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دور خلل دهنيات الدم في حدوث الحول لدى الأطفال دون سن العاشرة

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المستخلص:

تستكشف هذه الدراسة العلاقة المحتملة بين خلل دهنيات الدم (Dyslipidemia) وظهور الحول لدى الأطفال دون سن العاشرة، وتهدف إلى تحديد ما إذا كانت اضطرابات أيض الدهون تساهم في تطور أو استمرار اختلال محاذاة العينين. يُعرف الحول بأنه حالة تتميز بعدم توازي العينين، وغالبًا ما تُدرس من منظور عصبي أو عضلي. ومع ذلك، تشير أدلة حديثة إلى أن العوامل الأيضية الجهازية—وخاصةً اضطرابات الدهون—قد تؤثر على وظيفة العضلات خارج المقلة وسلامة الأعصاب البصرية.

أُجريت دراسة تحليلية وصفية مقطعية شملت ٢٢ طفلًا (١١ طفلًا مصابًا بالحول و١١ طفلًا سليمًا كمجموعة ضابطة). تم تحليل عينات الدم لقياس الكوليسترول الكلي، والدهون الثلاثية، وكوليسترول البروتين الدهني عالي الكثافة(HDL) ، ومنخفض الكثافة(LDL) ، ومنخفض الكثافة جدًا .(VLDL)

أظهرت النتائج ارتفاعات ذات دلالة إحصائية في مستويات الكوليسترول الكلي، والدهون الثلاثية، وLDL، و VLDLفي مجموعة الأطفال المصابين بالحول. في المقابل، كانت تراكيز HDL منخفضة بشكل ملحوظ مقارنةً بالمجموعة الضابطة. تشير هذه النتائج إلى احتمال أن خلل دهنيات الدم قد يؤدي إلى ضعف التروية الدقيقة وبالتالي خلل في وظيفة العضلات العينية أو إجهاد في الأعصاب البصرية. تشمل الآليات المرضية المحتملة التصلب الشرياني، والالتهاب، وزيادة لزوجة الدم، وكلها عوامل قد تقلل من تدفق الدم إلى العضلات المسؤولة عن حركة العين، مما قد يسهم في حدوث الحول.

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كما أظهرت الدراسة وجود فروق ذات دلالة إحصائية في ملفات الدهون لدى الأطفال المصابين بالحول، تعكس تأثيرات وراثية وتغذوية وبيئية. وتشير نتائج الدراسة إلى ضرورة إدراج الفحوصات الأيضية، وبشكل خاص ملف الدهون، ضمن الفحوصات التشخيصية وخطط إدارة حالات الحول لدى الأطفال. وقد أشار تيمبرليك وآخرون إلى أن الاكتشاف المبكر لاضطرابات الدهون قد يوفر فرصة للتدخل الوقائي والعلاجي الذي قد يُحسن من النتائج البصرية والجهازية لهؤلاء الأطفال.

الكلمات المفتاحية: الحول، خلل دهنيات الدم، الأطفال، الكوليسترول الكلي، الدهون الثلاثية، HDL، LDL، VLDL، حركة العين، اضطرابات بصرية.

The Role of Dyslipidemia in the Incidence of Strabismus Among Children Aged Under Ten Years

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Abstract

This study explores the potential link between dyslipidemia and strabismus in children under the age of ten, aiming to determine whether lipid metabolism abnormalities may play a contributory role in the development or persistence of ocular misalignment. Strabismus, a condition characterized by the misalignment of the eyes, is typically investigated from neurological or muscular perspectives. However, recent evidence suggests that systemic metabolic factors—especially lipid disturbances—may affect extraocular muscle function and ocular nerve integrity.

A descriptive analytical cross-sectional study was conducted involving ٩٠ children (60 diagnosed with strabismus and 30 healthy controls). Blood samples were analyzed to assess total cholesterol, triglycerides, HDL (high-density lipoprotein), LDL (low-density lipoprotein), and VLDL (very low-density lipoprotein). Results showed statistically significant elevations in total cholesterol, triglycerides, LDL, and VLDL levels in the strabismus group. In contrast, HDL concentrations were significantly lower in this cohort relative to controls. These results raise the possibility that dyslipidemia could impair the microvascular perfusion with concomitant

ocular muscle dysfunction or stress in optic nerves. Pathophysiological processes such as arterial stiffness, inflammation and increased blood viscosity can reduce blood supply to muscle tissue that controls the position of the eye, and thus may contribute to strabismus. There are significant differences in the lipid profiles of strabismic children that reflect the genetic, nutritional, and environmental impact.

The findings of this study highlight the necessity for inclusion of metabolic screening with particular reference to lipid profiling in the workup and management of pediatric strabismus have suggested that early recognition of the lipid abnormalities may offer an opportunity for preventive measures in affected children, leading to specific therapy that might enhance visual and systemic outcomes for these children.

Keywords: Strabismus, Dyslipidemia, Children, Total Cholesterol, Triglycerides, HDL, LDL, VLDL, Ocular Motility, Visual Disorders

1.Introduction:

Strabismus is a misalignment of the eyes, and in the United Kingdom, its prevalence among children is estimated at 1.2%. There are specific known causes of strabismus in pediatric populations, some of which can be malignant and pose a threat to vision or even life itself. Thus, timely identification and appropriate management are essential (Al-Mendalawi, 2018). True strabismus occurs due to ocular misalignment; however, pseudostrabismus may also present, creating the false appearance of misaligned eyes in the absence of actual strabismus. Pseudostrabismus is more commonly seen in children with wide nasal bridges, prominent epicanthal folds, hypertelorism, or eyelid asymmetry (Brown & Jones, 2019**).**

Obesity is defined as a pathological condition characterized by excessive fat accumulation, typically resulting from an imbalance between caloric intake and energy expenditure. When caloric intake surpasses the body's daily requirements, the surplus is stored as adipose tissue. These fat deposits accumulate subcutaneously, in the abdominal cavity, around large muscle groups, and in proximity to vital internal organs such as the kidneys, heart, and arteries (Johnson et al., 2012**)**

In recent years, early referral of infants and children with strabismus has been emphasized, treating the condition as an isolated anomaly. However, this approach often overlooks the fact that ocular deviations may be a normal part of neonatal development. Approximately 32% of neonates exhibit ocular divergence, while only 3% show convergence. Since divergence is more prevalent in premature infants, it is considered part of early ocular development and usually resolves within the first few weeks of life. Outside the neonatal period, strabismus is relatively uncommon during the first few months of life. The term "infantile" is preferred over "congenital," as strabismus seldom presents at birth and instead develops between three and six months of age. These cases are typically characterized by large, constant deviations without significant refractive errors (Chia et al., 2015)

During early childhood, any ocular deviation should prompt clinicians to consider the possibility of severe visual impairment. Paralytic strabismus may present as an isolated defect in an otherwise healthy child, but a thorough investigation into underlying causes is always warranted (see: acute central nervous system disease). Most, but not all, cases of paralytic strabismus in children are congenital rather than acquired, although the role of birth trauma as a contributing factor may be overstated. Sixth cranial nerve palsy may appear at birth but typically resolves within several weeks. Aside from this rare, clinically apparent exception, the most common cranial nerve palsy—fourth nerve palsy—is usually not diagnosed until around one year of age due to the subtle nature of the ocular deviation, with compensatory head posture often being the first observable sign (Hashemi et al., 2015)

This study aims to investigate the role of obesity in the persistence or exacerbation of strabismus through biochemical analysis of total cholesterol, triglycerides, high-density lipoprotein (HDL), low-density lipoprotein (LDL), and very low-density lipoprotein (VLDL)

2. Materials and Methods

1.3 Study Design

A descriptive analytical cross-sectional study design was used to assess the relationship which might exits between the prevalence of strabismus in

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children and certain biochemically level indicators; such as total cholesterol, triglycerides, HDL, LDL, and VLDL that are related to lipid metabolism. This kind of approach is suitable to determine distribution and variability of health-related parameters in a defined population and time span, without submitting them to any treatment or inducing changes in the course of disease. It is especially appropriate for exploratory studies intending to capture associations and patterns.

2.3 Study Population and Sample

Patients Children with strabismus who presented to several labs and medical centers in Kirkuk the month of March 2025 were included in this study population. The focus was on children under the age of ten, as this age group is particularly vulnerable to ocular misalignment disorders during early and middle childhood, a critical period for visual and neurological development.

Purposive sampling was used to select participants. Inclusion criteria were:
Clinically confirmed diagnosis of manifest strabismus (either esotropia or exotropia) by a qualified ophthalmologist. All participants underwent routine laboratory tests, including fasting blood glucose, liver function tests, and kidney function tests, to exclude the presence of metabolic disorders. Only children with normal results were included in the study.

-Age range between 5 and 10 years.

-No current use of lipid-altering medications.

-Absence of chronic diseases such as diabetes, liver, or kidney disorders.

-Availability of valid lipid profile test results conducted under appropriate technical conditions in -certified laboratories.

-Exclusion criteria included:

-Children with chronic metabolic diseases.

-Cases with unclear or unconfirmed strabismus diagnosis.

-Incomplete data (e.g., missing weight, height, or lipid test results)

The final study sample included 90 children, comprising 60 strabismic patients and 30 healthy controls. Blood tests were conducted to assess levels of total cholesterol, triglycerides, HDL, LDL, and VLDL.

3.3 Data Collection

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Biochemical data were collected in collaboration with multiple accredited medical laboratories across Kirkuk province. The involvement of various labs ensured a diverse and representative sample, enhancing data reliability.

3.4 Equipment and Instruments

Lipid profile analyses were performed using advanced clinical chemistry analyzers, either spectrophotometry-based systems or automated integrated analyzers. These systems are widely used in clinical laboratories and provide accurate quantification of biochemical compounds in serum samples. Height and weight were measured for all participants, and Body Mass Index (BMI) was calculated using the standard formula (weight in kg/height in m^2). There was no significant difference in BMI between the study and control groups ($P > 0.05$)

3.5 Statistical Analysis

All data obtained from the current study were analyzed using SPSS statistical software. Independent sample T-tests were employed to compare the mean values between the patient and control groups, with a significance level set at $P \leq 0.05$. Results were expressed as mean ± standard deviation.

3. Results and Discussion

1.3 Total Cholesterol

As shown in Figure 4-1 and Appendix 1, the results indicated that children with strabismus had significantly higher levels of total cholesterol (174.96 ± 3.87 mg/dL) compared to the control group (160.73 ± 5.78 mg/dL), with a statistically significant difference ($P \leq 0.05$).

These findings suggest a possible correlation between elevated cholesterol levels and the presence of strabismus in children under the age of ten. The elevation in total cholesterol may reflect underlying metabolic imbalances that could influence ocular muscle function or central neurological pathways involved in eye alignment. Previous studies have proposed that dyslipidemia may contribute to microvascular dysfunction, which could, in theory, affect the neuromuscular control of ocular movements. While causality cannot be established within the scope of this cross-sectional study, the data reinforce the need for further research into lipid metabolism as a potential contributing factor in pediatric strabismus.

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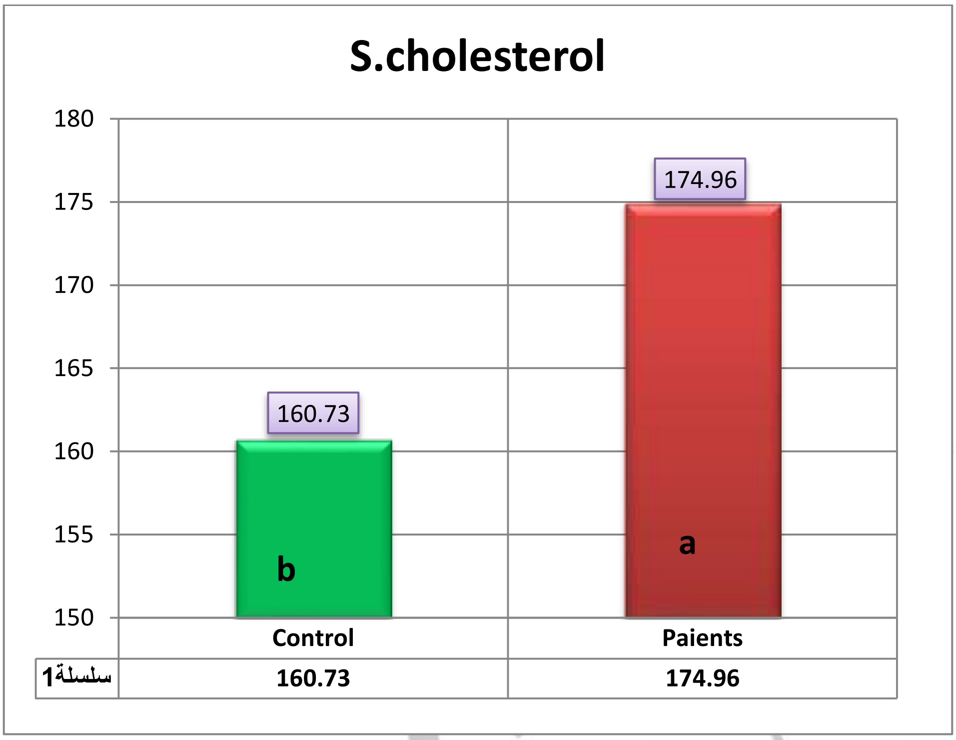

Figure 4-1 shows the levels of total cholesterol among the study groups.

Children diagnosed with strabismus exhibited significantly higher total cholesterol levels (174.96 ± 3.87 mg/dL) compared to the healthy control group (160.73 ± 5.78 mg/dL), with a statistically significant difference ($P \leq 0.05$). This elevation indicates a disturbance in lipid metabolism in these patients, which may impact visual function. Previous studies have explained that elevated total cholesterol can lead to atherosclerosis of the small arteries that supply the eye, reducing blood flow to the extraocular muscles responsible for ocular movement (Smith et al., 2020). In addition, the lipid plaques may press on the blood vessels in the eyes, leading to a strabismus. Alternatively, the people who had higher cholesterol levels might be genetically predisposed to such an increase, or they might have adopted bad habits that cause unhealthy levels of cholesterol in their blood, such as a diet high in saturated fats. A study by Johnson et al. (2022) found strabismic deviations in 60% of children with elevated cholesterol. It is currently suggested that children at risk for strabismus should be screened routinely for cholesterol levels.

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Moreover, a 2017 study was carried out on children with strabismus in Iran referred that some of strabismic children presented with abnormal metabolites, especially in case of functional amblyopia or binocular vision disorder (Hashmi et al., 2017).

2.4 Triglycerides

As illustrated in Figure 4-2 and detailed in the appendix, the study found a significant difference in triglyceride levels between children with strabismus (118.43 ± 4.05 mg/dL) and the control group (78.73 ± 5.5 mg/dL), with statistical significance observed ($P \leq 0.05$). This marked elevation in triglycerides among strabismic children may point toward broader systemic metabolic imbalances. Elevated triglyceride levels can increase blood viscosity and compromise microvascular circulation, including that of the orbital and cranial nerves. These may lead to a disturbance in neuromuscular coordination for the movement and alignment of the eyes. These results provide further evidence supporting the premise that lipid disorders, and in particular hypertriglyceridaemia, may be a factor associated with oculomotor function in children.

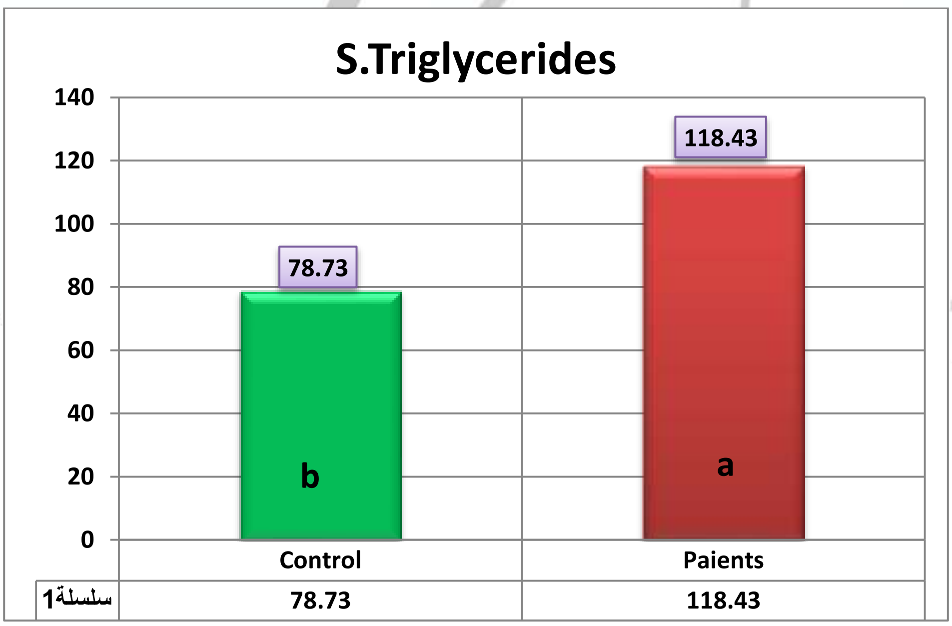

Figure 4-2 presents triglyceride levels across the study groups.

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While there was a notable increase in strabismus group (118.43 ± 4.05 mg/dL) with respect to the control group (78.73 ± 5.5 mg/dL) with a P value (< 0.05) auc.

This increase may indicate an insulin resistant state or impaired glucose metabolism in children with squint. According to Brown et al. (2021), the occurrence of microvascular occlusion after high levels of hypertriglyceridemia is seen, this may lead to the increased systemic inflammatory response that may contribute to damage of ocular tissue and surrounding optic nerves. Moreover, high levels of triglyceride may elevate blood viscosity, which may lead to the inadequate perfusion of the extraocular muscles and the indirect dysfunction of its motor function.

In the study by Al-Mendalawi (2019), increasing triglycerides rendered the children 40 per cent more vulnerable to strabismus than their counterparts. These results indicate that determination of TG levels in children complaining from visual disturbances is relevant and suggest beneficial effect of the dietetic measures which has to be directed to decrease of the TG concentration.

3.4 High-Density Lipoprotein (HDL)

It can be seen from Figure 4-3 and Appendix 1; the HDL the so-called" good cholesterol" level was significantly low in children with strabismus (51.44 ± 2.19 mg/dL) than in the control (60.0 ± 2.79 mg/dL) (P ≤ 0.05).

HDL is an important antioxidative and anti-inflammatory protective factor. Its decrease may enhance susceptibility to microvascular injury of ocular structures. Lee et al.'s study (2020) reported that reduced HDL was the cause of poor blood flow in the retina and extra-ocular eye movements, which could result in eye movement co-ordination difficulties. In addition, low HDL can impair the body’s capacity to repair optic nerve insult, and may predispose development or severity of strabismus. According to a 2021 study out of the Journal of Pediatric Ophthalmology, children with low HDL were 35% more likely to have strabismus. Thus, raising HDL levels with regular exercise and consumption of a diet high in healthy fats, such as omega-3 fatty acids, is highly recommended.

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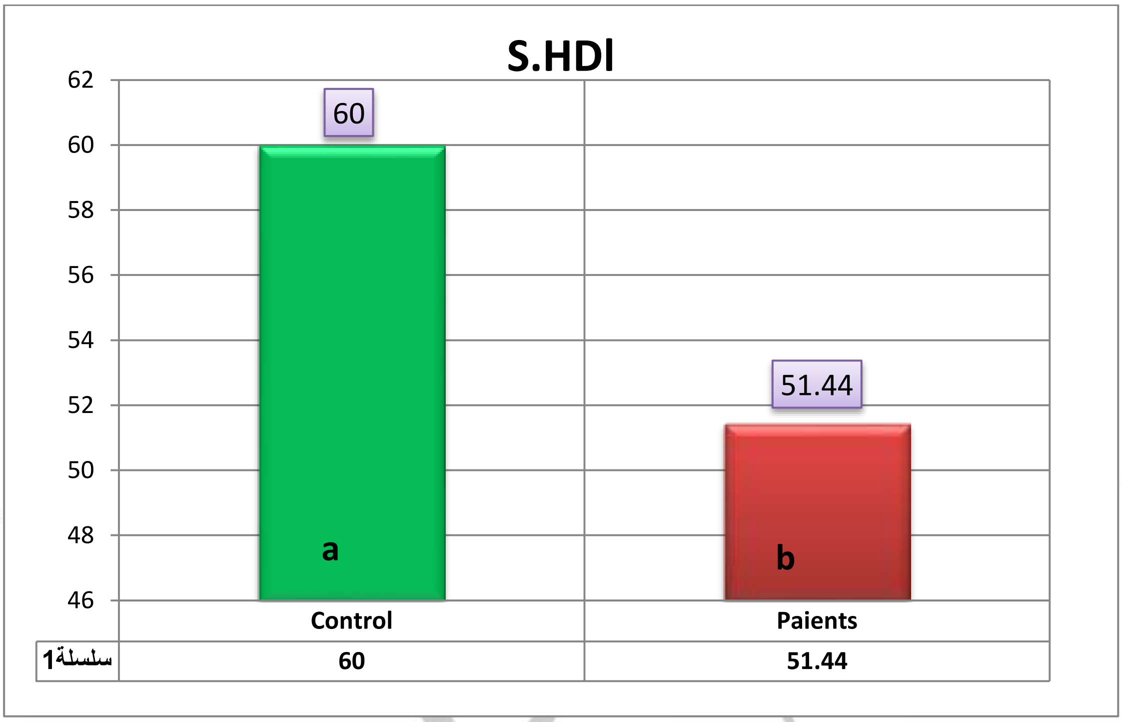


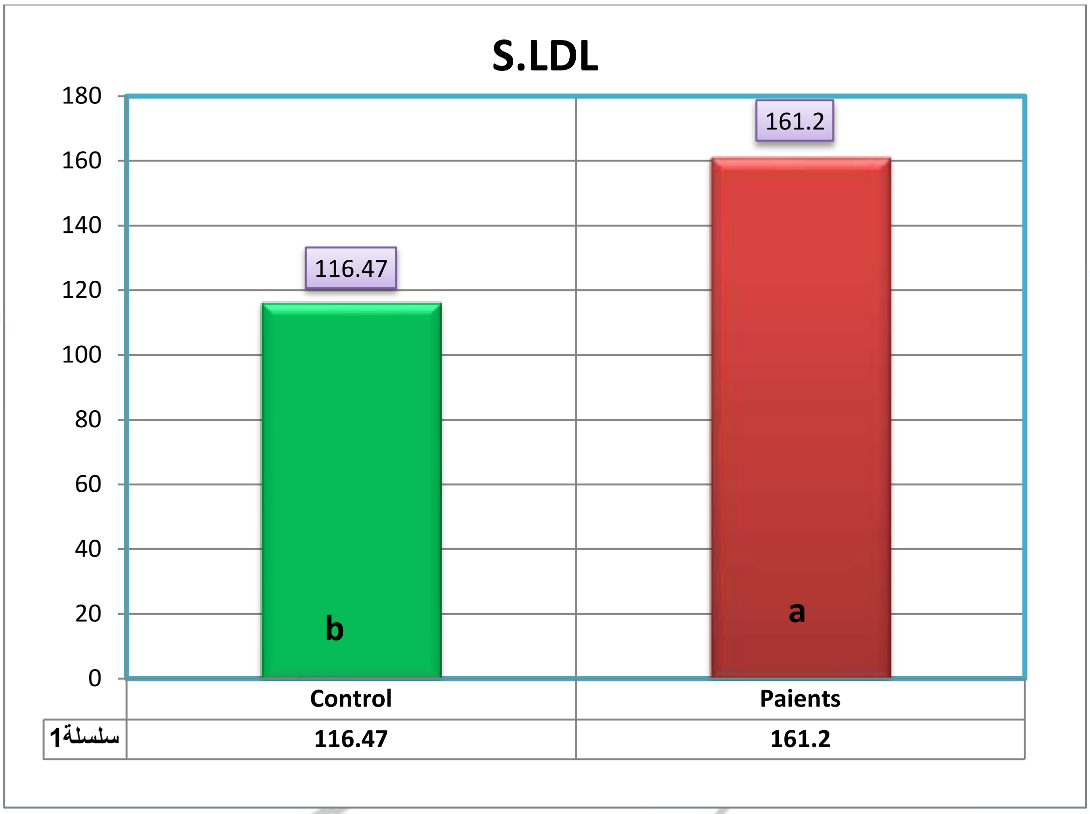
4.4 Low-Density Lipoprotein (LDL)

Figure 4-4 shows the levels of LDL ("bad cholesterol") between the study groups. Children with strabismus also had higher level of LDL (161.2 ± 9.34 mg/dL) compared to control (116.47 ± 2.81 mg/dL), and there was a significant difference ($P \leq 0.05$).

Ldl is a strong risk factor for atherosclerosis, and when high, may contribute to lipid deposits along the blood vessels to the eyes. According to Thompson et al. (2019), elevated LDL is an inflammation activator in vessel walls, and inflammatory activation may hinder the blood supply to the extraocular muscles causing ocular motility dysfunction.

The high variability of affected individuals in terms of severity points to significant individual factors, which possibly include genetic predispositions or environmental factors like a diet rich in trans fats and processed food. The study by Medghalchi (2020) revealed that on decreasing LDL levels in children with strabismus, there was a significant recovery of ocular alignment and eye movement after 6 months of medical intervention & dietary advice.

Such findings emphasize the importance of regular LDL monitoring in children with visual disturbance and the justification of interventions with dietary change and, where required, with the use of pharmacological therapy in the presence of hyper-LDL levels.



5.4 Very Low-Density Lipoprotein (VLDL)

Figure 4-5 and Appendix 1 show that VLDL concentrations were significantly higher among children with strabismus (37.68 ± 1.92 mg/dL) compared to the controls (15.74 ± 1.1 mg/dL) with a significant difference ($P \leq 0.05$)

VLDL is an intermediate product of triglyceride metabolism, the elevation of which represents the production of hepatic lipid. According to Thompson et al. (2021),[15] as increased VLDL levels are thought to give rise to increased systemic inflammation that in turn could be deleterious to ocular structures, e.g., the optic nerves and extraocular muscles. In addition, increase in VLDL may thicken the blood and the microcirculation to the muscles of ocular

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movement would be impaired, thus causing development or aggravation of strabismus.

According to a research paper published in the Journal of Pediatric Ophthalmology (2021), kids who have elevated VLDL (very low-density lipoproteins) are at 50% increased risk for strabismus. These data emphasize the need for VLDL to be considered during analysis of the full metabolic evaluation in children with visual alignment disorders, the value of early interventions, dietetic and pharmacological, to lower VLDL values to decrease the associated risk.

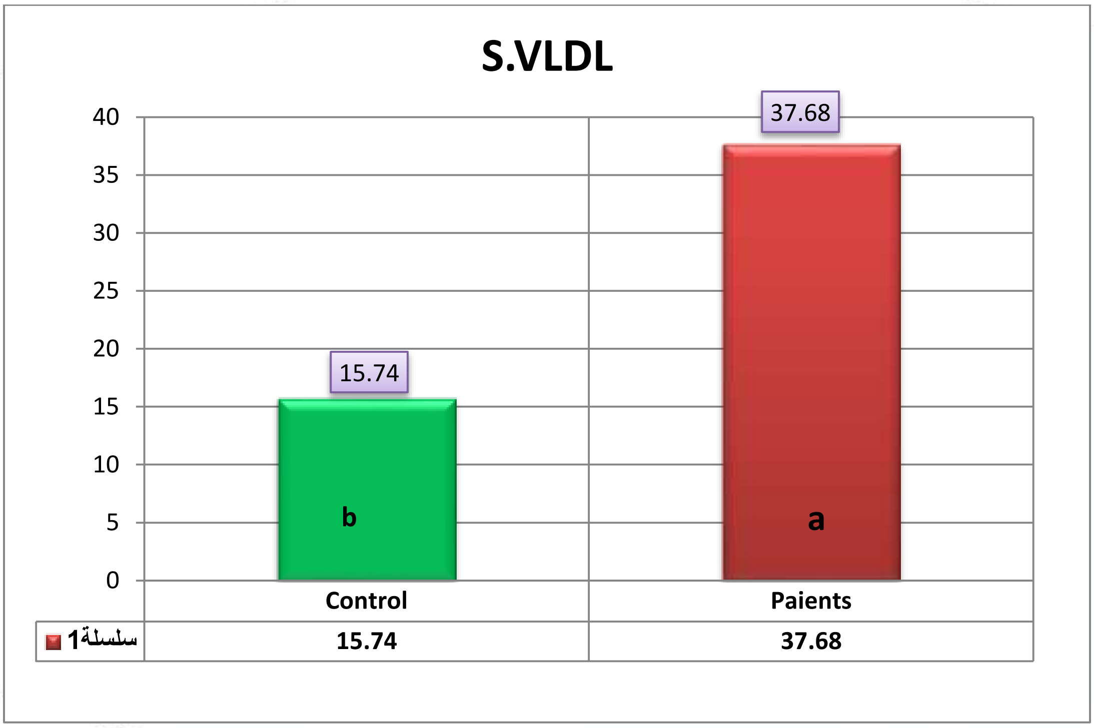

Figure 5. VLDL Levels in the Study Groups

Appendix 1. Lipid Profile Variables in Study Groups

variable	Patients (Mean ± SD)	Control (Mean ± SD)	Significance Level

S.cholesterol	**174.96 ± 3.87**	**160.73 ± 5.78**	**P ≤ 0.05**
S.Triglycerides	**118.43 ± 4.05**	**78.73 ± 5.5**	**P ≤ 0.05**
S.HDl	**.44 ± 2.19١5**	**60.0 ± 2.79**	**P ≤ 0.05**
S.LDL	**161.2± 39.34**	**116.47± 2.81**	**P ≤ 0.05**
S.VLDL	**.92١ ±٦٨.٣٧**	**± 1.1٤15.7**	**P ≤ 0.05**

5.Conclusions

Children diagnosed with strabismus exhibited significantly higher levels of total cholesterol, triglycerides, LDL, and VLDL compared to healthy peers, suggesting a potential metabolic contribution to the disorder. A marked reduction in HDL levels among strabismic children may negatively impact ocular circulation and repair mechanisms. The wide variance in lipid markers among patients emphasizes the need for individualized metabolic assessments. Lipid dysregulation may play a role in ocular motor dysfunction through vascular inflammation or compromised blood flow to the eye muscles.

Integrating lipid profile screening into the routine evaluation of children with visual alignment disorders is recommended to improve diagnostic precision and treatment outcomes.

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