

# Pattern scan laser versus single spot laser in panretinal photocoagulation treatment for proliferative diabetic retinopathy

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## 多点与单点激光治疗增殖性糖尿病视网膜病变的疗效比较

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### 摘要

**目的:** 观察 577-nm 多点激光用于新近诊断的增殖性糖尿病视网膜病变 (proliferative diabetic retinopathy, PDR) 行全视网膜光凝 (panretinal photocoagulation, PRP) 的疗效。

**方法:** 该前瞻性对照研究共纳入 32 例 40 眼 PDR 患者, 随机分为 2 组, 每组 16 例患者 (20 眼)。第 1 组采用多点激光 (pattern scan laser, PSL) 行 PRP 治疗, 第 2 组采用单点激光 (single spot laser, SSL) 治疗。所有患者在 PRP 治疗前与最后一次 PRP 治疗后 3mo 均行荧光素眼底血管造影检查 (fundus fluorescein angiography, FFA), 以判断是否存在无灌注区。激光点数、完成 PRP 的治疗次数、治疗时长以及患者在治疗时的疼痛程度均作为判断指标。

**结果:** PSL 组患者需 3 次治疗以完成 PRP, 而 SSL 组需 4 次完成。第 1 组每次治疗时间为  $7.3 \pm 2.3$  min, 较第 2 组的时间 ( $13.2 \pm 4.1$  min) 明显缩短 ( $t_{38} = 5.596, P < 0.01$ )。第 1 组的治疗疼痛指数较第 2 组明显降低 ( $P < 0.01$ )。最后一次 PRP 治疗 3mo 后复查 FFA, 第 1 组有 5 眼 (25%) 出现无灌注区, 而第 2 组有 8 眼 (40%) 出现无灌注区, 需要进一步治疗。

**结论:** 多点激光用于 PDR 行 PRP 治疗较单点激光有着明显的优势。它具有效率高, 治疗疼痛轻, 疗效好的特点。

**关键词:** 全视网膜光凝; 多点激光; 增殖性糖尿病视网膜病变

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### Abstract

• **AIM:** To investigate the efficacy of 577-nm pattern scan laser in panretinal photocoagulation (PRP) treatment in newly diagnosed proliferative diabetic retinopathy (PDR).

• **METHODS:** Prospective and comparative observation was performed in totally 32 patients with high-risk PDR. They were randomly divided into group 1 (using pattern scan laser, PSL) and 2 (using single spot laser, SSL), each containing 16 subjects to which totally 20 eyes received PRP. Non-perfusion region was identified with fundus fluorescein angiography (FFA) before and 3mo after final PRP. The advantage of PSL was verified in terms of the number and the duration of PRP sessions needed for satisfactory outcomes, and the pain score.

• **RESULTS:** Three PRP sessions were needed for each eye to complete the treatment using PSL, while 4 sessions were needed using SSL. The duration of each session with PSL in group 1 was  $7.3 \pm 2.3$  min, which was significantly shorter than that with SSL in group 2 ( $13.2 \pm 4.1$ ,  $t_{38} = 5.596, P < 0.001$ ). Treatment-related pain score was also significantly lower in group 1 than in group 2 ( $P < 0.01$ ). Three months after the final PRP, the number of eyes with retinal non-perfusion regions that required additional treatment was 5 (25%) in group 1 and 8 (40%) in group 2.

• **CONCLUSION:** PSL showed clear advantages over SSL in the PRP treatment of PDR, not only in the improved efficacy, but also in the reduction of pain and the improvement of effectiveness.

• **KEYWORDS:** panretinal photocoagulation; pattern scan laser; proliferative diabetic retinopathy

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### INTRODUCTION

Diabetic retinopathy (DR) is the leading cause of vision loss in working-age populations worldwide<sup>[1-2]</sup>. Advanced proliferative diabetic retinopathy (PDR) is the severe stage of DR. Currently, the gold standard treatment for PDR is panretinal photocoagulation (PRP)<sup>[3-6]</sup>, which is not only used under slit lamp, but also as the destined method of pars plana vitrectomy (PPV)<sup>[7-12]</sup>, and by which the risk of

severe vision loss can be significantly reduced<sup>[2-4]</sup>. The major benefit of PRP therapy is the reduction or cessation of neovascularization, resulting in a decrease of retinal blood flow<sup>[9-13]</sup>. However, the PRP treatment is considered painful, time consuming and needs to be repeated in several sessions<sup>[7,14]</sup>. In the present study, we evaluated the advantages of using pattern scan laser (PSL) over the single spot laser (SSL) that was used conventionally in PRP therapy.

**SUBJECTS AND METHODS**

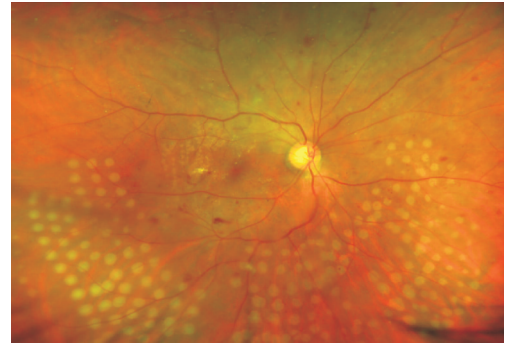
**Subjects** A prospective and comparative study with a between-group design was conducted in the Affiliated Eye Hospital of Nanjing Medical University. Data of PDR treatments were collected between Jan. 2014 and Feb. 2015 from totally 32 newly found patients with high-risk PDR, 16 subjects each randomly (listed in advance by table of random numbers) allocated in group 1 with PSL and in group 2 with SSL. In each group, totally 20 eyes were treated. The subjects in the two groups were matched in age and gender and the duration/history of diabetes (Table 1). The patients all had diabetes (based on WHO criteria) and were eligible for focal laser treatment as defined by the ETDRS criteria<sup>[15]</sup>. This study was adhered to the tenets of the Declaration of Helsinki and was approved by the Medical Research Ethics Committee of the Affiliated Eye Hospital of Nanjing Medical University. Written informed consent was obtained from all participants.

**PRP Treatment** A 577-nm laser photocoagulator (Supra Scan, Quantel Medical, France) was employed for PRP with both PSL and SSL. In 18 spot PSL, the major settings of the equipment include power of 450-800 mW and duration of 0.035-0.050s for each spot of 200-300 μm. In the classical SSL, the corresponding settings were power of 250-450 mW and duration of 0.25-0.30s for each spot of 200-300 μm. The settings were adjusted in above ranges so that the retinal spots showed moderate whitening immediately after being burned by the laser beam.

The interval between consecutive sessions was 2wk in both groups. Before every following session, visual acuity and macula OCT were examined. If more than 20% drop in visual acuity and/or 20% increases in the thickness of macula was/were found, the following session would be postponed till these laser induced side reactions alleviated.

**Evaluations** The evaluations involve several measures. 1) Fundus fluorescein angiography (FFA) test was performed in each patient before and 3mo after the final PRP to verify retinal non-perfusion regions; 2) The duration of each session was recorded from the time when the contact lens was placed to the time when it was taken off; 3) The pain score was quantified in ranking by each patient immediately after each session in a way reported previously<sup>[16-17]</sup>: 0 = no pain, 1 = little pain, 2 = moderate pain, 3 = severe pain. A standard instruction was used in the ranking to avoid bias.

**Statistical Analysis** The quantitative data are presented as mean ± SD. The treatment duration was compared between groups using Student's *t*-test. The pain score was compared



**Figure 1** A fundus image taken immediately after the first treatment from a group 1 subject. The burned spots show grey to moderate white and spread evenly in lower posterior retina.

**Table 1** Pretreatment data of patients

Patients	Group 1	Group 2
No. of patients (eyes)	16(20)	16(20)
M:F	8:8	7:9
Mean age (a, Mean±SD)	46.5±9.6	50.2±11.2
History of diabetes		
≤10a	8	8
>10a	8	8

**Table 2** Pain scores as indicated by the number of eyes

Groups	Pain scores			
	0	1	2	3
Group 1 (eyes)	4	10	5	1
Group 2 (eyes)	1	3	12	4
<i>P</i>	<0.01			

*P* values are the results of post-hoc pairwise comparisons (Mann-Whitney Rank Sum Test) between groups.

using ranking comparison (Mann-Whitney Rank Sum Test). Differences are considered significant when *P*<0.01.

**RESULTS**

In group 1 (PSL group), three sessions were needed to complete PRP. In each session, approximately 400 spots were burned(18 spots at one shoot), which were spread evenly in lower posterior retina (Figure 1), upper posterior retina, and the third session, peripheral retina and subsidy. In group 2 (SSL group), four sessions of treatment were needed for each eye, and approximately 250 spots were burned in one of the 4 quarters of fundus in each session: lower nasal + macular temporal, upper temporal, lower temporal, upper nasal respectively. No treatment session was postponed due to the laser induced side reactions.

The duration of each PRP session was 7.3±2.4min in group 1, which was 44.5% shorter than that of group 2 (13.2±4.1min, *t*<sub>38</sub>=5.596, *P*<0.001).

Table 2 showed the ranked pain perception score by the subjects. A rank test (Mann-Whitney method) showed significantly less pain in group 1 than in group 2 (*P*<0.01). Shown by FFA 3mo after final session of PRP, 5 eyes (25%) in group 1 were found with retinal non-perfusion regions, and this number was 8 (40%) in group 2.

## DISCUSSION

PRP currently is generally acknowledged as the mainstay and gold standard therapy for PDR since the studies on diabetic Retinopathy were published<sup>[3-6]</sup>. It is estimated that about 60% PDR patients respond to laser PRP with retinal neovascularization regression within 3mo<sup>[18]</sup>. However, PRP is a destructive procedure, which is time consuming, often painful, and cannot be completed without multiple sessions of treatment. PRP is also often accompanied by a decrease in peripheral visual field and an increase in the risk of macular edema<sup>[6]</sup>. In order to minimize the damage, laser spots must be evenly-distributed in each session in which hundreds of spots were burned rapidly over the whole retina. PSL technique was more suitable for this purpose<sup>[12,14,19-22]</sup>. Using this technique, many more spots can be burned in one session. Therefore, fewer sessions are needed. The result of the present study is consistent with that reported by others<sup>[23]</sup>. Furthermore, many more spots were burned in group 1 (-1200 points/eye) in a shorter period of time than in group 2 (-1000 points/eye). This was because 18 spots were burned in one shoot. Although more spots and larger total area were burned in one session using PSL, no more side reaction was found.

The primary effect of laser treatment is a thermal injury induced at the level of the retinal pigment epithelium (RPE). But concurrent damage to adjacent retinal photoreceptors and choriocapillaris occurs as a result of heat transmission. The evidence of thermal spread from the RPE is shown as the whitening of the retinal, which is taken as the index of successful laser burn. This damage may result in macular edema which could induce loss of central vision, decreased contrast sensitivity and reduced visual fields<sup>[17-18,24-27]</sup>. In conventional PRP using SSL, laser pulse duration is 0.25-0.30s, which is much longer than the duration in PSL. Such long pulse duration is needed in order to produce visible whitening on the isolated spot. On the other hand, the effective burning can be achieved with shorter duration in PSL, in which 18 spots were burned in a close neighborhood. This makes it possible to reduce the pulse duration<sup>[28-29]</sup>.

The shorter duration likely confines the damage to the RPE/choroid melanin granules. It has been shown that laser exposure of shorter duration affects mainly the RPE, and with little or no damage on the photoreceptors or choriocapillaris. In addition, the heat affected area in each spot would also be reduced when short duration is used. This is accompanied by reduced inflammatory cytokines in retina as compared with the results of long pulse duration in SSL<sup>[28]</sup>. The shorter duration for each treatment and the less damage of the tissues around RPE are likely the reason for the low pain score in group 1. Related to the larger number of spots burned in PSL, the treatment was extended to more peripheral area of retina. This appears to be beneficial in neovascularization clear-up and regression. Correspondingly, a longer lasting of the treatment effect using PSL was supported by less reoccurrence of non-perfusion region that required additional treatment in this group.

Although different laser beams, such as that with 532-nm wavelength, had been used in PSL, here, we chose the 577-nm yellow laser beam, which was proved to be more effective than other available lasers<sup>[30-31]</sup>.

Several limitations exist in the present study, including an overall small sample size. We recommend further studies including a randomized treatment trial to make a clear comparison across different methods of PRP.

In conclusion, the present study demonstrated the advantage of 577-nm pattern scan laser on the management of patients with PDR over conventional single spot laser PRP. The evidence supports the choice of the pattern scan laser substitute to replace single spot laser in future.

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