Morphology of the Trabecular Meshwork Three Years After Erbium:YAG Laser Trabecular Ablation

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Abstract. Laser trabecular ablation (LTA) is an ab-interno approach with the purpose to improve outflow facility by removing trabecular tissue and open Schlemm’s canal. In a blind eye with secondary glaucoma following silicone oil surgery, Erbium:YAG LTA had been performed applying 12 neighboring single laser pulses (5-7 mJ) pulse energy, 200 μs pulse duration) to the trabecular meshwork. Enucleation was performed three years after the procedure that did not achieve pressure control. Light-microscopy revealed neither marked scarring nor endothelial proliferation in the treated trabecular meshwork. However, most of the recognizable ablation craters failed to open Schlemm’s canal. Although limited scar formation within the trabecular meshwork after LTA is a promising aspect, the present technique of Er:YAG LTA still needs technical and surgical improvements to guarantee reliable and reproducible openings of Schlemm’s canal. [Ophthalmic Surg Lasers 2001;32:483-485]

INTRODUCTION

Although trabeculectomy seems to be the standard procedure for the surgical treatment of glaucoma during the last decade, there is obviously a growing interest in surgical alternatives with a minor risk profile, eg, nonperforating surgery and ab-interno procedures. Ab-interno laser procedures of the trabecular meshwork have remarkable conceptual advantages over ab-externo filtering surgery because there is no complete change of the intraocular hydrodynamics and only the diseased tissue is the target of surgery. Because ab-interno surgery does not involve the conjunctiva, future glaucoma surgery will not be prejudiced. However, the morphologic analysis of the chamber angle in animals after ab-interno laser surgery revealed a considerable repair cascade obviously limiting the mid- and long-term success of these procedures.

Because reasons for clinical failure of laser trabecular ablation are still obscured, the morphologic changes after this procedure in glaucoma patients should be of outstanding interest.

CASE REPORT

The histology of the chamber angle region in a 60-year-old glaucoma patient who underwent LTA 3 years ago is reported. Chronic open-angle glaucoma was known for 2 decades in both eyes, 8 years before vitreoretinal surgery and lensectomy had been performed in the myopic left eye because of retinal detachment. Silicone oil had been used because of complete detachment with signs of proliferative vitreoretinopathy. After removal of the silicone oil, only a few single emulsified oil remnants were detectable in the upper chamber angle region. Because intraocular pressure (IOP) raised to 40 mm Hg despite topical antiglaucomatous medication causing temporary discomfort to the blind eye, we performed gonioscopically controlled LTA of the nasal circumference of the chamber angle applying 12 single pulses (5-7 mJ pulse energy). We used an Erbium:YAG laser (MCL 29, Aesculap Meditec, Heroldsberg, Germany) emitting single pulses in the normal spiking mode (20, μs). Pulse energy was delivered by contact mode via a
quartz fiber endoprobe (core-diameter 320 μm, coating-diameter 385 μm). Although initially after LTA the intraocular pressure dropped to 25-30 mm Hg without medication, IOP raised again several months later. The enucleation of the blind eye was then performed 3 years after laser trabecular ablation because the patient complained of recurrent superficial irritation and lack of eye function.

After enucleation, the treated chamber angle region was marked by episcleral sutures and the whole globe was fixed by immersion in 5% formaldehyde. Serial sections of the nape-inferior chamber angle were radially cut and stained by hematoxylin-eosin. Several laser-induced craters could be identified because of the sharp discontinuation of the trabecular lamellae. No collateral thermal damage was seen near the craters. Only two laser-induced craters revealed complete penetration of the trabecular meshwork with the opening of Schlemm’s canal (Figure 1). Several ablation craters did not reach the lumen of Schlemm’s canal (Figure 2). There were neither filling of the craters by scar tissue nor any endothelial proliferation emerging from Schwalbe’s line, although the formation of anterior synechiae was observed near one ablation crater. The untreated chamber angle region showed structural integrity of the trabecular meshwork, but there was mild cellular infiltration of the uvea probably because of previous silicone oil surgery.

DISCUSSION

Morphologic proof of laser craters without signficant scarification 3 years following Er:YAG laser trabecular ablation in this enucleated eye may demonstrate the massive differences in healing processes between young healthy animals and old glaucoma patients. Even in treatment areas where the laser-induced craters were localized adjacent to Schwalbe’s line, we found no endothelial covering of the anterior meshwork as previously reported in animal studies. This may be a hopeful sign for any kind of ab-interno surgery including excimer trabeculopuncture and mechanical goniotomography.

Because massive tissue repair response was not present in this patient who failed IOP control after LTA, other reasons than scarring have to be looked for to explain the surgical failure. One reason may be the insufficient number of ablation craters creating apertures of Schlemm’s canal, although, from a theoretical point of view, two openings of Schlemm’s canal should be sufficient to control the intraocular pressure. Possibly, the collector channel system has been occluded by silicone oil or by other secondary tissue changes in this eye with chronic inflammation, thus limiting the initial pressure-lowering effect. Based on this background, we do not recommend LTA as a pressure-reducing intervention in eyes with uveitis or previous silicone oil surgery. Besides, progressive formation of anterior synechiae may be promoted by any ab-interno surgery in uveitic eyes.

Reasons for an incomplete ablation of the trabecular meshwork are many sided. A lack of trabecular pigmentation may lead to misidentification of the tar-
get tissue as well as a reduced visibility by reflux bleeding from Schlemm’s canal after successful openings. Manual pressure along the fiber tip axis by the surgeon also influences the ablation depth because of a photo-hydraulic effect.

Considering the morphological variability of the ablation craters, an increased number of single pulses should also increase the number of full-penetrating openings of Schlemm’s canal. The first clinical pilot study of Er:YAG LTA indeed showed a tendency that an increased number of pulses might be associated with a lower postoperative intraocular pressure. Further qualitative innovations of laser technology as well as increasing surgical experience with this kind of chamber angle surgery should help to improve the functional results of laser trabecular ablation.

REFERENCES