implementation remains constrained by the necessity for robust randomized clinical trials in human subjects to investigate the adverse effects of diverse therapeutic interventions. Ophthalmologists are poised to be the primary healthcare professionals to evaluate and diagnose this condition. They must possess the expertise to accurately identify and differentiate PCO from other pathologies, ensuring that patients receive the most suitable treatment—Nd: YAG capsulotomy or posterior capsulotomy—as expeditiously as possible to mitigate its impact on their quality of life.

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