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YAG Laser Capsulotomy: Indications, Risk, and Care

Capsulotomia YAG laser: indicações, riscos e cuidados

Capsulotomía con láser YAG: indicaciones, riesgos y cuidados

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ABSTRACT

Posterior lens capsule opacification (PCO) is the most common complication after cataract surgery. Its treatment comprises Nd:YAG laser capsulotomy, which is also indicated in cases of capsular contraction syndrome, capsular bag distension syndrome, and negative dysphotopsia. Although it is a safe procedure, many complications occur when it is applied to patients with PCO. These complications include marks or fissures on the intraocular lens (IOL), increased intraocular pressure, displacement of the IOL, uveitis, cystoid macular edema, retinal detachment, macular hole, retinal hemorrhage, and endophthalmitis. Meticulous cortical cleaning, the IOL inside the capsular bag, continuous curvilinear capsulorhexis (which overlaps the optical edge of the 360° IOL), and changes in IOL designs and materials have all helped to decrease the rate of complications associated with PCO treatment. Antiglaucomatous eye drops and topical corticosteroids have also been used to prevent and treat complications associated with the use of Nd:YAG laser.

RESUMO

A opacificação da cápsula posterior do cristalino (OCP) é a complicação mais comum após a cirurgia de catarata. O tratamento é realizado por meio da capsulotomia com *Nd: YAG* laser, que também é indicado na Síndrome da contração capsular, na Síndrome da distensão do saco capsular e na disfotopsia negativa. Apesar de ser um procedimento seguro, várias complicações são relatadas quando aplicado na OCP, que incluem: marcas ou fissuras na LIO, aumento da pressão intraocular (PIO), deslocamento da LIO, uveíte, edema macular cistoide, descolamento de retina, buraco macular, hemorragia retiniana e endoftalmite. Limpeza cortical meticulosa, LIO dentro do saco capsular, *capsulorhexis* curvilínea contínua, que se sobrepõe à borda óptica da LIO 360 graus, modificações no desenho das LIOs e do material levam à diminuição da taxa de complicações na OCP. Colírios antiglaucomatosos e corticosteroides tópicos também são usados para prevenir e tratar complicações relacionadas ao uso do *Nd: YAG* laser.

RESUMEN

La opacificación capsular posterior del cristalino (OCP) es la complicación más común después de la cirugía de catarata. El tratamiento se realiza por medio de la capsulotomía con ND: láser YAG, que también es indicado en el Síndrome de la contracción capsular, en el Síndrome de la distensión del saco capsular y en la disfotopsia negativa. Aunque sea un procedimiento seguro, hay relatos de varias complicaciones cuando este es aplicado en la OCP, que incluyen: marcas o cisuras en la LIO, aumento de la presión intraocular (PIO), desplazamiento de la LIO, uveítis, edema macular cistoide, desprendimiento de retina, agujero macular, hemorragia retiniana y endoftalmitis. Procedimientos tales como limpieza cortical meticulosa, LIO dentro del saco capsular, capsulorhexis curvilínea continuada, que se sobrepone al borde óptico de la LIO 360 grados, modificaciones en el diseño de las LIOs y del material llevan a la reducción de la tasa de complicaciones en la OCP. Colirios antiglaucomatosos y corticosteroides tópicos también se utilizan en pro de precaver y tratar complicaciones relacionadas al uso del ND: láser YAG.

Keywords:
Posterior capsulotomy;
Lasers;
Cataract;

Palavras-Chave:
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INTRODUCTION

Posterior lens capsule opacification (PCO) after cataract surgery has been known since many years and is still the most common complication of this surgery.[1] The remaining epithelial cells in the capsular bag of the lens proliferate and migrate to the visual axis, leading to opacification and shrinking of the posterior capsule, which results in reduced visual acuity.[1] The time of PCO onset may vary from months to years in adults. It is more common in younger patients, and it occurrence decreases with age. Its incidence varies from 3% to 50% in the 5 years after surgery.[1] This incidence has decreased since new phacoemulsification techniques, flexible IOLs with square edges, and improved IOL materials have been developed and small incision surgeries have been introduced.[2, 3] PCO may reduce visual acuity, contrast sensitivity, and stereoscopic vision; it may also cause difficulties with brightness or color vision as well as monoclonar diplopia. In such cases, the use of Nd:YAG laser is recommended.[4]

Before the introduction of Nd:YAG laser, the only option for PCO removal was surgery with polishing or removal of the posterior capsule from the visual axis. With the advent of Nd:YAG laser, the procedure has become safer and more effective. Nd:YAG laser is a solid-state laser with a 1064-nm wavelength. It disrupts the ocular tissues using a short, high-powered pulse that results in ionization or the formation of ocular tissue plasma.

INDICATIONS

Nd:YAG laser is most commonly indicated in patients with PCO; however, an assessment of functional visual incapacity is required. This assessment may be performed using various methods, including visual acuity tests, contrast sensitivity, glare testing, and video imaging analysis.[5,6,7]

In practice, the decision to apply this laser is generally based on a visual acuity assessment, the appearance of the posterior capsule, and the visibility of fundus structures. The pearl form of PCO is associated with poor visual acuity and contrast sensitivity.[8]

Fibroses caused by PCO are subjective and often deceiving. Therefore, it is potentially difficult to perform a precise assessment of visual outcomes. The two main methods proposed for resolving this problem are measuring the potential of visual acuity and using a laser interferometer. Both project an image on the retina in an attempt to treat the PCO.[9]

Another indication for Nd:YAG laser capsulotomy is capsular contraction syndrome. After creating a continuous curvilinear capsulorhexis during cataract surgery, the anterior capsule contracts slightly in normal eyes.[10] However, studies have also shown that this contraction occurs intensely in eyes with pathological conditions, such as pseudoexfoliation, retinitis pigmentosa, and diabetic retinopathy. In such eyes, the opening of the anterior capsule usually contracts to a size smaller than that of the pupil.[11] In these patients, relaxing incisions are made in the anterior capsule using Nd:YAG laser.[12]

Nd:YAG laser is also indicated in patients with capsular bag distension syndrome, which is characterized by the adhesion of the capsulorhexis edge to the anterior surface of the IOL and by the accumulation of clear or milky white fluid between the posterior capsule and the posterior surface of the IOL. This syndrome is associated with an increase in the space between the IOL and posterior capsule and may lead to the anteriorization of the IOL, anterior arching of the iris, presence of a shallow anterior chamber, and accumulation of fluid behind the IOL.[13] The fluid inside the capsular space may become cloudy, resulting in reduced vision.[14]

Patients with negative dysphotopsia, which was first described more than a decade ago by Davison et al.,[15] may also benefit from the use of Nd:YAG laser. Negative dysphotopsia manifests as a dark shadow in the temporal visual field and is perceived by the patient as retinal detachment or vascular occlusion. Because one etiology proposed for negative dysphotopsia involves the reflection of the anterior capsulotomy edge onto the nasal retina, the nasal portion of the anterior capsule can be removed with by applying Nd:YAG laser. This approach may result in significant improvement or complete resolution in most patients with this problem.[16,17]

RISKS

Several complications, including marks or fissures on the IOL, increased intraocular pressure (IOP), displacement of the IOL, uveitis, cystoid macular edema (CME), retinal detachment, macular hole, retinal hemorrhage, and endophthalmitis, have been reported with the use of Nd:YAG laser in patients PCO.[18]

Many studies on retinal detachment after applying Nd:YAG laser have shown an increase in its incidence from 0.5% to 3.6% relative to that patients who did not receive the laser treatment.[19] The exact mechanism underlying this pathogenesis remains unclear. Most

authors believe that the loss of the intact posterior capsule initiates changes in the vitreous, such as liquefaction, which decreases viscosity and depolymerizes the vitreous, as well as shock waves that may also induce direct changes in the posterior vitreous.[20]

The increase in IOP after applying Nd:YAG laser has been well documented, and many mechanisms have been postulated. Trabecular meshwork obstruction by inflammatory cells and debris can be responsible for reducing drainage capacity. Lynch et al.[21] have found a quantifiable reduction in drainage capacity in monkey eyes after applying Nd:YAG laser, and the histopathology studies performed after the monkeys were euthanized have shown that the trabecular meshwork contains fibrin, lens material, inflammatory cells, pigments, and erythrocytes. Schubert et al.[22] believe that the loss of protein from the dialysable vitreous is responsible for the increase in IOP.

CME is an uncommon complication after applying Nd:YAG laser. Although the gold standard for the diagnosis of this problem is fluorescein angiography, many studies have highlighted a good correlation with optical coherence tomography (OCT), particularly with new-generation spectral-domain OCT.[23] The risk of CME may be reduced by increasing the interval between cataract extraction and laser capsulotomy.[24]

Nd:YAG laser may also damage the IOL by corrosion, holes, cracks, and displacement. Factors that contribute to these complications include high laser energy, the precision of the laser focus, the distance between the IOL and posterior capsule, the IOL material and design. Lee et al.[25] have described opacities, holes, and fractures in an 2.0 D IOL of PMMA (polymethylmeth- acrylate) after capsulotomy. Hsieh et al.[26] have reported a case in which an IOL with glass optic and polyamide loops were fractured after a capsulotomy performed using the laser.

CARE-BASED MEASURES

Many care-based measures taken during the surgical procedure have led to a reduction in PCO rates. These measures include meticulous cortical cleaning, the IOL inside the capsular bag, continuous curvilinear capsulorhexis (which overlaps the optical edge of the 360-degree IOL), and changes in IOL design and materials. However, none of these methods have completely eradicated PCO, particularly in pediatric eyes, eyes with uveitis, and diabetic patients.[18]

In the last 10–15 years, it has become clear that the IOL design plays an important role in preventing PCO. The use of square-edged lenses, introduced in the early 1990s, has been associated with less opacity than other IOLs.[27] As a result of these discoveries, new IOLs with square-edged optics have been introduced. Recent studies have shown that silicone lenses with square edges have a rate of opacification similar to that of hydrophobic acrylic lenses.[28,29,30]

Fallor and Hoft[31] have compared damage resulting from the use of Nd:YAG laser in four types of IOLs in an experimental study and have found that IOLs with a narrow separation between the lens and the posterior capsule experience more damage because of the use of Nd:YAG laser.

In their comparison of the most frequently used patterns of Nd:YAG laser application, Ruiz-Casas et al.[32] have discovered that less energy is used when this laser is applied in a cross pattern than when it is applied in a circular pattern; however, the cross-pattern technique involves a higher risk of damage to the center of the lens. Because this risk is low for experienced surgeons, using the circular pattern is unjustified.

Reports on the impact of polishing the anterior capsule of the lens in the formation of PCO are contradictory. In cases of complete removal of the cortical material and polishing of the anterior capsule, the two-handed irrigation/aspiration (I-A) technique has been shown to be superior to the coaxial I-A technique because of the improved access to all areas of the capsular bag, which allows for improved cortical cleaning.[33,34]

Contact lenses or Abraham lenses for Nd:YAG laser may be used to stabilize the eye, improve the laser beam, facilitate precise focusing, and decrease the area of the laser in the posterior capsule. As little energy as possible is desired for achieving capsule rupture and disaggregation. In most lasers, a typical capsule may be opened using a 1–2-mJ pulse. To avoid marks on the IOL, the laser may be intentionally focused posterior to the capsule. The shock wave radiates forward and breaks the capsule. The incision in capsulotomy should be as large as the pupil in isotopical conditions, such as when driving at night, when the glare from the exposed capsulotomy edge is most likely. For a patient at a higher risk of retinal detachment, a small opening may be preferred.

Nd:YAG laser capsulotomy may result in significant postoperative complications involving ocular pressure. These include a temporary and immediate increase in postoperative IOP, onset of glaucoma, or worsening of existing glaucoma. The most common complication is

the increase in IOP (peaking within the first 2 h), although this increase is generally temporary. This increase is generally approximately 5–10 mmHg and may damage the vision, particularly in patients with advanced glaucoma who are most likely to experience this complication.[35]

Many medications are used to prevent these peaks in IOP after applying Nd:YAG laser. For example, 0.5% apraclonidine hydrochloride and 0.2% or 0.15% brimonidine tartrate (alpha-2-adrenergic agonists) are used as standard drugs to prevent these events.[36,37] Carbonic anhydrase inhibitors are also safe and effective for preventing peaks in IOP. Topical dorzolamide and oral acetazolamide administered in a single dose as a preventive measure before applying Nd:YAG laser have also been found to be safe and effective in preventing increases in IOP.[38] A study comparing the efficacy of topical dorzolamide to that of apraclonidine has found similar outcomes for both drugs.[38] Levobunolol and timolol (beta blockers) have been found to be effective in the long-term reduction in IOP in patients with glaucoma or ocular hypertension.[39,40]

The safest option is to treat the patient with these prophylactic medications if they present risk factors for a considerable increase in IOP. These risk factors include aphakia, glaucoma, pre-existing IOP > 20 mmHg, high myopia, and vitreous or retinal diseases. In high-risk patients, IOP can be measured again 1 h after the laser treatment. If it is increased by ≥5 mmHg, another measurement should be taken within 4 h in patients with pre-existing glaucomatous damage. If the increase in IOP persists, the ophthalmologist should continue the antiglaucomatous therapy for at least 1 week.

Post-laser treatments using topical steroids or cycloplegic agents vary according to the surgeon's experience. The use of topical steroids four times a day for 1 week during the postoperative period is often useful for alleviating any discomfort or inflammation.

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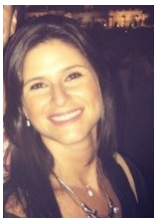

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