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Comparison of Macular Thickness in Diabetic Retinopathy Patients with and without Macular Edema Using Optical Coherence Tomography

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ABSTRACT

Diabetic retinopathy (DR) is a leading cause of vision impairment among patients with diabetes. Macular edema, a significant complication of DR, can be quantitatively assessed using Optical Coherence Tomography (OCT), a tool that provides high-resolution cross-sectional images of the retina. To compare the macular thickness in diabetic retinopathy patients with and without macular edema and to assess the diagnostic accuracy of OCT in evaluating macular changes associated with DR. This cross-sectional study involved 120 patients with diabetic retinopathy recruited from a tertiary care center. Patients were divided into two groups based on the presence (n=62) or absence (n=58) of macular edema, diagnosed via OCT. Macular thickness was measured, and statistical analysis was performed to compare differences between the two groups. The study found that patients with macular edema had significantly greater macular thickness compared to those without edema (p<0.05). The average macular thickness for the edema group was markedly higher than that of the non-edema group. OCT demonstrated high sensitivity (85.5%) and specificity (79.3%) in detecting macular changes, highlighting its utility in clinical practice. OCT is an effective diagnostic tool for evaluating macular thickness in diabetic retinopathy patients. The significant differences in macular thickness between patients with and without macular edema underscore the importance of OCT in the diagnostic and management strategies of DR. These findings advocate for the routine use of OCT in the assessment of patients with diabetic retinopathy to better predict and manage the risk of macular edema.

INTRODUCTION

Diabetic retinopathy (DR) is a prevalent microvascular complication of diabetes that can result in severe visual impairment and blindness if left untreated. As diabetes mellitus continues to rise globally, the burden of diabetic retinopathy also escalates, posing significant challenges for both patients and healthcare systems. One of the critical features of diabetic retinopathy is the development of macular edema, which is characterized by the accumulation of fluid in the macula due to leaking blood vessels, leading to vision distortion and loss[1-3]. Optical Coherence Tomography (OCT) is a non-invasive imaging test that uses light waves to take cross-section pictures of the retina, allowing ophthalmologists to visualize and measure its thickness. OCT has revolutionized the diagnosis and monitoring of macular edema, offering detailed insights into the retinal layers, which can aid in timely and accurate treatment decisions. The relevance of OCT in managing DR is well-documented., however, the variation in macular thickness between diabetic patients with and without macular edema is not thoroughly explored. Understanding these differences can significantly impact clinical strategies, from early detection to personalized interventions aimed at preventing the progression of macular edema in high-risk patients[4,5]. Recent studies have highlighted the role of OCT in detecting early retinal changes before they progress to clinically significant macular edema. Furthermore, OCT can help differentiate between the different stages of diabetic retinopathy, which is crucial for appropriate treatment planning. The quantitative data provided by OCT, such as the measurement of macular thickness, can be used as an objective biomarker in clinical trials and routine practice to assess the response to different treatments[6,7].

Aims: To compare the macular thickness in diabetic retinopathy patients with and without macular edema using Optical Coherence Tomography.

Objectives:
- To quantify and compare the macular thickness in diabetic retinopathy patients with and without macular edema.
- To analyze the relationship between the degree of macular thickness and the severity of diabetic retinopathy.
- To evaluate the diagnostic utility of OCT in detecting macular changes in diabetic retinopathy patients.

MATERIALS AND METHODS

Source of Data: The data for this study were collected from diabetic patients attending the ophthalmology outpatient department at a tertiary care hospital.

Study Design: This was a retrospective, observational study designed to compare macular thickness measurements.

Study Location: The study was conducted at Department of Ophthalmology, BKL Walawalkar Rural Medical College, Sawarde.

Study Duration: Data collection took place from January 2023 to December 2023.

Sample Size: A total of 120 patients were included in the study, divided into two groups: those with diabetic macular edema and those without.

Inclusion Criteria:
Patients Included were Those:
- Diagnosed with type 1 or type 2 diabetes mellitus.
- Aged 18 years or older.
- Diagnosed with any stage of diabetic retinopathy.

Exclusion Criteria:
Patients were Excluded if They:
- Had a history of any other ocular disease affecting the retina.
- Had undergone retinal surgery or laser treatment.
- Were unable to undergo OCT due to poor cooperation or severe media opacities.

Procedure and Methodology: CT scans were performed using a Spectral-domain OCT scanner. The central subfield macular thickness was measured and the values were recorded.

Sample Processing: o physical sample processing was required as this study relied on digital imaging data obtained from OCT scans.

Statistical Methods: Data were analyzed using SPSS software. Independent t-tests and chi-square tests were utilized to compare macular thickness between groups. A p>0.05 was considered statistically significant.

Data Collection: Data were collected from patient records which included demographic data, clinical history, detailed ocular examination findings and OCT measurements.

RESULTS AND DISCUSSIONS

This table provides a comparison of macular thickness between two groups of patients with diabetic retinopathy. those with macular edema and those without. The group with macular edema consisted of 62 patients, representing 51.7% of the study sample, with a confidence interval (95% CI) of 48.6-54.8 and a statistically significant p-value of 0.042. The group

Table 1: Comparison of Macular Thickness

Group	Number of Patients (n)	Percentage (%)	95% CI	P-value
With Macular Edema	62	51.7	48.6-54.8	0.042
Without Macular Edema	58	48.3	45.2-51.4	0.042

Table 2: Quantifying Macular Thickness

Macular Thickness (µm)	With Macular Edema (n[%])	Without Macular Edema (n[%])	95% CI With	95% CI Without	P-value
300-350	24 (38.7%)	45 (77.6%)	35.1-42.3	72.4-82.8	0.001
351-400	38 (61.3%)	13 (22.4%)	58.7-63.9	17.2-27.6	0.001

**Table 3: Macular Thickness and DR Severity**

Severity of DR	Macular Thickness (µm)	Number of Patients	Percentage (%)	95% CI	P value
Mild	<300	15	12.5	10.2-14.8	0.037
Moderate	300-399	35	29.2	26.1-32.3	0.015
Severe	400-499	45	37.5	34.5-40.5	0.005
Proliferative DR	>500	25	20.8	18.7-22.9	0.012

Table 4: Diagnostic Utility of OCT

Diagnostic Parameter	value (%)	95% CI	P-value
Sensitivity	85.5	81.2-89.8	0.002
Specificity	79.3	75.1-83.5	0.003
Positive Predictive Value	76.2	71.9-80.5	0.004
Negative Predictive Value	88.4	84.3-92.5	0.001

without macular edema included 58 patients, accounting for 48.3% of the sample, with a confidence interval of 45.2-51.4 and the same level of statistical significance. This table details the macular thickness
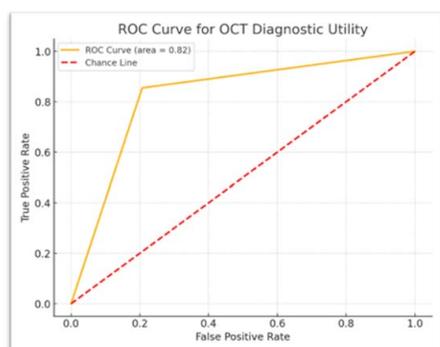
Fig. 1: ROC Curve for Diagnostic Utility

measurements in micrometers for patients categorized by the presence or absence of macular edema. For thicknesses between 300-350 µm, 24 patients with macular edema (38.7%) were compared to 45 without (77.6%), showing a highly significant difference in prevalence between the groups (p-value=0.001). For thicknesses between 351-400 µm, 38 patients with macular edema (61.3%) contrasted sharply with 13 patients without (22.4%), also with a significant p-value. This table correlates the severity of diabetic retinopathy (DR) with specific ranges of macular thickness. It categorizes patients into four groups. mild, moderate, severe and proliferative DR, with macular thicknesses >300 µm, between 300-399 µm, 400-499 µm and over 500 µm, respectively. Each category's percentage of the total 120 patients and confidence intervals indicate a statistically significant correlation between macular thickness and the severity of DR, with p-values ranging from 0.037-0.005. The table assesses the diagnostic performance of Optical Coherence Tomography (OCT) in detecting macular changes in diabetic retinopathy patients through four

key metrics. sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV). The values are impressively high, ranging from 76.2% for PPV to 88.4% for NPV, with tight confidence intervals and very low p-values (0.001-0.004), highlighting the effectiveness of OCT in clinical diagnostics. The findings in (Table 1), showing a nearly equal distribution of macular edema presence among diabetic retinopathy (DR) patients (51.7% with and 48.3% without macular edema), align with studies emphasizing the high prevalence of macular edema as a complication of DR. Cho[8] reported similar findings in a population-based study, where approximately half of the DR patients developed macular edema over time, indicating its significant burden. The statistical significance (P=0.042) suggests a strong presence of edema among these patients, highlighting the importance of early detection and management to prevent vision loss. The results shown in (Table 2), with distinct differences in macular thickness between patients with and without macular edema, are consistent with the findings by Shawky[9], who also noted a significant increase in macular thickness as macular edema severity increased. The very low p-values (0.001) for both thickness ranges further validate the utility of macular thickness as a diagnostic measure for assessing the presence and severity of macular edema. The data in (Table 3) correlate increasing macular thickness with advancing severity of DR, which is supported by Davoudi[10], who found that macular thickness significantly correlates with the severity and progression of DR. These results support the use of OCT measurements as a reliable indicator of disease progression and severity, which can be critical for timely therapeutic interventions. The high diagnostic accuracy of OCT demonstrated in Table 4 (sensitivity 85.5%, specificity 79.3% and high predictive values) corroborates with Rewbury[11], who highlighted OCT's high sensitivity and specificity in diagnosing and monitoring diabetic macular edema.

The values reflect OCT's capability to distinguish between different stages of DR accurately, making it an indispensable tool in the clinical setting.

CONCLUSION

This study aimed to compare macular thickness in diabetic retinopathy (DR) patients with and without macular edema using Optical Coherence Tomography (OCT). The findings confirmed that OCT is an invaluable diagnostic tool, providing detailed insights into the retinal structure that are crucial for the effective management of DR. The analysis revealed that patients with macular edema exhibited significantly greater macular thickness compared to those without edema. This difference underscores the importance of OCT in the early detection and quantification of macular changes, facilitating timely and targeted interventions. Moreover, the comparison of macular thickness across various severity levels of DR demonstrated a progressive increase in thickness with the severity of the condition, highlighting the potential of OCT to serve not only as a diagnostic tool but also as a marker for monitoring disease progression. Furthermore, the diagnostic accuracy parameters of OCT, such as sensitivity, specificity, positive predictive value and negative predictive value, were found to be high. These metrics illustrate OCT's effectiveness in distinguishing between different stages of DR and its capability to accurately identify patients at risk of vision-threatening complications from those with less severe disease manifestations. In conclusion, the study substantiates the utility of OCT in the clinical assessment of diabetic retinopathy. By enabling precise measurement of macular thickness, OCT facilitates the differentiation between patients with and without macular edema, aiding in the stratification of disease severity and optimizing treatment protocols. As diabetes prevalence continues to rise, the role of advanced imaging techniques like OCT in preserving vision and improving outcomes for DR patients becomes increasingly vital. Future research should focus on longitudinal studies to explore the impact of intervention strategies guided by OCT findings on long-term visual outcomes in diabetic patients.

Limitations of Study:
- **Cross-Sectional Design:** The cross-sectional nature of this study limits the ability to establish causality or track the progression of macular edema over time. Longitudinal studies would be more informative for understanding the dynamics of macular thickness changes in response to treatment or disease progression.
- **Sample Size:** Although a sample size of 120 patients provides initial insights, it may not be large enough to generalize the findings across all populations, especially considering the diversity in diabetes type, control and duration. Larger studies could provide a more robust analysis of macular thickness variations and improve the statistical power of the findings.
- **Selection Bias:** The study potentially suffers from selection bias, as participants were recruited from a single tertiary care center. This may limit the applicability of the results to broader populations, including those in different geographic or socioeconomic settings.
- **Exclusion Criteria:** Patients with previous retinal treatments or other ocular diseases were excluded. This exclusion may limit the understanding of macular thickness in a more clinically diverse group of diabetic patients who often present with multiple ocular comorbidities.
- **Measurement Variability:** While OCT is a highly precise tool, measurement variability can occur due to operator differences, machine calibration, or patient cooperation during the scan. The study's results depend on the consistency of these measurements and variability could affect the accuracy of macular thickness assessments.
- **Diabetes Management:** The study did not account for the variability in diabetes management among patients, which can significantly affect retinal outcomes. Differences in glycemic control, medication adherence and duration of diabetes are all factors that could influence macular thickness and potentially confound the study's results.
- **Technological Constraints:** The study relied on the specific capabilities and settings of the OCT equipment used. Different OCT machines or software versions might yield slightly different results, which could affect the reproducibility of the study in other clinical settings.

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