Correlation of Pre-Operative Retinal Nerve Fiber Layer Thickness with Visual Recovery Following Decompression of Pituitary Macroadenoma

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ABSTRACT

Background : *Reduction in the retinal nerve fiber layer (RNFL) thickness due to Pituitary macroadenomas results in visual impairement. The surgical removal of macroadenoma improve visual function, but its resulted visual outcome is variable. This study aimed to determine the correlation of preoperative RNFL thickness for postoperative visual recovery.* ***Methods:*** *A prospective observational study was conducted over one and half years in the Department of Neurosurgery at Bangladesh Medical University (BMU), Dhaka. A total of 29 patients with magnetic resonance imaging confirmed pituitary macroadenoma and visual impairment were selected through purposive sampling based on predefined criteria. Visual field (VF) assessment (perimetry) was done using a Humphrey Field Analyzer, and preoperative RNFL thickness was measured using 3D Stratus Optical coherence tomography (OCT).* ***Results:*** *The study participants were male predominante with mean age of 36.48 ± 15.09 years. The mean value of preoperative VF in mean deviation (MD) was -13.30±8.14 dB and -16.55±9.11 dB in right and left eye, respectively. Average RNFL thickness was 89.30 ± 19.71µm and 84.38 ± 23.12µm in right and left eye, respectively. Preoperative RNFL thickness and the degree of VF impairment were shown to be significantly correlated, however there was no substantial improvement in VF parameters following surgery, nor was there an correlation between preoperative RNFL thickness and visual recovery.* ***Conclusion:*** *Given the limited visual recovery observed in the early postoperative period and the lack of significant correlation with preoperative RNFL thickness, the utility of RNFL as a predictive marker for early visual outcomes remains uncertain.*

Key-words: Pituitary macroadenomas, Retinal nerve fiber layer (RNFL), Optical coherence tomography, visual impairement, predictor, early visual outcomes.

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INTRODUCTION:

Pituitary adenomas account for 10-25% of all brain tumors, mostly affect during the fourth to sixth decade of life, cause direct chiasmal compression and disturbances of the blood supply of the optic chiasm, resulting in ischemia and mechanical damage to nasal retinal fibers crossing each other and eventually visual impairment [1–5]. As a result, visual imparments [visual field (VF) defects and loss of visual acuity (VA)] is a typical complaint among 69 to 96 percent of pituitary adenoma patients [6,7]. The surgical resection of lesions or decompression improve visual function, but its resulted visual outcome is variable and unpredictable, and predicting the extent of recovery is challenging [4,6,8]. Due to the variability in visual recovery among patients, preoperative assessment and predictive prognosis have become significant concerns for both neurosurgeons and patients [9].

The patient's age, preoperative VF impairment, and duration of symptoms before to surgery are the primary predictive factors for postoperative VF recovery in patients with pituitary adenoma [9]. Recently, in patients with chiasmal compression, the thickness of the retinal nerve fiber layer (RNFL) has been recommended as a predictor of postoperative visual restoration [6,9,10]. RNFL is which is made up of axons from retinal ganglion cells (RGCs). Long-term compression of RGC axons causes RFNL thining (irreversible damage), which is considered to cause poor visual outcomes following surgery [8,11,12]. For quick, objective, and quantitative measureing of the thickness of RNFL and predicting the visual outcomes Optical coherence tomography (OCT) is a useful non-invasive approach [12,13]. Measuring visual recovery by OCT following pituitary tumor surgery have been shown to have predictive value in recent years [4,14]. Preoperative RNFL thickness and its correlation to visual recover may aid in preoperative counseling, patient selection, and surgical decision-making, enabling early identification of patients at risk for poor visual recovery and could set realistic expectations regarding postoperative recovery. Furthermore, early identification or prediction of patients at risk of poor visual recovery would allow for closer postoperative monitoring and tailored rehabilitation strategies.

Despite the potential, few studies have systematically evaluated RNFL thickness as a predictive tool for visual outcome in pituitary macroadenoma patients, particularly in diverse populations. This study aimed to address this knowledge gap by investigating the correlation of pre-operative RNFL thickness with visual recovery following decompression of pituitary macroadenoma and thus shed light on the predictive usefulness of preoperative RNFL thickness for postoperative visual recovery.

MATERIALS AND METHODS:

A prospective observational study was done in the Department of Neurosurgery at Bangladesh Medical University (BMU) in Dhaka, Bangladesh from October, 2023 to March, 2025. A total of 29 patients of pituitary macroadenoma [confirmed by Magnetic Resonance Imaging (MRI) scan] with visual impairment who came to the hospital for treatment were included in the study following inclusion and exclusion criteria through purposive sampling technique. Patients with glaucoma, choroiditis, retinitis pigmentosa, non-pituitary sellar and suprasellar lesions, optic neuritis, or any other ocular disease impacting the VF, and those with history of previous pituitary adenoma surgery were excluded from the study. Patients for whom preoperative visual field assessment and RNFL thickness measurement could not be performed, as well as those who were unavailable for postoperative follow-up, were excluded from the study. Infromed written consent was obtained from the each participant or guardian. Formal ethical approval of the study was taken from ethical review board (IRB) of Centre for Medical Research & Development (CMRD) (Ref. no. CMRD/ERB/2023/107). Data regarding the demography, preoperative and postoperative VF assessment, preoperative RNFL thickness measurement, histopathological findings of pituitary macroadenoma were collected in a preformed data collection sheet. Following inclusion in the study, each patient underwent MRI scan of the brain with contrast for determining the tumor dimension and a preoperative VF assessment/perimetry two weeks prior to surgery. A postoperative evaluation was subsequently performed two weeks after the surgical intervention. Perimetry was performed using a Humphrey Field Analyzer (32-2 test; Humphrey Instruments, London, United Kingdom). Mean deviation (MD) which is primarily a measure of the extent of the VF defect and and pattern standard deviation (PSD), which depicts a localized abnormality's pattern were both measured by using static perimetry. The severity of VF impairment was classified according to the widely used Hodapp-

Parrish-Anderson criteria [15], with slight adaptation of thresholds to suit our study population. In this study, mild to moderate VF impairment was defined as a mean deviation (MD) of –11 dB or better, while severe impairment was categorized as an MD worse than –11 dB.

The study calculated 52 eyes instead of 58 eyes in 29 individuals. Two patients had no perception of Light (PL)/PR (Projection of Rays) on right eye, one patient had perceived only hand movements (HM) on the right eye, two patients had no PL/PR on left eye and one patient had perceived only HM on the left eye. Due to significantly impaired visual acuity, VF analysis could not be conducted on the Humphrey Field Analyzer for these individuals. The 3D Stratus OCT (Zeiss Humphrey, Dublin, CA) with software version 3.0.1 was used to measure RNFL thickness. The optical principles and applications of the OCT have been described in detail elsewhere [16]. This study utilized the fast RNFL protocol, which comprised of three circular scans centered on the optic disc, each measuring 3.46 mm in diameter. Following surgical intervention, histopathological reports of pituitary adenoma were documented. All research procedures involving study participants were carried out in accordance with the Declaration of Helsinki's standards. Confidentiality and privacy was maintained accordingly.

Statistical analysis

The statistical analysis of the study was performed utilizing the Statistical Package for Social Sciences (SPSS) for Windows, version 23. Numerical variables were reported as mean, standard deviation, minimum, maximum. Categorical variables were provided as frequency and percentage. The data's normality was assessed using the Shapiro-Wilk test. Correlation of preoperative RFNL with preoperative mean deviation (in dB) of VF, postoperative VF improvement was assessed by pearson correltion coefficient test. Difference in the RFNL thickness between mild to moderate and severe visual impairment was assessed by indepentdent sample T test. Improvement in VF from preoperative to postoperative status was assessed by paired t test. P values <0.05 were considered statistically significant.

RESULTS:

Table 1 shows total of 29 patients with macroadenoma participated in the study. The mean age of the participants was 36.48 ± 15.09 years, majority (34.5%) were from 31-40 years age group and more than sixty percent of theparticipants were male.

Table 1: Distribution of the participants according to demographic characteristics

Demographic characteristics	Frequency	Percentage
Age (years)	≤20	5	17.2
	21 – 30	6	20.7
	31 – 40	10	34.5
	>40	8	27.6
	Mean ± SD	36.48 ± 15.09	
	Min – Max	15 – 69	
Gender	Male	18	62.07
	Female	11	37.93

Data presented as frequency, percentage, Mean ± SD and Minimum, Maximum

Figure I presents headache was reported by 24 participants (82.8%), while dimness of vision was noted in 26 participants (89.7%). Abnormal body growth, blurred vision, hormonal abnormalities and sudden visual deterioration were observed in 7 (24.1%), 17 (58.6%), 16 (55.2%) and 5 (17.2%) participants, respectively. The highest proportion of VF defects in the right eye was observed in the temporal field, affecting 11 participants (37.9%). In contrast, the most common VF defect in the left eye was the three-quadrant field defect, noted in 10 participants (34.5%).

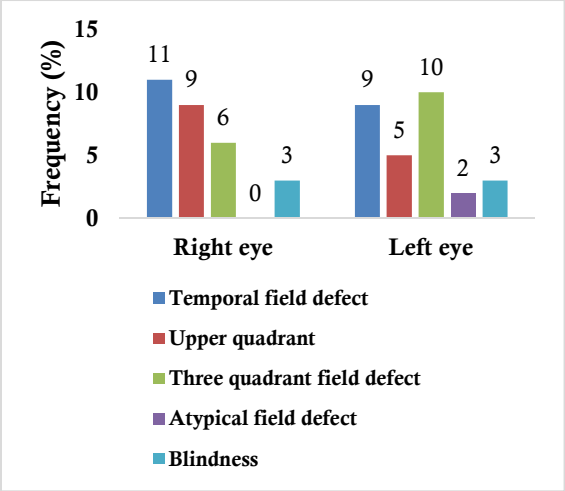

Figure I: Preoperative visual field impairment among the study participants

Table 2 shows the mean value of preoperative VF testing in mean deviation (MD) was -13.30±8.14 dB and -16.55±9.11 dB in right and left eye, respectively. Average Retinal nerve fiber layer (RNFL) thickness was 89.30 ± 19.71µm and 84.38 ± 23.12µm in right and left eye, respectively. The lowest mean RNFL thickness was observed on the temporal quadrant in both (right and left) eye, which was 65.74 ± 16.28 µm and 55.34 ± 12.43 µm, respectively._Significantly

reduced average RNFL thickness was observed in patients with severe VF impairment than mild to moderate VF impairment in both right eyes (78.29±9.60 µm vs 107.36±10.76) and and left eyes (76.17±19.14 µm vs 109.50±8.88 µm).

Table 2: Preoperative RNFL Thickness according to visual field impairment of right eye (n=26) and left eye (n=26)

	Visual field impairment	Nasal quadrant thickness (µm)	Temporal quadrant thickness (µm)	Superior quadrant thickness (µm)	Inferior quadrant thickness (µm)	Average thickness (µm)	P value
Right eye	Mild to moderate (n=11)	89.27±12.66	75.91±12.76	127.73±13.16	136.09 ± 17.67	107.36± 10.76	<0.001
	Severe (n=15)	59.33±14.14	57.43±10.20	100.21±15.04	97.50 ± 16.18	78.29±9.60	
	Average	70.39 ± 20.70	65.74 ± 16.28	108.78 ± 23.36	110.96 ± 28.37	89.30 ± 19.71	
Left eye	Mild to moderate (n=8)	96.63±14.22	67.00±6.78	137.25±14.52	137.63±12.30	109.50± 8.88	<0.001
	Severe (n=18)	61.17±18.25	51.44±11.80	95.61±30.35	96.78±23.24	76.17±19.14	
	Average	70.38 ± 23.45	55.34 ± 12.43	106.28 ± 32.88	105.79 ± 29.74	84.38 ± 23.12	

Mild to moderate visual field impairment was defined as a mean deviation (MD) of –11 dB or better, while severe impairment was categorized as an MD worse than –11 dB.

Data presented as mean, standard deviation

Independent sample t test was done

Table 3 presents in both eyes, a significant moderate to strong positive correlation between thickness of RNFL and mean deviation of VF was observed in all quadrants which implies that patients with reduced level of RNFL tend to have more severe VF impairment before surgery. However, such relation was more evident in inferior quadrant RNFL thickness and mean deviation of the visual field in both right (r=0.697, p-value: <0.001) and left eyes (r=0.787, p-value: <0.001).

Table 3: Correlation of Mean Deviation of visual field with pre-operative RNFL thickness of right eye and left eye (n=26)

Visual field defects	RNFL thickness	r value	p value
Mean Deviation of visual field of right eye	Nasal quadrant thickness (µm)	0.471	0.015
	Temporal quadrant thickness (µm)	0.528	0.007
	Superior quadrant thickness (µm)	0.573	0.003
	Inferior quadrant thickness (µm)	0.697	<0.001
	Average thickness (µm)	0.685	<0.001
Mean Deviation of visual field of left eye	Nasal quadrant thickness (µm)	0.642	<0.001
	Temporal quadrant thickness (µm)	0.511	0.008
	Superior quadrant thickness (µm)	0.664	<0.001
	Inferior quadrant thickness (µm)	0.787	<0.001
	Average thickness (µm)	0.719	<0.001

Mean deviation is the deviation of visual field in visual field analysis

Data presented as r, correlation coefficient

Pearson's correlation coefficient test was done

Table 4 shows however, two weeks after surgical resection of the macroadenoma, VF assessment revealed MD values of –13.24 ± 8.79 dB in the right eye and –16.42 ± 9.54 dB in the left eye, indicating persistent VF impairment in both eyes postoperatively. The MD values remained largely unchanged in both eyes postoperatively, indicating persistent VF impairment. The findings demonstrate that there was no significant improvement in VF parameters within two weeks following surgical resection of pituitary macroadenoma (p value: >0.05).

Table 4: Mean value of pre and post-operative visual defects of eyes

Visual field defect in MD	Right eye (n=26)			Left eye (n=26)		
	Pre-operative	Post-operative	p value *	Pre-operative	Post-operative	p value *
Mean deviation (dB)	-13.30 ±8.14	-13.24± 8.79	0.407	-16.55 ±9.11	-16.42 ±9.54	0.920
Pattern Standard deviation (dB)	7.38± 4.73	7.43± 4.98	0.632	6.87± 4.23	6.78± 4.12	0.923

Mean deviation is the deviation of visual field in visual field analysis

Data presented as mean, standard deviation

Paired t test was done

Table 5 shows non-significant, weak correlation between pre-operative RNFL thickness and changes of the VF from pre-operative to post-operative period also signifies persistent impairment following pituitary macroadenoma resection (Table 5).

Table 5: Correlation of change in Mean Deviation of visual field of right and left eye with pre-operative RNFL thickness (n=26)

Visual field	Pre-operative RNFL thickness (µm)	r value	p value
Change in Mean Deviation of visual field of right eye (Pre- and postoperative)	Average thickness	0.153	0.466
Change in Mean Deviation of visual field of left eye (Pre- and postoperative)	Average thickness	0.164	0.424

r= correlation coefficient

Pearson's correlation coefficient test was done

DISCUSSION:

Pituitary macroadenomas, due to their close anatomical relationship with the optic chiasm, often lead to visual impairment. Although surgical decompression commonly results in visual improvement, outcomes can vary widely among individuals, and conflicting findings have been reported. In this study, patients with lower preoperative RNFL thickness were found to have more severe VF deficits prior to surgery. However, no significant visual improvement was observed within the early postoperative period, and preoperative RNFL thickness did not correlate with postoperative visual recovery. The limited postoperative visual recovery

and lack of significant correlation render the utility of RNFL thickness as a predictive marker for early visual outcomes after pituitary macroadenoma resection remains uncertain.

Pituitary adenomas affect people of all ages, but they are most common during the third and sixth decades of life. Functional pituitary adenomas are more common in younger adults, but nonfunctioning adenomas becomes more common as people grow older [3,17]. The majority proportion (34.5 %) of participants with pituitary macroadenomas in this study were in their fourth decade, with a mean ±SD age of 36.48±15.09 years. This study findings was comparable to the mean age of pituitary macroadenomas patients reported by Lee et al. (2011) and Barzaghi et al. (2012) [18,19]. Males outnumbered females patients, so as by Barzaghi et al. (2012), Danesh et al. (2015) and Lee et al. (2011) [13,18,19]. Dimness/ gradual loss of vision (89.7%), Headache (82.8%) with no specific varity and severity, blurred vision (58.6%), and sudden visual deterioration (17.2%) were reported by study participants. Presentation (headache and visual abnormality) was as similar with Dhasmana et al. (2011) [20].

In our study, the preoperative mean (±SD) of RNFL thickness in the right and left eyes was 89.30±19.71 µm and 84.38±23.12 µm, respectively, which was considerably lower than the findings reported by Garcia et al. (2014) and Malik et al. (2012), where the mean preoperativel RNFL thickness was 93.86±16.09 µm and 101.07±10.13 µm, respectively [21,22]. The lowest mean RNFL thickness was recorded in the temporal quadrant of both eyes, measuring 65.74 ± 16.28 µm in the right eye and 55.34 ± 12.43 µm in the left eye. Kurian et al. (2022), Nair et al. (2024) and Menon et al. (2022) also reported the same findings of lowest mean RNFL thickness in the temporal quadrant [23–25]. In this study, preoperative mean MD was found, -16.4 ± 9.12 dB (range, –34.10 to –2.59 dB). This study finding was almost identical to those of Yu et al. (2015) and Barzaghi et al. (2012), who reported preoperative mean MDs of -17.50 ± 0.82 dB (range, –30.80 dB to –1.40 dB) and -11.9 ± 0.6 dB (range, –31.9 to –1.6 dB), respectively [18,26].

Danesh et al. (2015), Menon et al. (2022), Nair et al. (2024) had concluded that, thin pre-operative RNFL thickness was associated with worse VF impairement at presentation [13,24,25]. On the contrary, Johansson (2009) observed the pattern of RNFL loss was not well correlated with the VF defect [27]. In this study, statistically significant correlation between preoperative VF impairment and RNFL thickness was determined, which signifies that when the thickness of the RNFL diminishes, so does the field of vision. The patient's VF impairment at presentation was worse in this study than in other studies, which could be owing to the markedly reduced thickness of RNFL, patient's long history of visual disturbances and the tumor's larger size at presentation.

Previous studies have reported variable degrees of VF improvement depending on the timing of postoperative assessment, which ranges from one week to several years, with most improvements typically noted within 3 to 6 months after surgery [13,28,29]. Dekkers et al. (2007) reported that visual acuity improved significantly within the first three months following transsphenoidal surgery, with continued improvement observed up to one year postoperatively [30]. Following surgery, a slight but statistically non-significant improvement in VF was observed in both eyes of the participants. The absence of statistically significant improvement in the present study is likely attributable to the early timing of the VF assessment, conducted just 14 days postoperatively, a period during which substantial visual recovery may not yet be evident. In addition to the observed non-significant improvement in VF parameters, this study found no significant correlation between preoperative average RNFL thickness and postoperative VF recovery. Lack of significant correlation render the utility of RNFL thickness as a predictive marker for early visual outcomes after pituitary macroadenoma resection remains uncertain. Notably, our results align with those reported by García et al. (2014) [21], who also questioned about predictive value of RNFL thickness for immediate postoperative visual recovery. The divergence from earlier studies may be attributable to differences in the timing of postoperative assessment, patient characteristics, or methodological variability across studies. Ultimately, surgical decompression through removal of the pituitary macroadenoma leads to improved visual outcomes. However, significant recovery often requires time, and while preoperative RNFL thickness may hold predictive value for long-term visual improvement, its utility in forecasting early postoperative outcomes remains uncertain.

LIMITAIONS AND RECOMMENDATION

It's worth mentioning that this research has some of shortcomings. Because the study was brief in duration and had a small sample size, it could not be generalized to a large scale. Only early postoperative VF recovery (on the 14th day) was evaluated, and no postoperative RNFL measurements were taken. If the assessment of VF would have also done in early slow phase (1 to 4 months) and late phase of mild improvement (6 months to 3 years), this study could have concluded and evaluated the correlation of preoperative RNFL thickness for VF recovery more appropriately.

CONCLUSION

This study highlights that thining of preoperative RNFL thickness was significantly associated with greater visual field (VF) impairment in patients with pituitary macroadenoma. However, no significant improvement in visual function was observed within the first two weeks following surgical decompression. Furthermore, the correlation between preoperative RNFL thickness and postoperative changes in VF parameters was weak and statistically non-significant. These findings suggest that early postoperative visual recovery is limited, and due to the absence of a strong correlation with preoperative RNFL thickness, its utility as a predictive marker for early visual outcomes remains uncertain. Clinicians should therefore exercise caution when relying solely on preoperative RNFL measurements to predict immediate postoperative visual improvement.

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