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Abstract:

Purpose: To evaluate the effectiveness of focal laser for treatment of diabetic macular edema (DME) performed by ophthalmology residents.

Methods: Chart review of DME patients treated in a resident clinic with focal laser. Visual acuity (VA), OCT central subfield thickness (CST), and maximum subfield thickness (MST) at initial, 1 month, and 6 month visits were recorded.

Results: For 32 reviewed patients, average VA was 20/58 initially and 20/39 at 6 months ($p=0.18$). Mean CST was 311 µm initially and 305 µm at 6 months ($p=0.09$). Mean MST was 413 µm initially and 382 µm at 6 months ($p=0.007$). Factors favoring success are: initial CST <400 µm, treatment of localized microaneurysms, and prior focal laser treatments.

Conclusion: Focal laser performed by residents was effective in decreasing MST and maintained visual acuity. Initial CST, localized microaneurysms and repeat focal treatment predicted improved outcomes.

Introduction

Diabetic macular edema (DME) is the most common cause of vision loss in diabetic retinopathy.[1] It is a prevalent disease, affecting 7% of people with diabetes.[2] The mechanism for edema in diabetic retinopathy is due to abnormal vascular permeability.[3] As in diabetic retinopathy, the greatest modifiable risk factor for the development of DME is hyperglycemia.[4] DME is diagnosed by the presence of macular thickening observed via slit lamp biomicroscopy, stereoscopic fundus photos, or on optical coherence tomography (OCT) (figure 1). Other exam findings such as hard exudates in the presence of microaneurysms and blot hemorrhages within one disc diameter of the fovea have been utilized for diagnosis as well.[4] Fluorescein angiography (FA) can also aid in diagnosis. It will show vascular leakage in the setting of edema, which frequently correlates well with OCT findings.[5]

Treatment of DME, with goals of immediate and sustained visual improvement and prevention of vision loss, has evolved through the years. The first available treatment option began in 1985 when the Early Treatment Diabetic Retinopathy Study established the effectiveness of laser photocoagulation for DME.[6] Laser can be performed in focal pattern, targeting specific leaking microaneurysms, or in a grid pattern to target areas of more diffuse leakage.[6] Our study concentrates on focal laser photocoagulation.

While laser was the only treatment option available for 20 years, there are now several other modalities available. The advent of intravitreal anti-vascular endothelial growth factor (VEGF) medications, beginning with pegaptanib in 2005 introduced a second treatment option, particularly useful for center-involving DME that is not amenable to laser treatment.[7] Currently, ranibizumab, aflibercept, and the off-label use of bevacizumab, are available anti-VEGF agents, and these agents have dramatically changed the treatment of DME. The release of the Diabetic Retinopathy Clinical Research Network (DRCR.net) Protocol I data, demonstrated the role of intravitreal anti-VEGF agents in combination with focal/grid laser treatment.[8]

There are additional treatment options that may be utilized, particularly in refractory cases. This includes intravitreal triamcinolone, which was superior to laser alone in pseudophakic eyes when studied in DRCR.net protocol I, as well as various other ocular steroid formulations.[9] Lastly, DME that is associated with posterior hyaloid traction and/or epiretinal membrane may be amenable to improvement with pars plana vitrectomy.[10]

Given the multitude of treatment options and various treatment algorithms that have been studied, the decision for when focal laser is indicated is very practitioner-dependent and frequently based on personal experience. Our study analyzes focal laser treatments performed by multiple physicians in an inner-city population to identify patient selection factors and treatment parameters that correlated with successful outcomes.

Methods

Patients with DME were selected from outpatient visits with multiple physicians at Parkland Memorial Hospital (Dallas, TX). The study was conducted in accordance with the World Medical Association Declaration of Helsinki.

The study consisted of 32 patients, 24 (75%) of which were male. The population was predominantly Hispanic (59.4%), and the average age was 65 years old. Average hemoglobin A1c was 8.3%. See table 1 for additional demographic characteristics.

Patient selection for receiving focal laser treatment was physician dependent, and these selection factors were analyzed in the study. Exclusion criteria included macula edema not secondary to diabetic retinopathy (e.g. retinal vein occlusion, Irvine-Gass Syndrome, uveitic macular edema), lack of return for the 1 month follow-up appointment, or if pre-treatment or post-treatment OCT's (Heidelberg Spectralis) were not available.

For each selected patient, laser treatment was performed with an Iridex 532 nm green laser through a slit-lamp delivery system in single spots without pattern scanning. The lens used for all treatments was a Volk Area Centralis contact lens. Treatment parameters including laser power and duration settings, spot size, number of shots, and pattern of treatment were analyzed.

Patients returned for 1-month follow-up, with the primary outcomes examined at that visit including visual acuity change, OCT central subfield thickness (CST) change, and maximal subfield thickness (MST) change as compared to pre-treatment values. MST was analyzed because the goal of many focal laser treatments was to target a non-central area of leakage in order to prevent future central involvement.

Results

Visual acuity was recorded on logMAR scale, with a pre-treatment average visual acuity of 0.42 (corresponding to 20/52) and 1-month post treatment average visual acuity of 0.34 (corresponding to 20/44). The average CST was 322.26 μm pre-treatment and 325.81 μm post-treatment, while the average MST did improve marginally from 418.29 μm to 407.74 μm. Average laser parameters used were 96.78mW power, 0.1 second duration, 91.38 μm spot size, and shot count of 4.43.

When comparing patients with less than 400 μm CST (n = 57) pre-treatment to patients with greater than 400 μm (n = 10), there was a statistically significant ($p = 0.0001$) difference in CST change and MST change at 1 month, favoring those patients with thinner pre-treatment CST. This is attributable to the fact that in eyes with CST greater than 400 μm, significant amount of the leakage was centrally located and was not amenable to focal laser. This OCT improvement did not, however, correlate with statistically significant visual acuity improvement advantage for those with less than 400 μm pre-treatment. See **Table 2** for detailed study results.

Conclusions

For patients who had less than 5 microaneurysms targeted with laser treatment, there was a statistically significant difference in visual acuity, CST, and MST outcomes at 1 month as compared to other targets of treatment. In those patients with fewer microaneurysms targeted, the source of leakage was more focal and therefore responded better to laser treatment.

Due to limited resources at our county hospital, FA was only able to be obtained prior to laser treatment in 1/3 of the cases where the source of leakage was uncertain (i.e. many candidate microaneurysms), but there was no significant relationship found between visual acuity or OCT outcomes at 1 month whether the patient had an FA conducted prior to treatment or not.

Laser parameters were evaluated, and patients were found to have worse outcomes when power settings outside the range of 80-100 mW were utilized, with worse visual acuity, CST, and MST outcomes at 1 month ($p = 0.039$, 0.022, and 0.014, respectively), as compared to those treatments conducted within the 80-100 mW range. This is likely due to laser power of less than 80 mW being inadequate to sufficiently coagulate microaneurysms or induce significant local photo-chemical changes, and power greater than 100 mW likely inducing more local inflammatory changes which temporarily worsened the swelling at 1 month.

Visual acuity outcomes at 1 month were worse for patients who had previous focal or grid laser treatment prior to this study as compared to those who had no prior laser ($p = 0.07$).

There was no significant correlation found between hemoglobin A1c level and visual acuity, CST, or MST outcomes at 1 month follow up. There was also no correlation found between number of intravitreal bevacizumab (Avastin) injections received in the previous 6 months and post-laser outcomes.

Overall, focal laser photocoagulation for DME in an inner-city county hospital population improved visual acuity and stabilized macular swelling at 1 month post-treatment. Predictive factors for favorable focal laser outcomes included pre-treatment CST of less than 400 µm, treatment targeting fewer than 5 microaneurysms in a focal area of swelling, and using laser parameters of power between 80 mW and 100 mW. Prior fluorescein angiography, prior macular laser treatments, and hemoglobin A1c percentage did not correlate with improvement at 1 month.

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Figure legends

Figure 1 - OCT images from a patient who received focal grid laser treatment. **1A -** pre-treatment image with temporal macular edema. **1B -** 1 month post-treatment image with improved temporal macular edema.