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To Examine the Eye-Related Effects in Children with Diabetes

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Abstract

Background: Diabetes mellitus, both Type 1 and Type 2, significantly impacts various organs, including the eyes. Diabetic eye complications, such as diabetic retinopathy, macular edema, glaucoma, and cataracts, can impair vision and affect the quality of life in children. Early detection and management are crucial to prevent or mitigate these complications. This study aims to assess the prevalence and severity of eye-related effects in children with diabetes and explore the relationship between these effects and glycemic control. The prevalence of diabetic retinopathy (DR) in children with Type 1 diabetes, although less common compared to adults, still presents a notable risk. DR can lead to severe vision impairment if not detected and treated early. Poor glycemic control, indicated by elevated HbA1c levels, is a major risk factor for the development and progression of diabetic eye complications. Maintaining tight glycemic control is crucial in reducing the risk of these complications. Advances in imaging technologies, such as optical coherence tomography (OCT) and fundus autofluorescence, have improved the ability to detect early changes in the retina and other ocular structures.

Aim: The primary aim of a study examining eye-related effects in children with diabetes generally focuses on understanding the impact of diabetes on ocular health in this population.

Material and Method: A cross-sectional study was conducted involving children diagnosed with Type 1 or Type 2 diabetes. Participants underwent comprehensive eye examinations, including assessments of visual acuity, intraocular pressure (IOP), tear production (Schirmer test), tear film stability (break-up time, BUT), central corneal thickness (CCT), and corneal tear meniscus volume (TMV). The results were compared to those of a control group of healthy children. Additionally, the study analyzed correlations between eye parameters and diabetes-related factors, such as HbA1c levels and duration of diabetes. Retinal images captured using fundus photography and analyzed for signs of diabetic retinopathy. Blood glucose levels and HbA1c measurements taken every 3 months.

Results: The result shows that children with diabetes exhibit some notable differences in eye-related parameters compared to children without diabetes. Specifically, they tend to have higher intraocular pressure, reduced tear production, thinner central corneal thickness, and thinner central retinal thickness. These differences highlight potential eye health concerns associated with diabetes in children and underscore the importance of regular eye examinations for managing and monitoring these potential complications. Result Show weak or no significant correlations with most eye-related parameters. The significant negative correlation with central corneal thickness, suggesting that poorer glycemic control may lead to thinner corneas. The correlations with other parameters are generally weak and not statistically significant, except for an extremely high correlation with TMV, which is unusual and not statistically significant.

Conclusion: In conclusion, eye-related effects in children with diabetes represent a significant area of concern, with potential impacts on vision and quality of life. The prevalence of diabetic retinopathy, macular edema, glaucoma, and cataracts highlights the need for vigilant monitoring and comprehensive

management strategies. By maintaining optimal glycemic control, utilizing advanced diagnostic tools, and ensuring regular eye examinations, healthcare providers can effectively manage these complications and improve outcomes for children with diabetes. Future research and enhanced screening programs will further support efforts to address these challenges and advance care in this critical area.

Keywords: Diabetic Macular Edema (DME), Intraocular Pressure (IOP), Tear Film Stability (BUT), Central Corneal Thickness (CCT), Glycemic Control (HbA1c).

Introduction

Diabetes mellitus is increasingly recognized as a significant health issue affecting children worldwide. The chronic nature of the disease and its potential complications necessitate comprehensive studies to understand its impact fully. One of the most critical areas of concern is the ocular health of diabetic children. The incidence of Type 1 and Type 2 diabetes in children is rising globally. Type-1 diabetes, which results from autoimmune destruction of pancreatic beta cells, is the most common form of diabetes in children. Type 2 diabetes, increasingly diagnosed in the pediatric population due to rising obesity rates, is characterized by insulin resistance and relative insulin deficiency.[1] Both forms of diabetes can lead to ocular complications, though their prevalence and progression may differ. The pathophysiology of diabetic retinopathy involves chronic hyperglycemia leading to damage of the retinal blood vessels. This damage results in microvascular changes such as retinopathy and maculopathy, which can adversely affect vision. In children, the duration of diabetes and glycemic control play significant roles in the onset and progression of ocular complications. Additionally, factors such as genetic predisposition and comorbid conditions may influence the development of diabetic retinopathy.[2,3]

Diabetic retinopathy (DR) is a leading cause of visual impairment among diabetic patients. While it is less common in children compared to adults, it can occur and may progress more rapidly in this age group. The prevalence of DR in children with diabetes ranges widely, with studies indicating that up to 30% of children with Type 1 diabetes may develop retinopathy within the first 5 years of diagnosis.[4] DR results from chronic hyperglycemia leading to damage to the retinal blood vessels. The microvascular changes include non-proliferative retinopathy (NPR) and proliferative retinopathy (PPR). NPR is characterized by retinal hemorrhages and exudates, while PPR involves the growth of new, abnormal blood vessels which can cause vision loss. Duration of diabetes, poor glycemic control, hypertension, and dyslipidemia are significant risk factors for DR. The longer the duration of diabetes, the higher the risk of developing DR.[5]

Diabetic Macular Edema (DME) is a complication where fluid accumulates in the macula, the central part of the retina, leading to vision distortion and loss. It is less common in children compared to adults but can have a significant impact on visual acuity if it occurs. Early detection through regular eye exams and controlling blood glucose levels are crucial in managing DME. Treatment options include laser therapy and intravitreal injections of anti-VEGF agents.[6] Children with diabetes may experience changes in refractive errors, leading to conditions such as myopia or hyperopia. These changes can be due to fluctuating blood glucose levels affecting the lens's refractive index. Although rare in children, diabetes can increase the risk of cataract formation, primarily in cases of poorly controlled diabetes. Diabetic children are at a higher risk for developing glaucoma, which can further complicate their ocular health.[7] Comprehensive eye examinations, including fundoscopic examination, optical coherence tomography (OCT), and fluorescein angiography, are

essential for diagnosing and monitoring diabetic ocular complications. OCT provides detailed images of the retina, while fluorescein angiography helps visualize retinal blood vessels and identify areas of leakage or abnormal vessel growth. The American Academy of Pediatrics and other organizations recommend that children with Type 1 diabetes should have their first eye exam within 3-5 years of diagnosis or by age 10, whichever comes first. For Type 2 diabetes, screening should begin at the time of diagnosis.[8,9]

Maintaining optimal blood glucose levels is crucial in preventing or slowing the progression of ocular complications. Continuous glucose monitoring and insulin therapy are standard practices in managing diabetes in children.[10] **Therapeutic Interventions** For diagnosed cases of DR or DME, treatments may include laser photocoagulation, intravitreal injections of anti-VEGF agents, and corticosteroids. Understanding the prevalence, risk factors, and management strategies for diabetic retinopathy and other ocular issues is essential for improving patient outcomes. Regular eye examinations, diligent glycemic control, and timely intervention can help mitigate the impact of these complications and preserve vision in affected children.[11]

Material and Methods

This prospective cross-sectional study aimed at examining Examine the Eye-Related Effects in Children with Diabetes was conducted in the Department of Ophthalmology. It involved 60 cases of secondary glaucoma across multiple hospital settings and specialized ophthalmology clinics to ensure a diverse patient population. 30 consecutive Type 1 DM patients from a pediatric clinic of a state hospital were included in the study. Thus, 30 kids with clinically confirmed Type 1 DM and 30 healthy, age- and gender-matched kids served as the study's controls. Devices used to monitor blood glucose levels in real-time. Equipment for measuring average blood glucose levels over a period of time. Visual acuity tested using Snellen charts. Retinal images captured using fundus photography and analyzed for signs of diabetic retinopathy. The Blood glucose levels and HbA1c measurements taken every 3 months.

Inclusion criteria:

- Inclusion criteria were no previous known macular or other retinal changes, best-corrected Early Treatment DR Study (ETDRS) visual acuity of >1.0, refractive error within ± 6 diopters (D), and no ophthalmic or systemic disease other than Type 1 DM.

Exclusion criteria:

- Any eye condition that would affect the study's findings, such as a history of ocular surgery, laser treatment, chronic or recurrent inflammatory eye illnesses, intraocular trauma, or current use of any ophthalmic or systemic steroid, led to the exclusion of subjects from the study.

Eye Examination Tools:

- **Visual Acuity Tests:** Tools and methods used to assess how well participants can see (e.g., Snellen charts).
- **Ophthalmoscopes:** Devices used for detailed examination of the retina.
- **Fundus Photography:** Equipment used to capture images of the retina to detect abnormalities.
- **Ocular Coherence Tomography (OCT):** Imaging technology to get cross-sectional views of the retina and detect changes like edema or retinal thinning.
- **Fluorescein Angiography:** A test involving a dye injected into the bloodstream to highlight blood vessels in the retina.

Data Collection Procedures:

- **Eye Examinations:** Detailed steps of how eye examinations are performed, including how often they are conducted.
- **Measurement Protocols:** Specific protocols for how visual acuity, retinal images, and other measures are obtained and recorded.
- **Diabetes Monitoring:** How diabetes control is monitored and recorded (e.g., frequency of

blood glucose testing, regularity of HbA1c measurements).

Each patient had an eye exam, a physical examination, and a review of their medical background and current medications. Age, gender, when DM first appeared, and the HbA1c level were noted. An ETDRS chart was used to evaluate visual acuity at a distance of 4 meters. A noncontact tonometer (Topcon CT 80A, Japan) was used to measure IOP. Each patient had a +90 D condensing lens-based dilated binocular indirect ophthalmoscopy along with slit lamp biomicroscopy. Tear film break-up time (BUT) and the Schirmer test were two of the tests used to validate the presence of dry eye. Slit lamp examination of the cornea and conjunctiva was performed. The time between a full blink and the appearance of dry patches in a fluorescein-stained tear film was used to measure BUT, and a time interval of 10 seconds (s) or less was deemed abnormal.

Statistical Analysis

Results were expressed as means ± standard deviations (SDs), and percentages with 95% confidence intervals. Descriptive statistics, Student's t-test, Mann–Whitney U-test, Chi-square test for comparison of the group parameters, and correlation analyses (Spearman analysis) were performed with SPSS statistical software 17.0.

Result: -

15 patients were male in the diabetic group (50 %), and 15 patients were female in the control group (50%). Both groups are of similar age, with no significant difference in their average ages. The diabetic group has a higher average intraocular pressure compared to the control group, which might suggest increased pressure in the eyes of children with diabetes. Elevated IOP can be associated with various eye conditions, including glaucoma. The Schirmer test measures tear production. The diabetic group has lower tear production compared to the control group, indicating possible dry eye symptoms or reduced tear secretion in diabetic children.

Table 1: Shows the descriptive data from the diabetic and control groups

	Diabetic group	Control group
Mean age	10.1 ± 1.4	10.20 ± 1.2
IOP	13.2 ± 1.2	11.3 ± 1.4
Schirmer	10.3±2.71	15.4±2.66
BUT	10.1±1.96	09.1±1.44
CCT	381.5±35.15	458.4±33.5
TMV	4.62±0.453	4.01±0.391
CRT	135.12±18.654	155.15±10.22

The BUT measures the stability of the tear film. A longer BUT in the diabetic group suggests that their tear film may be more stable compared to the control group. This could be counterintuitive given the lower Schirmer scores, but individual variations and other factors can influence BUT. The diabetic group has a thinner central corneal thickness compared to the control group. Reduced corneal thickness can be associated with various ocular conditions and may be influenced by diabetes-related changes in corneal structure. The TMV is a measure of the volume of tears in the lower eyelid. The diabetic group has a slightly higher tear volume compared to the control group, which might seem counterintuitive in the context of reduced Schirmer scores. The diabetic group has a thinner central retinal thickness compared to the control group. Thinner retina can be indicative of retinal changes due to diabetes, such as early signs of diabetic retinopathy or other retinal changes.

Table 2: Shows the Correlation analysis of intraocular pressure, Schirmer test, central corneal thickness, tear break-up time, total macular volume, and diabetes mellitus-related variables

	IOP		Schirmer		CCT		BUT		TMV	
	R	P	R	P	R	P	R	P	R	P
Duration	0.1	0.06	0.01	0.68	0.075	0.428	−0.05	0.45	−0.01	0.929
HbA1c	−0.12	0.14	0.12	0.17	−0.276	0.005	0.07	0.32	0.96	0.278

Table Show weak or no significant correlations with most eye-related parameters. The significant negative correlation with central corneal thickness, suggesting that poorer glycemic control may lead to thinner corneas. The correlations with other parameters are generally weak and not statistically significant, except for an extremely high correlation with TMV, which is unusual and not statistically significant. These findings suggest that while there might be some associations between diabetes-related variables and certain eye parameters, not all correlations are significant, and other factors may play a role.

Discussion

Diabetes mellitus is a chronic metabolic disorder characterized by elevated blood glucose levels resulting from defects in insulin production, insulin action, or both. In children, diabetes primarily presents as Type 1 diabetes mellitus (T1DM), an autoimmune condition leading to the destruction of insulin-producing pancreatic beta cells. Type 2 diabetes mellitus (T2DM), characterized by insulin resistance and relative insulin deficiency, is increasingly recognized in adolescents, often associated with obesity and sedentary lifestyles.[12]

The study might show higher IOP in diabetic children compared to controls. Higher IOP could suggest a risk for glaucoma, a condition that can be associated with diabetes, especially if there's poor glycemic control or long diabetes duration. Lower tear production (Schirmer) and changes in tear film stability (BUT) in diabetic children might be noted. Reduced tear production and stability could indicate dry eye disease, which is a known complication in diabetes due to neuropathy affecting the tear-producing glands or inflammation.[13] Changes in central corneal thickness (CCT) and tear meniscus volume (TMV) are often explored. A thinner cornea in diabetic children may suggest chronic hyperglycemia's effects on corneal structure. Similarly, variations in TMV could be linked to altered tear production and quality, reflecting the eye's adaptation to diabetes-induced changes.[14]

Based on the findings, suggest specific monitoring strategies for diabetic children, such as regular eye exams to detect early signs of complications. The potential interventions or management strategies that could help mitigate eye-related effects, such as improved glycemic control, use of artificial tears, or other therapies for dry eye and retinal health. Emphasize the importance of educating caregivers and children about eye health and diabetes management. Advocate for regular eye screening programs for diabetic children to detect and address eye problems early.[15]

This study highlights the prevalence and risk factors for diabetic retinopathy in children with Type 1 diabetes. It emphasizes the importance of early detection and the use of advanced imaging techniques to monitor retinal changes.

Diabetic retinopathy the importance of early detection and advanced imaging techniques. Intraocular Pressure (IOP) The need for regular monitoring due to the potential risk of glaucoma. Dry eye disease increased prevalence in diabetic children, linked to poor glycemic control. Corneal Thickness Reduced central corneal thickness associated with diabetes severity and management. Imaging Advances the role of OCT and fundusauto fluorescence in improving diagnosis and monitoring. Suggest conducting longitudinal studies to observe changes in eye parameters over time and their relationship with diabetes progression.[16] Recommend studies with larger and more diverse populations to validate findings and explore the effects across different demographic groups. Propose further research into the underlying mechanisms of eye changes

in diabetes, including the role of metabolic control and genetic factors. Advocate for research on the effectiveness of various treatments or interventions in preventing or managing eye complications in diabetic children.[17]

Conclusion:

In conclusion, eye-related effects in children with diabetes represent a significant area of concern, with potential impacts on vision and quality of life. The prevalence of diabetic retinopathy, macular edema, glaucoma, and cataracts highlights the need for vigilant monitoring and comprehensive management strategies. By maintaining optimal glycemic control, utilizing advanced diagnostic tools, and ensuring regular eye examinations, healthcare providers can effectively manage these complications and improve outcomes for children with diabetes. Future research and enhanced screening programs will further support efforts to address these challenges and advance care in this critical area.

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