Role of Panretinal Photocoagulation in Improvement of Visual Acuity of Patients with Proliferative Diabetic Retinopathy

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Authors’ contributions

This work was carried out in collaboration among all authors. Authors ZG, SAB and SAA were involved in conception of idea and study design. Authors NAK and VN did data collection and performed bench work. Author SAB performed the statistical analysis. Authors ZG and MYD managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Objective: To determine the improvement of visual acuity in patients having proliferative diabetic retinopathy undergoing panretinal photocoagulation therapy.

Study design: This is a descriptive case series study.

Setting: Study carried out at Ophthalmology Department, Shaheed Mohtarma Benazir Bhutto Medical University Larkana, from 01-10-2019 to 31-03-2020 (06 months).

Materials and methods: We selected patient with proliferative diabetic retinopathy from the retina clinic after taking a careful history and clinical examination including visual acuity anterior and posterior segment examination and then patient selected for panretinal coagulation with the help of frequency-doubled Nd: YAG laser in three or four sittings.

Results: The total of 158 eyes of 110 patients with proliferative diabetic retinopathy were included in this study out of which improvement of visual acuity was found in 38 (24%) eyes and 120 (76%)

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eyes have no improvement or same vision.

**Conclusion:** Proliferative Diabetic Retinopathy (PDR) can successfully be treated with panretinal coagulation with the help of frequency doubled Nd: YAG laser therapy.

**Keywords:** Visual acuity; panretinal photoocoagulation; doubled Nd; YAG; photocoagulation.

1. **INTRODUCTION**

Patients with diabetes mellitus (DM) irrespective of developed or undeveloped countries are becoming victims of irreversible visual impairment 25 times higher than non-diabetics [1,2]. Pakistan’s Diabetic retinopathy Prevalence has been around 25%. In which non-proliferative diabetic retinopathy accounts for 15%, while 4% is macular edema and 6% is proliferative diabetic retinopathy [3,4]. From the past 30 years the rising efforts on the advancement of certain existing techniques, development of new ones such as early surgical interventions, laser photoocoagulation (LP), intravitreal injections of steroids and availability of specialist care to the patients has led to the early screening, diagnosis, and its accuracy more effective. Meyer-Schwickerathxalso reported usage of LP as an effective treatment for advanced RPD [5]. As per the thermal mechanism of action, the retinal pigment epithelium absorbs laser light by the melanin pigment cells, causing the coagulation of retinal photoreceptors and RPE. As they form a result laser burns in outer retina because of its reduced consumption of oxygen, which ultimately leads to diffusion of oxygen into the inner retina from the choroid through the windows created by thinning effect of laser therapy to the outer retina [6]. The krypton laser photoocoagulation and xenon arc therapy led to remarkable complications related to the vision of the patients by fabricating the full-thickness burns to the retina [7,8]. The reduction in progression of RPD, complete blindness by single-spot pan retinal photoocoagulation (PRP) was reported by DRS (Diabetic Retinopathy Study) [9]. They proposed the visible endpoint burns to retina in about 2000 by early Treatment Diabetic Retinopathy Study (ETDRS) suggesting Pan retinal photoocoagulation the gold standard for PDR. Now by the conventional photoocoagulation hypertrophy of RPE, loss of photoreceptors, damage to the inner retina and even the nerve fibers leading to peripheral/central loss of field of vision because of expansion of laser scars at the rate of (16.5%)/annum with continuous increment by 4 years post pan retinal photoocoagulation therapy is observed. overwise immediate effects of therapy are inflammation of the retina by high vascular permeability and in the long term as per se the damage to thickness of RNFLT and even ganglion cells can occur [6-10]. Contrary to this the strong association to hemoglobin and melanin/least absorption of xanthophylls with an added advantage of a long operating lifetime and least scattering ability makes frequency-doubled 532nm a superior option of choice [5,10,11]. We studied prospectively the changes in RNFLT via Spectral-domain (SD) type optic coherence tomography (OCT) which depicts signal-to-noise ratio and allows rapid signal assessment, maximum repetition and dependability for measuring RNFLT and it showed that the pantetinal photoocoagulation therapy produces thinner RNFL in diabetics than non-diabetic retina [12,13]. An improved standard/baseline visual acuity can be achieved with panretinal photoocoagulation therapy.

2. **MATERIALS AND METHODS**

An informed consent was taken after properly explaining the procedure of study and getting approval of ethical committee. This was a case series study with probability consecutive sampling carried out at Retina Clinic, Department of Ophthalmology, Chandka Medical College Hospital at Shaheed Mohtarma Benazir Bhutto Medical University Larkana were included in this study. Recently diagnosed patients of PDR were included in study. Patients having visually significant cataract, patients with history of uncontrolled diabetes (HbA1C > 7.0%), uncontrolled hypertension (>140/90) or previous treatment of diabetic retinopathy (intravitreal anti-VEGF/laser photoocoagulation), taut posterior hyaloid membrane, advanced diabetic eye disease (Pre-retinal / vitreous haemorrhage or tractional retinal detachment) and cystoid macular edema (on OCT) were also excluded from the study. Complete ocular examination was performed that includes visual acuity both distance and near with and without glasses, colour vision, pupillary reaction, slit lamp examination and application tonometry for intraocular pressure. The patient’s pupil was fully
dilated with tropicamide 1% and phenylephrine 10% eye drops for fundus examination with indirect ophthalmoscope 20D lens and 90D lens on slit lamp biomicroscope. Colour fundus photography were taken in all cases to record clinically evident changes and Fundus Fluorescein Angiography was performed, to reach the diagnosis of the proliferative diabetic retinopathy and patients was advised panretinal photocoagulation with the help of frequency doubled Nd:YAG in three or four sittings. Panretinal photocoagulation was performed in patients with fully dilated pupil under topical anaesthesia with proparacain 5mg drops. The following parameters setting for laser photocoagulation was observed such as, the spot size (200-500µm) laser power (300-500 mw) pulse duration (0.05-0.1 second) and then by using panfundoscopic PRP lens for focusing the laser onto fundus. All collected information were entered into the predesigned proforma. Statistical analysis was done through statistical software SPSS 22 Version, Mean ± standard deviation were taken for age, duration of diabetes mellitus type II, frequency and percentage were calculate for gender, hypertension and improvement of visual acuity yes/no. Effect modifiers were controlled through specification of age, gender, hypertension, duration of Diabetes Mellitus type II, post stratification apply chi-square test takenP-Value ≤ 0.05 as significant.

3. RESULTS

One Hundred and Fifty Eight eyes of 110 patients with proliferative diabetic retinopathy were included in this study. Mean ± SD of age was 58.62±8.45 with C.I (57.02---60.21) years (Table 1). Out of 110 patients 65 (59.09%) were male and 45(40.90%) were female. While 72 (65.45%) patients were hypertensive and 38(34.54%) patients normal. Mean ± SD of duration of diabetes mellitus type II was 13.26±4.85 with C.I (12.34---14.17) years as shown in Table 1.

Improvement in visual acuity was found in 22 (13.92%) eyes of age between (40-55 years) and 16 (10.12%) eyes of (56-70 years) of age and P value found to be highly significant i.e. (0.001). Gender improvement in visual acuity was found in 23 (14.55%) eyes of males and 15(9.49%) eyes of females and P value found to non-significant i.e. (0.742). Improvement in visual acuity of in hypertension were found in 17 (10.75%) eyes with hypertensive positive and 21(13.29%) eyes with hypertensive negative and P value found to be significant i.e. (0.015). Improvement in visual acuity were found in 35 (22.15%) eyes with duration of type II diabetes mellitus 11-20 years and 3 (1.89%) eyes with duration more than 20 years and P value found to be significant i.e. (0.013) (Table 3). Improvement in visual acuity was found in 38 (24%) eyes out of 158 eyes as shown in Fig. 3.

| Table 1. Descriptive statistics n=110 |
|--------------------------------------|
| Variable                              | Mean  | ±SD   | 95% Confidence Level |
| Age (Years)                           | 58.62 | 8.45  | 57.02-60.21          |
| Duration of Diabetes (Years)          | 13.26 | 4.85  | 12.34-14.17          |

| Table 2. Demographic Variable n=110 |
|--------------------------------------|
| Demographic                           | Frequency (N) | Percentage (%) |
| Gender                                |                |                |
| • Male                                 | 65             | 59.09%         |
| • Female                               | 45             | 40.90%         |
| Age (years)                           |                |                |
| • 40 to 55 years                      | 78             | 70.90%         |
| • 56 to 70 years                      | 32             | 29.09%         |
| Hypertension                          |                |                |
| • Yes                                  | 72             | 65.45%         |
| • No                                   | 38             | 34.54%         |
| Eye Involved                          |                |                |
| • Unilateral eye                      | 62             | 56.36%         |
| • Bilateral eyes                      | 48             | 43.63%         |
Table 3. Efficacy of panretinal photocoagulation according different variable n=158(EYES)

| Variable                  | Improvement of visual acuity | P-Value |
|---------------------------|-----------------------------|---------|
|                           | Yes                         | No      |         |
| **Age Group(Years)**      |                             |         |         |
| • 40 to 55                | 22(13.92%)                  | 35      | 0.001   |
| • 56 to 70                | 16(10.12%)                  | 85      |         |
| **Gender**                |                             |         |         |
| • Male                    | 23(14.55%)                  | 69      | 0.742   |
| • Female                  | 15(9.49%)                   | 51      |         |
| **HYPERTENSION (years)**  |                             |         |         |
| • Positive                | 17(10.75%)                  | 29      | 0.0001  |
| • Negative                | 21(13.29%)                  | 91      |         |
| **DIABETES MELLITUS (years)** |                       |         |         |
| • 11-20                   | 35(22.15%)                  | 89      | 0.013   |
| • >20                     | 3(1.89%)                    | 31      |         |

Fig. 1. Improvement of visual acuity n=158

4. DISCUSSION

The assessment of visual acuity improvement after PRP with frequency-doubled Nd:YAG in patients with PDR was targeted in our study. Immediate macularedema and intra-retinal inflammation may cause blindness because of thermal rise and spread in outer retina after undergoing Laser photocoagulation therapy [14,15]. Some studies at animal models suggest that PRP causes macularedema because of leukocyte-endothelial cell inter-playing association with excessive cytokine release and increased permeability of retinal capillaries, so producing outer retinal cone shaped lesions and spearing the inner retina leaving the outer retina as major site of laser burns [16,17]. Some animal models manifested the fibrosis in laser burns of retina at longer durations of laser pulse [18]. A temporal nerve fiber thickening was reported by Blankenship GW in a rabbit after LP [19]. A current multi-sitting PRP protocol practice specified by retinologists of UK was used to study the hypothesis for damage of neuronal axons and there progressive loss with time, so we tested the visual fields of our patients to assess whether the changes in nerve fiber layers are associated with loss of function. We used 300μm along with standard pulseduration for ensuring the adequate intensity of ETDRS burn as a present practice rather than 500μm used by some centers leading to big laser burns with expansion rate of 16.5% [20-23].
Taking into consideration the non-proliferative, Multinational Study of vascular disease in diabetes [27], which is similar to the results of WHO Multinational Study of vascular disease in diabetes [27-29]. An association with reduction in visual acuity and PDR was elicited. According to our study there is a strong association of HTN with PDR and outcome of patients undergoing PRP and our results are in coordination with United Kingdom Prospective Diabetes Study (UKPDS). Korean and Japanese [30,31] So the timely treatment of clinical or subclinical proliferative DR or PDR is suggested need along with other complication associated to diabetes and other comorbidities as well [32,33]. We support the future advancement researches on laser photocoagulation LP and its combination therapy with newer treatments like anti-vascular endothelial growth factors (anti-VEGFs) for improved outcomes [34].

5. CONCLUSION

It is to be concluded that the proliferative diabetic retinopathy (PDR) can successfully be treated with panretinal coagulation with the help of frequency doubled Nd: YAG laser therapy.

CONSENT AND ETHICAL APPROVAL

An informed consent was taken after properly explaining the procedure of study and getting approval of ethical committee.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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