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## ORIGINAL RESEARCH

# Krypton yellow laser for the treatment of macular hole in high myopia without retinal detachment

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### Abstract

**Purpose** To evaluate the prophylactic effect of krypton yellow laser for the treatment of macular holes in high myopic eyes in order to reduce the risk of retinal detachment.

**Methods** Twenty-seven eyes of 27 patients with high myopia and macular holes were randomly assigned to two groups. Fifteen patients (group A, 15 eyes) were subject to laser photocoagulation around the hole margin along with an oral placebo (vitamin B1), while 12 patients (group B, 12 eyes) were only given the oral placebo (vitamin B1). The incident rate of retinal detachment due to macular hole and the mean best-corrected visual acuity of the two groups before and after treatment were measured. The data were statistically tested by  $X^2$  test and Student's  $t$  test.

**Results** The incident rates of retinal detachment in group A and group B were 20%(3/15) and 58.3%(7/12), respectively ( $X^2=4.201$ ,  $P<0.05$ ). The mean best-corrected visual acuity (BCVA) of group A on the initial examination was 20/200, while the mean BCVA at the final follow-up was 24/200 ( $P>0.05$ ). The mean BCVA of group B on the initial examination was 24/200, while the mean BCVA at the final follow-up was 30/200 ( $P>0.05$ ). No significant difference in initial visual acuity ( $P>0.05$ ) or final visual acuity ( $P>0.05$ ) was found between the two groups.

**Conclusion** Krypton yellow laser photocoagulation could reduce the incidence of retinal detachment due to a macular hole in high myopia with acceptable functional results in this study.

A macular hole is a full-thickness defect of the retinal tissue primarily involving the anatomic fovea, thereby affecting central visual acuity. Although the understanding of the pathogenesis of macular holes is incomplete, the management of macular hole lesions has progressed. In 1982, Gonvers and Machemer first recommended vitrectomy, intravitreal gas, and prone positioning for retinal detachments secondary to macular hole.<sup>1</sup> With refinements in surgical techniques, more and more vitreoretinal surgeons have offered surgical intervention to afflicted patients because of the potential for better visual outcomes. In fact, a greater than 90% anatomic success rate may be achieved through surgery for retinal detachments due to macular holes.<sup>2-4</sup>

Most of the retinal detachments due to macular holes occur in highly myopic eyes. It is clear that vitrectomy and intraocular gas or silicone oil tamponade should be recommended for a patient with retinal detachment due to a macular hole, but it is unclear whether to do so for highly myopic macular holes without retinal detachment. Are there any alternatives for patients who are reluctant to accept surgery, who cannot endure the postoperative prone position and who cannot afford the cost of the surgery?

Laser photocoagulation alone, to the edge of a macular hole, has been reported to help flatten the surrounding neurosensory detachment.<sup>5</sup> It was also reported that the success rate of vitreous surgery for retinal detachment caused by a macular hole in high myopia can be improved with additional laser photocoagulation applied intraoperatively and postoperatively. Furthermore, the application of laser photocoagulation to the rim of a macular hole has no influence on postoperative visual acuity.<sup>3,6,7</sup> These observations suggest that the application of laser photocoagulation for a macular hole in high myopia without retinal detachment can reduce the risk of both retinal detachment and further visual loss afterwards. We designed a clinical study aimed to evaluate the application of laser photocoagulation for macular holes in high myopia to prevent retinal detachment.

### Patients and methods

This prospective consecutive clinical study included 27 eyes of 27 patients (eight males and nineteen females) of highly myopic macular holes diagnosed between January 2000 and June 2006. The study was approved by local Ethics Review Board. All of the patients who were willing to accept the non-surgical treatment provided informed consent and underwent a complete ophthalmic examination including visual acuity, slit-lamp, fundus examination with three-mirror contact lens and B-scan ultrasonic examinations; some of them also had fluorescence fundus angiography. Nine patients had stage 3 macular holes and 18 patients had stage 4 macular holes (Gass classification). Patients with white macular holes (without pigmentation around the hole) were excluded. The patients were randomly (by random number/complete randomization) assigned to two groups (group A, with laser photocoagulation treatment; group B, without photocoagulation). Besides the laser photocoagulation, an oral placebo of vitamin-B1 was given to all patients in both groups. There were 20 cases in each group, but only 27 cases had complete data (15 in the

experimental group, and 12 in the control group). There were five males and ten females in group A with a mean age of 56.2 yr (range, 29 to 70 yr) and mean refractive error of -10.6 diopters (range, -8.0 to -14.5 diopters). Group B consisted of two men and ten women with a mean age of 53.8 yr (range, 32 to 76 yr) and mean refractive error of -11.1 diopters (range, -8.5 to -15.0 diopters). The mean initial best-corrected visual acuity was 20/200 (range, 10/200 to 40/200) in group A and 24/200 (range, 10/200 to 60/200) in group B. Five eyes had stage 3 macular holes and ten patients had stage 4 macular holes in group A, and four eyes had stage 3 macular holes and eight patients had stage 4 macular holes in group B. Cases with retinal detachment due to macular holes were not included even though the detached retina was quite limited.

Mydriasis and topical anesthesia were administered before the krypton yellow laser was applied to the macular hole with a three-mirror contact lens. Laser parameters were: wavelength 568nm, intensity 100~300mw, duration 0.1s, spot size 100 $\mu$ m. Cases with marginal retinal edema of the macular hole and/or with turbid refractive media needed higher intensity, but none of the spot reactions exceeded the TsoII grade. Photocoagulation spots were applied to the edge of hole with one row, and space was reserved between every adjacent spot in order to retain some cone cells in the macular area. All laser photocoagulation procedures were performed by one doctor, once for each patient. The follow-up was scheduled for 1 month after the treatment and every 3 months afterwards.

The incident rate of retinal detachment due to the macular hole and the mean best-corrected visual acuity of the two groups before and after treatment were measured. The data were statistically tested by  $\chi^2$  test and Student's *t* test.

## Results

The mean follow-up was 47.3 months (range, 24 to 71 months). No differences were found in initial visual acuity (VA), refractive error and macular hole classification between group A and group B. Retinal detachment due to macular hole (including small detachments of the posterior pole) occurred in three cases (20%) in the experimental group and in seven cases (58.3%) in the control group. In terms of the incidence of retinal detachment due to macular holes, there was a difference between the two groups ( $X^2=4.201$ ,  $P<0.05$ ). All patients with retinal detachment were operated on by vitrectomy with gas or silicone oil tamponade and, finally, all retinas were reattached. The initial mean best-corrected visual acuity in the experimental group was 20/200 and the final (more than six months after photocoagulation or vitrectomy) was 24/200 (P: NS). On the other hand, 60.0% (9/15) of the patients in the experimental group had their visual acuity stabilized or slightly improved. Meanwhile, there was no difference between the mean initial (24/200) and final (30/200) best-corrected visual acuity in the control group. However, only 66.7% (8/12) of the patients in the control group had their visual acuity stabilized or slightly improved. There was no difference between the two groups in this respect (60.0% and 66.7%).

## Discussion

Visual deterioration of macular holes may be related to increasing and chronic subretinal fluid, cystoid retinal changes, or photoreceptor atrophy. Sometimes, loss of the central and, then, peripheral vision is related to progressive retinal detachment. This is most commonly associated with a myopia of 6 D or greater.<sup>8</sup> The management of macular holes has evolved from an untreatable condition to a microsurgical procedure with considerable success. Most surgeons currently favor pars plana vitrectomy with an intraocular gas tamponade, some of which have anatomic success rates as high as 90% and visual success

rates as high as 75% in anatomically flattened cases.<sup>7,9-11</sup> However, there are some surgical complications, including a high rate of subsequent nuclear cataract progression (up to 81% after 2 years)<sup>12</sup>, and at least 25% of patients require postoperative cataract surgery.<sup>9,13</sup>

It is commonly accepted that idiopathic macular holes do not require laser photocoagulation because of the rarity of subsequent retinal detachment and, thus, steady visual acuity. However, laser photocoagulation still constitutes a potent adjuvant therapy that may improve anatomical and visual outcomes of surgery for large idiopathic macular holes.<sup>14,15</sup>

Macular holes due to myopia may lead to retinal detachment, but the precise incidence of retinal detachment secondary to macular holes in highly myopic eyes remains to be reported. Tsujikawa found four macular holes during a 12 month or longer documented follow up in the fellow eyes of 37 patients with bilateral high myopia who had retinal detachments associated with macular holes in one eye. Among those four eyes, only one macular hole was noted to lack retinal detachment, and the other three had retinal detachments caused by macular holes.<sup>16</sup>

Theoretically, laser photocoagulation could be applied to highly myopic macular holes to stabilize the holes and thus prevent retinal detachment leading to further visual impairment. Simultaneously, however, as laser photocoagulation may possibly cause damage to the macular area and decrease central and paracentral vision, we should weigh the advantages and disadvantages between the benefits of preventing retinal detachment and the risk of vision drop caused by laser photocoagulation. Although previous studies indicated that laser photocoagulation neither improved anatomic retinal reattachment rate with the application of vitrectomy for retinal detachments due to highly myopic macular holes, nor led to a further impairment of vision that may possibly be caused by laser photocoagulation damage to the cone cells in the macular area<sup>5,6</sup>, more clinical studies are needed to verify the necessity

or benefit of laser photocoagulation for highly myopic macular holes.

This prospective and consecutive clinical trial was designed to evaluate the efficiency of laser photocoagulation for the treatment of macular holes in highly myopic eyes to prevent retinal detachment. Krypton yellow laser was used for laser photocoagulation in this study, which is the best laser to treat macular diseases. Laser energy with a wavelength of 568nm cannot be absorbed by lutein and does the least amount of damage to macular neuroepithelia. Thus, the krypton yellow laser is theoretically better and safer than green lasers or red lasers for the treatment of macular diseases such as macular holes. According to the results in this study, the incidence of retinal detachment was 20% in the photocoagulation group and 58.3% in the other group. A difference between them indicates that laser photocoagulation is a relatively effective method for the treatment of macular holes in high myopic eyes to prevent retinal detachment. On the other hand, if we compared the mean initial best-corrected visual acuity with the final, there is no significant difference between them, which may indicate krypton yellow laser photocoagulation for highly myopic macular holes does not worsen visual impairment.

Comparing the rates of visual stability and improvement-60% in the laser group & 66.7% in the control group-in the two groups, we found no significant difference between them, which indicates that laser treatment for highly myopic macular holes is useful to keep vision stable. Therefore, the application of a krypton yellow laser for the treatment of macular holes in highly myopic eyes can not only reduce the incidence rate of retinal detachment, but can also keep vision stable.

Surgical intervention is recommended for almost every patient with a macular hole in developed countries. The average cost for the treatment of highly myopic macular holes without retinal detachment is about \$50 if treated by laser photocoagulation, and about \$1000 if treated by vitrectomy with a gas tamponade in China. In developing countries such as

China, \$1000 may be the annual income of a family (without social medical insurance) in some rural areas. It is, therefore, not reasonable to perform a vitrectomy for every case of macular hole in highly myopic eyes without retinal detachment. Alternative approaches should be considered. Laser photocoagulation is, of course, a relatively cost-effective way to treat this disease. However, due to the insufficient number of cases in this study, a conclusion cannot be made. Larger studies and long-term evaluation are required.

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