THE RIGHT TO SELECT THE BEST BIOMATERIALS FOR YOUR PATIENTS

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INTRODUCTION

Cataract surgery is a very common procedure, and the number of cataract surgeries performed in England has risen from 325,000 to nearly 450,000 from 2016 to 2021, forecasted to grow exponentially by 50% until 2035.[1] However, the procedure can also lead to posterior capsule opacification (PCO). This complication can result in reduced visual acuity, impaired contrast sensitivity, and glare disability.[2] Posterior capsule opacification (PCO) is the most frequent complication of cataract surgery. It can develop soon after a few years post-procedure[3,4], with incidence figures ranging from <5% to as high as 50%.[2] PCO involves lens epithelial cell growth and proliferation, leading to reduced visual acuity, and may develop in a few months to years following cataract surgery.[5,6] The risk of PCO is understood to be influenced by several factors, including edge design,[7,8] intraocular lens (IOL) design, haptic design,[5] and lens material.[2,6]

Types of IOLs vary in terms of both optic and material properties. IOL design and materials constantly evolve, aiming to improve refractive outcomes with minimal incision size and host-cell response since it may cause PCO, anterior capsular opacification (ACO), and lens epithelial cell (LEC) proliferation. IOL materials vary in water content, chemical composition, refractive index, and tensile strength, while IOL designs have different optic sizes, edge profiles, and haptic materials and designs, with the primary goal of minimizing decentration, dislocations, optical aberrations, and opacifications.[9, 10] The most commonly used IOL materials are hydrophobic and hydrophilic acrylic material. The differences between hydrophobic and hydrophilic IOL materials have already been widely published.[7, 8, 11-17] There are several parameters where the hydrophobic acrylic materials have shown superiority over hydrophilic material, e.g., square edge profiles,[7,8] posterior capsule opacification,[6,12,16,17] IOL opacification,[13,14] good quality of vision,[15] etc. However, some reports show that hydrophilic IOLs did better with regard to glistening.[18] Although, it is still debated whether the glistening impacts the quality of vision,[18-20] nowadays manufacturers have developed glistening-free* hydrophobic IOLs.[21] Moreover, several studies show the superiority of hydrophobic acrylic material over hydrophilic.[7,8,11-17] Why should we use hydrophilic acrylic IOLs at all? Some reports have highlighted this issue.[11,13,22] The reason why the choice between hydrophilic and hydrophobic still exists is due to the surgeon's preference of wanting the IOLs to fold or unfold quickly or slowly, the ease of explantation if required, the capsule adherence properties and rotational stabilities, the potential to cause dents and marks with forceps, etc.[13,22] If the surgeons/hospitals are incentivized for an Nd: YAG capsulotomy procedure, then they may have a vested interest in choosing the lens which generates more patients for capsulotomies.

Hydrophobic material has been shown to have significantly reduced PCO in several studies. Linnola's "sandwich theory" states that bioactive materials allow a single LEC to bond to the IOL and the posterior capsule.[23] This produces a sandwich pattern including the IOL, the LEC monolayer, and the posterior capsule, thus preventing further cell proliferation and capsular bag opacification.[23] Other studies carried out by Linnola et al. evaluated the adhesiveness of fibronectin, vitronectin, laminin, and type-IV collagen to IOL materials (PMMA, silicone, hydrophobic acrylate, and hydrogel), both in vitro[24] and in cadaver eyes.[25,26] They found that fibronectin and laminin bond best to hydrophobic acrylate IOLs, resulting in better attachment to the capsule. This stronger binding could explain the enhanced adhesion of hydrophobic acrylate IOL to the anterior and posterior capsules and, as a result, the lower PCO and Nd: YAG capsulotomy rates.[3,27-29] In a study by Ursell et al following cataract surgery with single-piece monofocal IOLs, different incidence rates of PCO were observed with different IOLs.[6] They also found that AcrySof IOLs were associated with a significantly lower incidence of PCO requiring Nd: YAG treatment over 3 and 5 years.[6] While all of the IOLs assessed in the study by Ursell et al[6] were marketed as having a square-edged profile, it could be the case that the degree of sharpness of the posterior optic edge may have some bearing on the variation in the PCO inhibiting properties displayed by different IOLs.[8] In addition, our study[16] reported that IOLs with a radius of curvature of <10.0 mm appear to have good PCO performance. Clinical studies show that IOLs with a square-edged optic profile are associated with less PCO than those with a round-edged profile.[28,30-34] Nishi and Nishi[31] suggest that a square-edged IOL optic produces a sharp bend in the posterior capsule. When migrating LECs meet this sharp, discontinuous bend, they are subject to contact inhibition and stop proliferating and migrating (the contact inhibition theory).[35,36] In contrast, a round-edged IOL optic produces a more curved, non-sharp continuous bend that does not induce contact inhibition. Bhermi et al[37] suggest an alternative hypothesis whereby the square edge produces an increased pressure profile at the point on the posterior capsule where the posterior edge is compressed against the posterior capsule; this creates a physical pressure barrier to LEC migration (the capsule compression theory). Most manufacturers now produce square-edged IOLs; however, it has become apparent that there are variations in PCO prevention between them. Moreover, there is little evidence of how sharp the optic edge must be to prevent LEC migration effectively. Tetz and Wildeck,[34] using different edge designs with a poly(methyl methacrylate) (PMMA) block in cell culture, showed that sharper optic edges more effectively prevented the migration of LECs.

The standard treatment for the post-surgery PCO complication is neodymium-doped yttrium aluminium garnet (Nd: YAG) laser capsulotomy.[2] Previous studies evaluating the incidence of Nd: YAG capsulotomy in patients with different IOL types suggest that more favourable outcomes have been shown for hydrophobic acrylic lenses compared with those made from other materials, including silicone and hydrophilic acrylic IOLs.[27,36,38-40] In long-term observational studies (3–9 years post-cataract surgery) looking at the incidence of both PCO and Nd: YAG following cataract surgery, hydrophobic acrylic IOLs have been associated with a longer time until the need for Nd: YAG capsulotomy, with less frequent[27,38,41] and less severe[38] or dense[41] PCO, and with lower per-patient post-operative costs.[42] Nd: YAG laser capsulotomy is the only effective surgical treatment for PCO and is a routine and largely safe procedure, but could be associated with occasional complications that include elevated intraocular pressure, retinal detachment, and endophthalmitis.[5,42] The requirement to perform Nd: YAG capsulotomies as a consequence of PCO places a considerable financial burden on healthcare systems. This is due to the costs of the procedure itself, follow-up visits, and managing the associated complications that may arise because of the procedure.[3,4,6,42]

In summary, the evidence suggests using hydrophobic acrylic material is superior to hydrophilic on many fronts. The preference for using these materials is multifactorial. However, from the perspective of improving patients' outcomes, hydrophobic acrylic material stands out prominently compared to hydrophilic acrylic material. ■

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