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Original Article

Comparison of Mean Retinal Nerve Fiber Layer Thickness on Optical Coherence Tomography (OCT) in Patients of Primary Open Angle Glaucoma (POAG) After Trabeculectomy vs Anti Glaucoma Medication

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ABSTRACT

Trabeculotomy is a surgical procedure in which a fistula is created between anterior chamber and sub-conjunctival space for drainage of aqueous. Glaucoma is a chronic disease. **Objective:** To compare the mean retinal nerve fibre layer thickness in patients of primary open angle glaucoma after trabeculectomy versus anti glaucoma medication. **Methods:** This Randomized controlled study done in Institute of Ophthalmology, Eye Unit III, KEMU, Mayo Hospital, Lahore from 10th Nov 2021 to 10th May 2022. Non-Probability Convenient Sampling technique used for sample size calculation. 60 patients were selected fulfilling the inclusion and exclusion criteria. They were divided into two groups of 30 patients each. Group A patient were given topical anti-glaucoma treatment while Group B patients underwent trabeculectomy. Pre and three months post anti-glaucoma medication/trabeculectomy, OCT test was done and thickness of retinal nerve fibre layer documented. **Results:** In group A, mean post-treatment RNFL thickness was 0.076 ± 0.052 microns after three months of topical treatment. In group B, mean post-treatment RNFL thickness was 0.080 ± 0.0048 microns three months after trabeculectomy. **Conclusions:** Trabeculectomy increases the mean retinal nerve fibre layer thickness more than anti-glaucoma medication when measured on OCT.

INTRODUCTION

Glaucoma, the second leading cause of blindness worldwide, and third leading cause of treatable blindness in Pakistan [1, 2], is defined as the irreversible neurodegenerative disorder characterized by loss of ganglion cell layer and their corresponding retinal nerve fibres resulting in the characteristic visual field loss and optic nerve head cupping, one of the leading causative factors for which may be raised Intra-ocular Pressure (IOP). Primary open angle glaucoma (POAG) represents a major diagnostic problem because of the lack of worldwide epidemiological definition of, or standard for the diagnosis of POAG [2-4]. Common association with POAG include myopia and thinner central corneal thickness [5]. The causes of glaucoma are a point of active dissent and research work amongst researchers. Still lots need to be elucidated in the pathogenesis of this complex multi-factorial as well as multi-faceted disorder [6]. New technologies like confocal scanning laser ophthalmoscopy

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or Heidelberg Retinal Tomography (HRT), scanning laser polarimetry and Optical coherence tomography (OCT) are now available which provide quantitative and objective measurements of retinal nerve fibre layer (RNFL) thickness, which are reproducible as well. With newer and better Fourier equations allowing for spectral domain OCT and newest addition spectral is, OCT has become a revolutionary method of Glaucoma diagnosis and treatment response observation [7]. Hence OCT can be very usefully employed to detect early glaucomatous change and to measure the progression of disease over time and to detect the response to treatment. Medical treatment is inconvenient because of the regularity required to maintain dropping schedule. Also, the cost of the drops is a financial drain on lower as well as certain middle socio-economic strata [8]. Surgical management can be opted earlier in case of an eye that is precious, or those patients who are non-compliant either knowingly or un-wittingly, who need special care, and those who can't afford the medications, however with the risk of exposing the eye to sight and possibly eye threatening complications like endophthalmitis [9]. The tissue pressure of the intraocular contents is called the intraocular pressure (IOP). The normal range for IOP is 10-20 mmHg [10] and is maintained at this level throughout life and between the genders, though there is some diurnal and seasonal variation [11]. Intraocular pressure is mainly determined by the coupling of the production of aqueous humor and the drainage of aqueous humor mainly through the trabecular meshwork located in the anterior chamber angle [12]. The normal intraocular pressure varies from 10-20 mmHg. Goldmann Applanation tonometer is considered to be the gold standard in measuring intraocular pressure [13]. It works according to Imbert-Fick principle, which states that for an ideal, dry, thin walled sphere, the pressure inside equals to the force necessary to flatten its surface divided by the area of flattening [14]. Therefore, objective of this study was to compare Mean Retinal Nerve Fibre Layer Thickness following Intra Ocular Pressure Reduction after Trabeculectomy vs Anti Glaucoma Medication in patients of Primary Open Angle Glaucoma on Optical Coherence Tomography over a period of 3 months.

METHODS

It was a Randomized Control Study. Research was conducted at the Institute of Ophthalmology, Eye Unit-III, Mayo Hospital, Lahore. Duration of study was Six months. It was estimated as 60 cases (30 each group) using 95% CI, 80% power of test with an expected retinal nerve fibre layer thickness as 1.042 ± 0.284 mm and 0.24 ± 0.039 mm in medication and trabeculectomy respectively. Patients were selected by Non-Probability Consecutive Sampling. Sample selection was based upon the following inclusion and exclusion criteria. 60 patients presenting to the Institute of Ophthalmology Eye unit-III King Edward Medical University/Mayo hospital Lahore fulfilling the inclusion criteria were included in the study after the approval of synopsis. Informed consent was taken. Demographic information regarding name, age and gender were recorded. Patients were divided randomly using lottery method into two groups A and B each containing equal number of patients. Presenting retinal nerve fibre layer thickness was measured in each patient by the researcher with the help of Optical Coherence Tomography. Group A patients underwent anti-glaucoma medication alone while group B patients underwent trabeculectomy. Post trabeculectomy and post anti glaucoma medication therapy RNFL thickness was measured after 3 months by the researcher with the help of OCT and recorded on proforma. To avoid bias the whole procedure was done by single skilled surgeon and findings were recorded by researcher herself on the proforma. Mean RNFL thickness were measured as per operational definitions. OCT used was of Optovue, Inc. Serial no; TGF50-232000CH-000. The data were entered and analyzed in SPSS version 18.0. The quantitative data like age and pre and post treatment RNFL thickness were presented as mean standard deviation. The qualitative data like gender were presented in the form of frequency and percentage. Independent sample t-test was applied for comparison of mean retinal nerve fibre layer thickness after three months of treatment in both study groups. P-value ≤0.05 was considered as significant. Data were stratified for age and gender. Post stratification t-test was applied.

RESULTS

The mean age of patients in group A was 55.80 ± 6.94 years and in group B it was 54.47 ± 5.38 years. In group A there were 17 (56.7%) male patients and 13 (43.3%) female patients while in group B, 17(56.7%) patients were male and 13 (43.3%) patients were female. In group A 16 (53.3%) patients were equal to or below 55 years while 14 (46.67%) patients were above 55 years of age. In group B 20 (66.67%) patients were equal to or below 55 years of age while 10 (33.33%) were above 55 years of age. In group A, mean pre-treatment RNFL was 0.071 (71 microns) ± 0.0063 mm which increased to 0.076 (76 microns) ± 0.052 mm after three months of topical treatment. In group B, mean pre-treatment RNFL was 0.072 (72 microns) ± 0.0049 mm which increased to 0.080 (80 microns) ± 0.0048 mm. In group A, mean pre-treatment RNFL in male patients was 0.071 (71 microns) ± 0.0052 mm which increased to 0.076 (76 microns) ± 0.0052 mm after topical treatment. Mean pre-treatment RNFL in female patients was 0.072 (72 microns) ± 0.0063 mm which increased to 0.077 (77 microns) ± 0.0054 mm three months after topical therapy.

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In group B, mean pre-operative RNFL in male patients was 0.072 (72 microns) ± 0.0047 mm which increased to 0.076 (76 microns) ± 0.0052 mm three months after surgery. Mean pre-operative RNFL in female patients was 0.072 (72 microns) ± 0.0055 mm which increased to 0.082 (82 microns) ± 0.0036 mm three months after surgery. Total number of patients equal to or below 55 years of age were 37 out of which 16 (43%) underwent topical therapy whereas 21 (57%) underwent surgical treatment. Total number of patients above 55 years of age were 23 out of which 14 (61%) received medical therapy and 9 (39%) underwent surgical management. The mean pre-treatment RNFL in patients equal to or below 55 years of age was 0.073 (73 microns) ± 0.0058 mm which increased to 0.081 (81 microns) ± 0.0054 mm. The mean pretreatment RNFL in patients equal to or below 55 years of age who underwent medical treatment was 0.074 (74 microns) ± 0.0067 mm which increased to 0.079 (79 microns) ± 0.0052 mm after three months of treatment. The mean pretreatment RNFL in patients equal to or below 55 years of age who underwent trabeculectomy was 0.072 (72 microns) ± 0.0049 mm which increased to 0.083 (83 microns) ± 0.0050 mm three months after surgery. The mean pretreatment RNFL in patients above 55 years of age who underwent medical therapy was 0.068 (68 microns) ± 0.0044 mm which increased to 0.074 (74 microns) ± 0.0037 mm after three months of therapy. The mean pretreatment RNFL in patients above 55 years of age which underwent surgery was 0.072 (72 microns) ± 0.0054 mm which increased to 0.079 (79 microns) ± 0.0037 mm three months after trabeculectomy (Table 1).

Table 1: Descriptive Statistics of Post Treatment RNFL Thickness

Treatment	N	Mean ± SD
Medicine (Group A)	30	0.07647 ± 0.005244
Surgery (Group B)	30	0.08180 ± 0.004845
Total	60	0.07913 ± 0.005682

Mean Post treatment RNFL in patients in Group A who were given topical medical therapy for three months was 0.076 (76 microns) ± 0.0052 mm. Mean Posttreatment RNFL in Group B who underwent trabeculectomy was 0.080 (80 microns) ± 0.0048 mm. Independent t-test was applied to compare the mean of these two groups. P-value was 0.001 with 95 % confidence interval was significant. Data were stratified for age and gender. Total 34 patients out of 60 (56.67%) were male out of which mean Post treatment RNFL in patients receiving medical therapy was 0.076 (76 microns) ± 0.0052 mm, and mean Post treatment RNFL in male patients who underwent trabeculectomy was 0.0082 (82 microns) ± 0.0057 mm. Post-stratification t-test showed p-value to be 0.007. 26 patients out of 60 (43.33%) were female, in which mean post treatment RNFL in those receiving medical treatment was 0.077 (77 microns) ± 0.0054 mm, whereas post treatment RNFL in those who underwent trabeculectomy was 0.082 (82 microns) ± 0.0036 mm. Post-stratification t test was applied and p value was found to be 0.008. Data were stratified for age in to groups of below or equal to 55 years of age and above 55 years of age. Total 37 out of 60 patients (61.67%) were equal to or below 55 years of age. Mean post treatment RNFL in those who underwent medical therapy equal to or below 55 years of age was 0.079 (79 microns) ± 0.0052 mm. Mean post treatment RNFL in those who underwent trabeculectomy equal to or below 55 years of age was 0.083 (83 microns) ± 0.0050 mm. Post-stratification t-test was applied and p-value was found to be 0.030. 23 patients (38.33%) out of 60 were above 55 years of age. Mean post treatment RNFL in patients above 55 years of age who underwent medical treatment was 0.074 (74 microns) ± 0.0037 mm, whereas mean post treatment RNFL in those above 55 years of age who underwent trabeculectomy was 0.079 (79 microns) ± 0.0037 mm. Post-stratification t-test was applied and p-value was found to be 0.001 (Table 2).

Table 2: Post-Treatment Rnfl Thickness in Both Groups with Respect to Age and Gender

Variables	Mean Post-treatment RNFL thickness GROUP A (mm)	Mean Post-treatment RNFL thickness GROUP B (mm)	P-value
Total	0.076 ± 0.0052	0.080 ± 0.0048	0.001
Male	0.076 ± 0.0052	0.082 ± 0.0057	0.007
Female	0.077 ± 0.054	0.082 ± 0.0036	0.008
Age ≤ 55	0.079 ± 0.0052	0.083 ± 0.0050	0.030
Age > 55	0.074 ± 0.0037	0.079 ± 0.0037	0.001

Continuous variables were presented as Mean ± Standard deviation and Independent Sample t-test was applied. *P-value of ≤ 0.05 was considered significant. Post-treatment RNFL thickness is presented in millimeters.

DISCUSSION

Glaucoma is the leading cause of blindness next to cataract worldwide. And it is one of the foremost causes of preventable blindness if it is diagnosed at an early stage. In Pakistan it is the third leading cause of treatable blindness (7.1%) as per the Pakistan National Blindness and Visual Impairment Survey 2004 [15]. As per WHO estimates there are currently 4.3 million people suffering from glaucoma (which make-up about 15% of world blinds) and the number is estimated to rise to a staggering 76.0 million by 2020 and 111.8 million people by 2040. Currently the treatment options include medical therapy with once or twice daily mono or combined drug instillations. For uncontrolled cases, systemic medical therapy may need to be ensued. Other than medical therapy which is associated with its own inherent issues (foremost being the failure of patients to comply with rigorous dropping schedules), surgery is another treatment option. Surgical procedure of choice in a country like ours with limited resources at hand is

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trabeculectomy. In this procedure an alternate diversion is created for the passage of aqueous humour from the anterior chamber into the subconjunctival space [16]. Our study included individuals with controlled open angle glaucoma, whereas other recent studies have showed that phacoemulsification increased intraocular pressure. In Primary, anterior chamber depth and IOP decrease angle closure and other angles closure spectrum diseases. Certain factors influence the reduction in IOP Lin *et al.*, investigated iris thickness and lens vault were discovered to be linked to a reduction [17]. When the anterior chamber angle changes, IOP. When compared between eyes, resulted in a reduction in IOP. It was discovered using a narrow angle and normal eyes that These modifications were never noticed by those with normal values. Patients with pseudo-exfoliation were excluded from our research. Perez *et al.*, on the other hand, found a higher drop in IOP in eyes. In comparison to the controls, with pseudo-exfoliation. Perez investigated IOP predictors. They discovered that prior to surgery, IOP, anterior chamber IOP/ACD ratio, and gonioscopy score [18]. The post-operative IOP results were influenced. The expansion of the phakic angle to a broader pseudo phakic angle might be one explanation for the positive effect on glaucoma shown in our study. As a result of increased aqueous humour drainage IOP is reduced, and RNFL thickness improves. It is critical to realize that lowering the mean IOP. It is possible that IOP objectives will not be met following phacoemulsification.in individuals with glaucoma, as well as further IOP reduction. It is possible that drugs and/or surgery will be required. Our results and Chinese study result that states that Glaucoma has become an important cause of blindness in China since infectious ocular illnesses have declined. In this study, we confirmed that GCC thickness may distinguish glaucoma patients from non-glaucoma subjects better than peripapillary RNFL thickness. The changes were significant in Primary open angle glaucoma, but mild in suspects compared to healthy controls. It provides a medicine free, permanent treatment option for those who cannot afford the medications or are not physically or mentally capable to adhere to the schedules. People in high dependency and old-age institutions may benefit as well. In this study an effort was made to compare the effect of the treatment options of glaucoma on the main retinal nerve fibre layer of the retina which is the ultimate end-organ being put to damage in this disease. The thickness of retinal nerve fibre layer was measured before and after three months of medical and surgical therapies [19]. Some research ten years ago focused on the macula to detect glaucoma in healthy patients. Due to the low discriminating power of time domain (TD)-OCT, those studies assessed total macular thickness and discovered that peripapillary RNFL was advantageous than macular characteristics. Recent research has shown that for the identification of primary open angle glaucoma, GCC thickness and RNFL thickness have comparable diagnostic power [20]. The mean pre-treatment RNFL in patients who underwent medical treatment with topical drugs was 0.071 (71 microns) ± 0.0063 mm which increased to 0.076 (76 microns) ± 0.0052 mm, at the end of three months follow-up on Optical Coherence Tomography scan. In patients who underwent surgical treatment the mean pre-treatment RNFL was 0.072 (72 microns) ± 0.0049 mm which increased to 0.080 (80 microns) ± 0.0048 mm three months after the surgery. Hence the post-treatment RNFL was thicker on OCT scans in patients who underwent trabeculectomy rather than medical therapy. The post-treatment RNFL were almost equitable in male and female populations 0.076 (76 microns) ± 0.0052 mm VS 0.077 (77 microns) ± 0.0054 mm in medical group male and female respectively and 0.082 (82 microns) ± 0.0057 mm VS 0.082 (82 microns) ± 0.0036 mm in male and female who underwent trabeculectomy respectively. Leung et al used the Stratus TD-OCT to analyses macular RNFL and found that glaucomatous eyes had thinner RNFLs than normal eyes. Many investigations have been conducted to determine which OCT analysis produces the highest discrimination performance. Yoo *et al.*, study was found comparing the results of both treatment strategies, but no local study data relevant to the topic was found during literature search. In this study a comparison of mean retinal nerve fibre layer thickness is done on Optical-coherence tomography in patients of POAG undergoing trabeculectomy versus those taking medical treatment to suggest which one of both treatment plans are more effective [16]. The post-treatment RNFL thickness in patients equal to or less than 55 years of age in medical and surgical groups was more than pre-treatment RNFL. Also, a similar increase in RNFL thickness was observed above 55 years of age. The post-treatment RNFL thickness was more in group B who underwent trabeculectomy (p-value 0.001). This trend remained uniform when data were stratified for age (p-value 0.030 in ≤55 years and 0.001 in >55 years) and gender (p-value 0.007 in male and 0.008 in female). The RNFL thickness is better after surgical intervention in comparison to medical treatment. These results were in congruity with international studies. A study showed RNFL thickness increase from 0.913 ± 0.341 microns to 1.042 ± microns after anti-glaucoma medication. A study conducted by Jha *et al.*, showed RNFL increase 3 months after surgery to 1.2 ± 0.037 microns [21]. It is well understood that structural damage occurs before visual field loss is detectable by perimetry. As a result, quantitative examination of RNFL

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and ONH provides a more reliable means of assessing primary open angle glaucoma. Similar study evaluated GCC and discovered that the macular ganglion cell complex was thinner in perimetric in primary open angle glaucoma patients' eyes. The increase in RNFL thickness is more after surgical treatment than with medical therapy alone. F Mohammed *et al.,* compared the intra-ocular pressure fluctuations from baseline of 10.3 mm Hg following surgery and medical therapy; the fluctuation was found to be 13% in the surgical group whereas it was 40% in the medical group [22]. An effort of Perdana *et al.,* to study the combined effect of both modalities made newly diagnosed patients under-go a trial of medical therapy before surgery and compared it to patients who underwent surgery directly without a period of medical intervention. The success rate of trabeculectomy was significantly higher in the primary trabeculectomy group as compared with that in the multiple treatment group and this study support our results as in our study mean post treatment RNFL in patients in Group A who were given topical medical therapy for three months was 0.076 (76 microns) ± 0.0052 mm. Mean posttreatment RNFL in Group B who underwent trabeculectomy was 0.080 (80 microns) ± 0.0048 mm. Independent t-test was applied to compare the mean of these two groups. P-value was 0.001 with 95 % confidence interval was significant [23]

CONCLUSIONS

This study shows that both trabeculectomy and anti-glaucoma medication lead to a thickening of retinal nerve fibre layer thickness. But the retinal nerve fibre layer thickness is more after trabeculectomy as compared to that after anti-glaucoma medication as measured on OCT.

Authors Contribution

Conceptualization: SL
Methodology: SL, AQ
Formal analysis: MA, HZ, TS
Writing-review and editing: RR, IB, AQ, HZ, TS

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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