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RESEARCH LETTER

Precise Posterior Nd:YAG Capsulotomy without Creating Defects is Key for Patients' Quality of Vision

Andreas F Borkenstein, Eva-Maria Borkenstein

Borkenstein & Borkenstein, Private Practice and Privatklinik der Kreuzschwestern, Graz, 8010, Austria

Correspondence: Andreas F Borkenstein, Borkenstein & Borkenstein, Private Practice and Privatklinik der Kreuzschwestern, Kreuzgasse 35, Graz, 8010, Austria, Tel +433163313880, Email crustalith@gmx.at

Cataract extraction is the most frequent ophthalmological procedure with 60.000 procedures performed every day globally.[1] However, akin to any surgical procedure, there remains a chance of complications or consequences, with posterior capsule opacification (PCO) emerging as a notably significant issue. PCO, which can occur starting few months postoperatively, results in blurry vision, leaving the patient with symptoms similar to those of the original cataract. A study by Ursell et al on over 20,000 eyes observed that the incidence of PCO ranged between 4.7–18.6% at 3 years and 7.1–22.6% at 5 years.[2] Yet, the numbers in this context exhibit considerable variation due to the influence of numerous factors such as the surgery itself, additional secondary diagnoses in the eye, the intraocular lens characteristics (including material, geometry or edge design), and its positioning in the capsule. Neodymium:Yttrium-aluminum-garnet (Nd:YAG) lasers can address this problem through a capsulotomy, allowing the patient to restore clear vision, often immediately after the procedure. It may also have positive effects on glare and contrast sensitivity in some cases, improving the overall quality of vision.

The Nd:YAG laser, is a versatile and widely used device in ophthalmology. It has a variety of applications: treating narrow-angle or angle-closure glaucoma with peripheral iridotomy and it can be used for vitreous floaters. By far the most common area of application is posterior capsulotomy to treat PCO. It is an efficient, minimally invasive tool (gold standard) and is generally described as a simple, low-risk procedure. Appropriate equipment, proper patient selection, precise laser settings, and accuracy are the key factors of procedural success and patient satisfaction.

Ling et al observed that the incidence of Nd:YAG laser intervention to address PCO was 8.5% at 2 years postoperatively.[3] As with any procedure, and although minimally invasive, the technique can still carry a certain risk of complications, especially if not performed cautiously or if the energy level is not properly adjusted.[4] Studies have found that higher energy levels have led to more cases of elevated intraocular pressure (IOP) and macular oedema. In addition, defects in the intraocular lens (IOL), called YAG-pits, are another significant complication caused by inappropriate beam focusing, acoustic shock waves and heat conduction (Figures 1 and 2). In the last years, these YAG pits and their potential impact on visual acuity and quality of vision have been debated much like the effects of glistenings in intraocular lenses.

Several experimental studies conducted by our research team showed that they do have a negative impact on the quality of vision and the patient overall satisfaction. These studies have analysed the impact of YAG-pits in IOLs, describing their optical and surface properties and elucidating their potential effect on the overall IOL performance.[5–8] It appears that lenses with YAG-pits led to more blurred images and to the impression of a lower contrast with phenomena like halo/glare. The light field measurements showed that YAG-pits led to a dispersion and scattering effect, which was even higher in hydrophobic IOLs. Modulation transfer function showed a deterioration in damaged hydrophilic and hydrophobic IOLs, respectively. However, the impact level was strongly dependent on the number, size and position of the YAG-pits within the optic. Moreover, scanning electron microscopy and Raman spectroscopy revealed that the distinctive damage area in IOLs (with chemical changes in the material) was larger than visually recognizable.[5] Also, it was observed that the IOL image performance deteriorates with YAG-pits: the total intensity of transmitted light or

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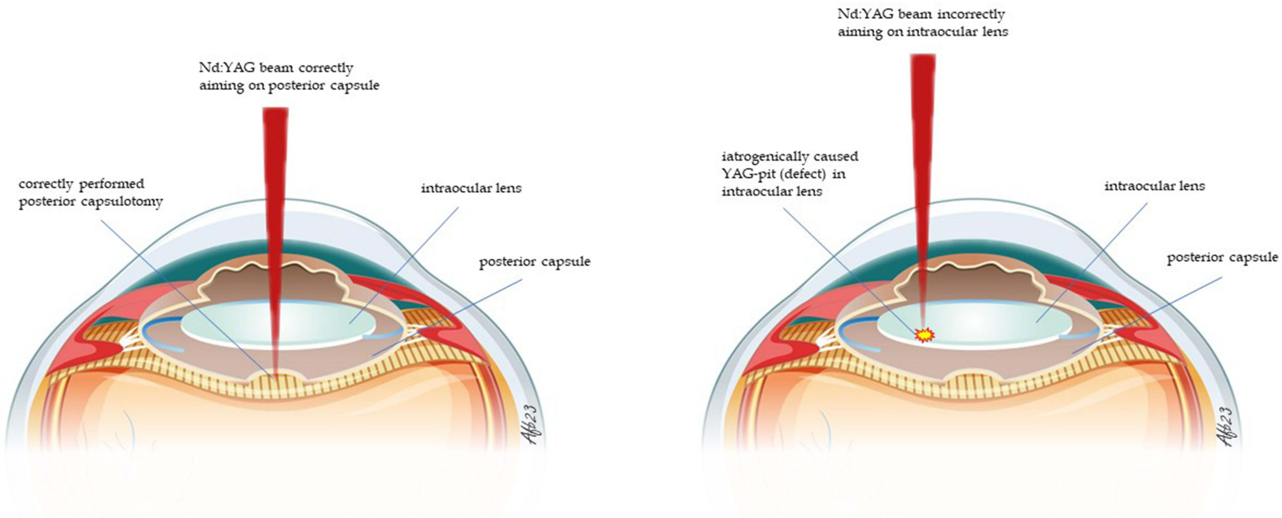

Figure 1 Schematic representation of the eye with application of the Nd: YAG laser beam. Correctly focused on the posterior capsule (left) and incorrectly focused (right) with creation of a defect on the intraocular lens.

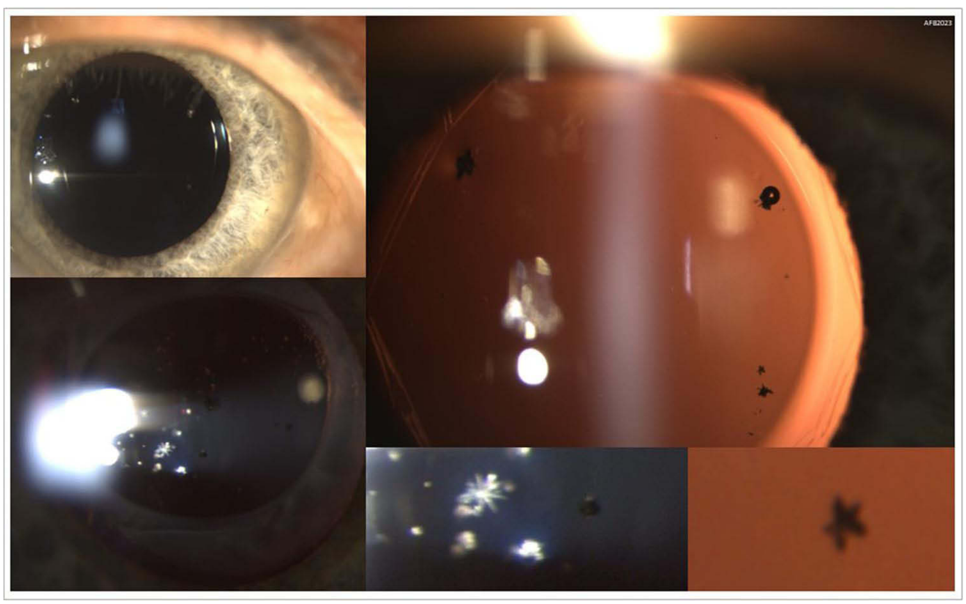

Figure 2 Slit lamp examination of patients with YAG pits. Note the defects which, depending on their number, size and position in relation to the optical axis, can have varying degrees of severity.

transmittance (without scattering) was reduced in the wavelength between 450 and 700 nm. The contrast was significantly reduced and United States Air Force (USAF) resolution test chart analysis showed worse results compared to unmodified counterparts.[6] In addition, our latest clinical case reports have shown that YAG-pits and defects influence quality of vision. These effects in everyday life can be very different, depending on the position of the defects and pupil size. However, the effects could also be measured objectively with the C-Quant device (Oculus, Germany), which is a straylight meter for quantification of light scattering in the eye. A case series recently conducted showed significant clinical impact in patients with YAG pits. In 24 consecutive cases that had received Nd:YAG capsulotomy in the last 6 months, straylight was analysed with the C-Quant device. All patients were pseudophakic with a clear, monofocal intraocular lens and aged between 68 and 91 years. In 17 cases, no defects in the intraocular lenses were observed. The straylight analysis of these 17 cases without lens defects showed age-appropriate results of 1.3–1.5 log/straylight parameter (Log/s). In 5 cases, YAG pits were detected within the central optical zone (3mm) of the intraocular lens. In 2 cases lens pits were observed only in the periphery of the lens optic. The C-Quant measurements showed in all 5 cases with central lens pits higher straylight values (above the normal age curve) with results of 1.6–1.9 Log(s). The 2 cases with lens pits in the periphery of the optic showed higher, borderline straylight values with 1.5–1.6 Log(s). The results were considered reliable as the expected standard deviation was <0.08 and the quality of the measurement >0.6 in all cases. However, this was only a case series and further multicentric studies with a good study design and pre-postoperative comparison of higher number of cases should clarify these initial results.

Therefore, it seems that also YAG capsulotomy is a fundamental procedure, and a very cautious approach is recommended when performing it, as defects in the surface structure of the implant can occur. Precise aiming of the focus during the procedure is crucial. Many reasons for incorrect focusing of the aiming beam have been identified: patient's movement, shaking or tremor, poor vision with reflexes and glare which may disturb the user; incorrect settings on the device or time factors during the procedure.

We have also tested newest devices on the market that are equipped with new safety features like the switchable 4- to 2-point aiming beam. Using the 2-point aiming beam is particularly beneficial when working with presbyopia-correcting, diffractive IOLs, tinted ("blue-blocker") IOLs, as well as in more complicated cases, such as in tilted, decentred or subluxated lenses. New, larger and informative displays of the devices offer an extra advantage, it allows visualization of the entire treatment area, the energy levels applied, and treatment parameters at the same time and throughout the laser procedure, which is useful to stay focused on the therapy session, and the device allows to change and adjust the laser parameters operating a joystick with a switch.

Patient counselling and education about their cataracts, posterior capsular opacities or their progression, anterior segment diseases, and any changes before and after their procedures is another critical aspect of the medical care. Hence, this needs to be addressed while performing YAG capsulotomy. Another feature provided by some new YAG-laser devices is the camera system attached to the slit lamp which allows capturing high-resolution images and videos that can be shown to patients as explanatory visual tools, so they can be more actively involved in their own treatment process. A video capture of the procedure can also show what exactly is being done to treat certain conditions. Occasionally, PCO may present only in the IOL periphery but may still be causing visual disturbances, making imaging an excellent tool to showcase that to the patient. This feature is also important for legal purposes and clinical status documentation; for PCO patients, documenting the fibrosis grade before doing the procedure should be required to justify that Nd:YAG capsulotomy is correctly indicated, thus preventing any potential reimbursement issues of the insurance companies.

New YAG laser devices integrate the digitalization of patient examinations in data management solution platforms, smoothening the workflow and allowing more precise diagnoses and treatment capabilities. Hence, the information that stems from the devices becomes easily accessible to colleagues and other clinics.

Coupled with the need for the most precise capsulotomy possible, this seems to be the key to making a significant positive impact on quality of vision.

In addition, these new "Nd:YAG laser combi devices" can be used to create an opening in the peripheral iris – peripheral iridotomy – to relieve the pressure in narrow-angle or angle-closure glaucoma and can be combined with a Selective Laser Trabeculoplasty (SLT) module and with an additional photocoagulation module (which can be used as a pretreatment to iridotomy to decrease the incidence of hemorrhage). SLT with a frequency-doubled Q-switched Nd:YAG laser has recently been used as a primary or adjunct therapy for open-angle glaucoma patients. Furthermore, YAG laser vitreolysis might be employed to treat bothersome vitreous opacities, improving visual comfort and reducing the need for invasive surgery.

The expectations of cataract patients are on the rise, with increasing emphasis on achieving precise refractive targets and the best quality of vision. During cataract surgery and implantation of an IOL, the aim is always to achieve best possible refractive outcome in order to meet everyday requirements and to achieve a high quality of life. Capsulotomy for the treatment of PCO is seemingly often underestimated as a simple and fast procedure. Iatrogenic defects in the IOL that are permanent can have a major negative impact on the overall quality of vision.

Experimental studies and clinical cases have proved that quality of vision depends on the clarity of the implant and optical axis. Case reports have shown that defects in the lens (lens pits) can lead to an increase in scattered light.

However, further clinical studies are needed. It seems that defects or opacities of any kind in the optics are disturbing and may lead to loss of quality with negative consequences for patients. The degree of the impact depends on many factors: the position, size and number of defects, the optics of the damaged IOL, pupil size and also factors in everyday life. Therefore, a precise and exact procedure is most important and more safety features in new devices are crucial in addressing this. Ophthalmologists as well as developing and manufacturing companies are addressed to keep the quality and accuracy as high as possible. A precise posterior Nd:YAG capsulotomy without creating any defects seems the key for long-lasting patients' Quality of Vision.

Disclosure

The authors report no conflicts of interest in this work.

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