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Comparison of macular parameters after femtosecond laser-assisted and conventional cataract surgery in age-related macular degeneration

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Purpose: To evaluate differences in postoperative central macular thickness, central macular volume, corrected distance visual acuity (CDVA), and number of intravitreal anti-vascular endothelial growth factor (VEGF) injections between conventional and femtosecond laser-assisted cataract surgery in wet age-related macular degeneration (AMD).

Setting: Tertiary referral center, Lucerne, Switzerland.

Design: Retrospective case series.

Methods: Consecutive patients with AMD and cataract were enrolled between January 2010 and December 2015. Associations between postoperative changes in central macular thickness, central macular volume, CDVA, and number of anti-VEGF injections with type of surgery were assessed statistically.

Results: The study comprised 140 eyes (110 patients). No differences in postoperative central macular thickness ($-9.20 \mu\text{m}$; 95%

confidence interval [CI], -41.68 to 23.28 ; $P = .576$), central macular volume (-0.08 mm^2 ; 95% CI, -0.36 to 0.19 ; $P = .553$), visual acuity (0.03 logarithm of the minimum angle of resolution; 95% CI, -0.09 to 0.15 ; $P = .647$) or postoperative number of anti-VEGF injections (0.30 ; 95% CI, -0.45 to 1.05 ; $P = .427$) were found between the femtosecond laser group and the conventional group over a mean follow-up of 619 days \pm 473 (SD). In the 33 eyes that had optical coherence tomography measurement within a postoperative period of 2 weeks, the central macular volume was significantly lower in femtosecond laser-treated eyes (-0.71 mm^2 ; 95% CI, -1.19 to -0.23 ; $P = .005$).

Conclusions: Overall, the postoperative course between wet AMD after femtosecond laser and conventional cataract surgery was equal. During the early follow-up, femtosecond laser-treated eyes had less subclinical macular edema, indicating a possible benefit for patients with macular vulnerability.

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Wet age-related macular degeneration (AMD)¹ and cataract often concurrently impair visual acuity. Recent studies report a transient increase in intraretinal fluid accumulation, and hence central macular thickness, as well as exacerbation of choroidal neovascularization (CNV) after cataract surgery in patients who have wet AMD.^{2,3} It has been argued that the underlying mechanism for postoperative macular thickening is a breakdown of the blood-aqueous barrier resulting from surgical manipulation.^{4,5} In cataract surgery, tissue trauma and subsequent inflammation might be induced by the corneal incision, capsulorhexis, and lens

fragmentation. However, an acceleration of wet AMD progression after cataract surgery in terms of an increased need for anti-vascular endothelial growth factor (VEGF) injections has never been shown.^{2,3,6}

Recently, technological progress has allowed the development of an alternative surgical method in the treatment of cataract involving femtosecond-laser assistance. In comparison with conventional cataract surgery, femtosecond-laser assistance has been shown to dissect and liquefy tissue with higher precision, less collateral damage, and a comparable complication rate.⁷⁻¹⁴ Moreover, femtosecond-laser assistance has been shown to

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induce less anterior chamber inflammation than conventional cataract surgery.¹⁵ However to date, there is no conclusive evidence of a beneficial effect on the postoperative macular status in femtosecond laser-assisted cataract surgery.^{16–18} In fact, Ewe et al.¹⁷ reported that postoperative macular thickening is more pronounced after femtosecond laser-assisted cataract surgery than after conventional phacoemulsification.

To contribute to this debate, this study assessed whether patients with wet AMD benefit from femtosecond-laser assistance in terms of postoperative macular status and disease progression. More specifically, we assessed the effects on central macular thickness, central macular volume, corrected distance visual acuity (CDVA), and the number of anti-VEGF injections after femtosecond laser-assisted versus conventional cataract surgery in a retrospective case series.

PATIENTS AND METHODS

This study received the approval of the relevant ethics committee (EKNZ 2015-315) and was performed according to the standards of good clinical practice. This retrospective comparative case series analyzed consecutive patients treated at the Eye Clinic of the Cantonal Hospital of Lucerne, Switzerland. All patients provided informed consent.

Using electronic patient records, patients who were treated for wet AMD by anti-VEGF injections and for cataract by surgery between January 2010 and December 2015 were identified. In regular clinical routine controls, experienced optometrists assessed the CDVA (using a logarithm of the minimum angle of resolution [logMAR] scale) as well as optical coherence tomography (OCT) measurements and documented them in electronic patient records. Retinal images and automatic follow-up horizontal 13-line raster scans with automatically measured central macular thickness, and central macular volume were obtained with OCT (Spectralis, Heidelberg Engineering GmbH). If required, demarcation lines of the inner limiting membrane and Bruch membrane were manually corrected. Demographic data, including patient age and sex, number of anti-VEGF injections, CDVA, central macular thickness, and central macular volume, were extracted by an ophthalmologic research fellow (T.J.E.).

Inclusion and Exclusion Criteria

Patients with a confirmed (by fluorescence angiography) case of wet AMD who were receiving anti-VEGF injections before cataract surgery were selected. Patients were excluded if they met 1 of the following criteria: (1) comorbid ophthalmologic diagnoses that could contribute to neovascularization, such as diabetic retinopathy or retinal vein occlusion; (2) complicated cataract surgery; (3) relevant complication resulting from anti-VEGF injections; (4) no CDVA or OCT measurements documented during the evaluation period; or (5) documented statement in an electronic patient record indicating the patient did not want to contribute personal health-related data to any study.

Surgical Technique

During the femtosecond laser-assisted cataract surgery (Catalys Precision Laser System, Abbott Medical Optics, Inc.), the anterior lens capsule was opened and the lens liquefied with a near-infrared laser. The laser light focuses at a 3 μm spot size and fires at ultra-short pulses of 10^{-15} seconds (femtoseconds). All patients treated with the femtosecond laser were paid out of pocket because standard coverage by the Swiss health insurers is not provided for this procedure. All included eyes had instillation of postoperative

topical steroids and antibiotics as recommended in the relevant current guidelines.

Monitoring and Intravitreal Anti-Vascular Endothelial Growth Factor Therapy in Wet Age-Related Macular Degeneration

All patients included in this study were followed for their wet AMD before and after cataract surgery by the clinic's AMD center according to a certified standard protocol. To monitor the wet AMD, patients presented for monthly clinical control visits involving continuous assessment of CDVA, OCT parameters, and clinical ophthalmic status.^{19,20} Criteria indicating further anti-VEGF injections therapy included intraretinal or subretinal fluid accumulation, an increase in retinal thickness of more than 20 μm , or an increase in pigment epithelium detachment size. Clinically, a newly detected macular hemorrhage was an indication of re-treatment, and CDVA might have been considered in ambiguous cases. This treatment approach is called *pro re nata*, or as needed.

Statistical Analysis

Dichotomous variates were described with percentages and continuous variates with means \pm SDs. Estimates and the precision of statistical modeling were presented with means and 95% confidence intervals (CIs).

Associations between changes in central macular thickness, central macular volume, CDVA, number of anti-VEGF injections, and type of treatment were assessed with multivariate mixed linear models. These models consider that patients have provided repeated measurements during follow-up. In addition, differences were further accounted for in the distribution of parameters at baseline, entering parameters with between-group differences to the models as follows: preoperative CDVA, number of anti-VEGF injections, CDVA, central macular thickness, and central macular volume. The models were fitted using the following formula: $\text{loglik} = -432.7(\text{o})1(\text{f})9-1.11\text{fro}(\text{s})-372.3\text{era}-\text{d} \text{crecongine}1.1128\text{Ttically}5(\text{,})261511\text{fro}(\text{s})-372.39.8(\text{f}42(\text{l}).\text{m}-432.7\text{e}53\text{T}46-647.\text{g}$

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