

Case Report

Pediatric Case: Serum Protein Electrophoretic

Safaa Hadrach^{1,2,3*}

¹Laboratory of Chemistry-Biochemistry, Environment, Nutrition and Health, Faculty of Medicine and Pharmacy, Hassan II University, Casablanca B.P. 5696, Morocco;

²Biochemistry laboratory, CHU Ibn Rochd of Casablanca, Morocco

³Care and Biology-Health/Care, Health and Sustainable Development Laboratory (2S2D), Higher Institute of Nursing and Health Technology, Professions. Casablanca-Settat., Morocco

***Correspondence author:** Safaa Hadrach, Laboratory of Chemistry-Biochemistry, Environment, Nutrition and Health, Faculty of Medicine and Pharmacy, Hassan II University, Casablanca B.P. 5696, Morocco; Biochemistry laboratory, CHU Ibn Rochd of Casablanca, Morocco; Care and Biology-Health/Care, Health and Sustainable Development Laboratory (2S2D), Higher Institute of Nursing and Health Technology, Professions. Casablanca-Settat., Morocco; Email: safaa.rx@gmail.com

Citation: Hadrach S. Pediatric Case: Serum Protein Electrophoretic. J Pediatric Adv Res. 2024;3(2):1-6.

<http://dx.doi.org/10.46889/IPAR.2024.32045>

Received Date: 27-06-2024

Accepted Date: 15-07-2024

Published Date: 22-07-2024



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Abstract

Serum protein electrophoresis is a straightforward, dependable and precise technique employed to separate serum proteins. This research aimed to discover abnormal patterns of serum proteins in pediatric cases using capillary electrophoresis and to interpret any detected abnormalities. The research involved 92 serum samples obtained from pediatric patients admitted to Children's Hospital in Casablanca. The study findings identified distinctive pathological electrophoretic patterns observed in pediatric cases: 36 children showed patterns indicative of inflammatory response, 3 had nephrotic syndrome, 4 had hypogammaglobulinemia, 24 exhibited polyclonal hypergammaglobulinemia and 1 had hypoproteinemia. Additionally, two rare cases of α 1-antitrypsin deficiency were highlighted through electrophoresis. Serum protein electrophoresis is highly recommended as a diagnostic tool in children to enhance the accuracy of diagnosing inflammatory diseases, liver disorders and immunodeficiency cases.

Keywords: Serum Protein Electrophoretic; Pediatric Case; Pathological Pattern

Introduction

Serum proteins mainly comprise albumin, fibrinogen and globulins, with a minor fraction consisting of antibodies, lipoproteins, enzymes and hormones [1]. In healthy individuals, these proteins are distributed relatively evenly across fractions. However, under certain conditions, there can be dysproteinemia, where individual protein components vary in quantity. Rarely, higher amounts of proteins or abnormal proteins can develop in response to different conditions. Hypoalbuminemia, marked by decreased albumin levels, is found in a range of conditions including malabsorption, malnutrition, neoplasia and nephrotic syndrome. It

serves as a significant prognostic indicator linked to increased mortality and morbidity. Conversely, albumin levels increase in cases of dehydration [2,3].

A lack of alpha-1 globulin is linked to lung disease and neonatal hepatitis [4,5]. Lowering of alpha-2 globulin levels can be observed in conditions such as hepatocellular damage, hemolytic and megaloblastic anemia, acute severe pancreatitis and disseminated intravascular coagulation syndrome. Beta-globulin serum levels decrease in autoimmune diseases, acute and chronic infections, cancer, nephrosis and hepatic diseases. The percentage of gamma-globulins decreases in hypogammaglobulinemia, agammaglobulinemia and nephrotic [6,7]. Gamma-globulin levels increase in conditions such as multiple myeloma, acute and chronic infections, cirrhosis, rheumatoid arthritis and systemic lupus erythematosus [8]. Capillary electrophoresis is a dependable and uncomplicated technique for separating protein fractions according to their physical

characteristics, including molecular weight, protein shape and charge [9]. Numerous studies have highlighted the importance of electrophoretic fractionation of serum proteins in diagnosing various diseases characterized by abnormal protein levels in the serum [10].

In Morocco, physicians do not frequently use serum protein electrophoresis. This study aimed to use electrophoretic screening to assess serum protein fraction levels in children hospitalized with various diseases at the Abderrahim Harouchi Children's Hospital in Casablanca. The objective was to determine the significance of abnormal serum protein levels in these pediatric patients.

Methodology

Experimental Part

The research involved 92 pediatric cases who were hospitalized at the Abderrahim Harouchi Children's Hospital in Casablanca between January 1, 2019 and January 1, 2020, for various diseases, spanning ages from 0 to 18 years. Informed consent was obtained from all patients or their legal representatives. Data collection involved an exploitation sheet containing anthropometric details (age and sex), medical history, treatments received, protein fraction values (% and g/L) and the type of serum protein profile identified via electrophoresis. Clinical information and other relevant details regarding the pediatric cases were extracted from patient medical records within the respective hospital departments. Capillary electrophoresis (Capillarys®, Sébia) was used to analyze 92 serum samples. This technique operates on the principle of free solution electrophoresis, facilitating rapid separation and automation of analysis. The capillarys system features 8 parallel capillaries, enabling simultaneous analysis. Samples are injected into the capillaries at the anode via suction and separation occurs under a high potential difference applied across the capillary terminals. Proteins are detected directly from 200 nm to the cathode side. Post-separation, capillaries are washed with a solution and buffer at basic pH, yielding six protein fractions in the order: γ -globulins, β globulins, α globulins and albumin. The software performs qualitative reconstruction of the proteinogram based on these results. Electrophoretic findings and total protein levels were analyzed in relation to the patients' ages. Serum total protein measurement was conducted using the biuret colorimetric test on the Architecte ci-8200 automated analyzer.

The data analysis was conducted using XLSTAT version 2022. Statistical procedures employed for data analysis included the chi-square test, t-test, ANOVA and Pearson correlation. Quantitative variables were presented as mean $\pm$ Standard Deviation (SD), while qualitative variables were expressed as percentages. Significance between groups was considered when $p < 0.05$.

Results and Discussion

This study included 92 pediatric patients. The average age of the pediatric patients is calculated as 5.65 ± 2.97 years. 40 cases were boys (3.66 ± 2.89 years old) and 52 cases were girls (6.61 ± 4.85 years old). The difference between sexes was not statistically significant among pediatric patients. The patients were categorized into 5 age groups: less than six months, 6 months to 1 year, 1 year to 2 years, 2 years to 7 years and older than 7 years. Illustrates that there is a higher prevalence of girls in the age group of 2 to 7 years.

Age (years)	Serum total protein g/L	Albumin % (g/L)	α -1 G % (g/L)	α - 2 G % (g/L)	β -1 G % (g/L)	β -2 G % (g/L)	γ G % (g/L)
< 6 months	64,5	58,9-73,4	3,2-11,7	10,6-14	4,8-7,9	2,1-3,3	3,5-9,7
		27,3-49,1	2,1-5,4	5,3-9,8	2,2-4,6	1,1-2,1	1,7-6,3
6-1 year	70	57,4-71,4	3-5	10,2-16,1	5,3-6,9	2,2-3,6	4,2-11
		36-50,6	2-3,7	6,3-12,1	3,3-4,9	1,4-2,6	2,8-8
1-2 years	72,5	57,4-69	3,2-5,4	10,7-15,5	5,6-7	2,6-4,2	7,7-14,8
		38,7-51,1	2,4-4	7,8-11,6	3,7-5,2	1,5-3,1	4,6-10,7
2-7 years	71	57,5-67,7	3,2-5,4	10-14,8	5,1-6,9	2,9-5,2	9,8-16,9

		30,5-48,9	2-3,7	5,6-10,6	2,7-5,2	1,7-3,9	6-12,7
>7 years	73	57,1-67,2	3,2-4,9	8,9-13	5,1-6,9	2,9-5,2	9,8-16,9
		30,9-49,5	1,7-3,7	4,8-9,7	2,7-5,2	1,7-3,9	6-12,7

Table 1: Reference ranges for total protein and protein fractions isolated through electrophoresis, by age groups.

Electrophoretics Pattern	N	Albumin	α 1-globulin	α 2-globulin	β 1-globulin	B2-globulin	y-globulin
	(%)*	(g/l)	(g/l)	(g/l)	(g/l)	(g/l)	(g/l)
Inflammatory	36	36,90 $\pm$ 6,84	4,66 $\pm$ 1,27	2,19 $\pm$ 10,12	4,17 $\pm$ 1,94	3,28 $\pm$ 1,02	13,51 $\pm$ 6,07
Polyclonal hipergamma- globulinemia	24	33,12 $\pm$ 8,58	1,44 $\pm$ 4,45	2,99 $\pm$ 7,40	2,15 $\pm$ 4,59	1,97 $\pm$ 3,95	24,10 $\pm$ 7,87
Hipogamma globulinemia	4	42,08 $\pm$ 5,12	2,05 $\pm$ 0,09	1,86 $\pm$ 9,50	3,90 $\pm$ 0,33	0,94 $\pm$ 5,09	5,05 $\pm$ 0,13
hypoprotidemia	3	26,93 $\pm$ 0,65	2,76 $\pm$ 0,12	3,76 $\pm$ 0,83	3,40 $\pm$ 0,63	2,43 $\pm$ 0,73	9,10 $\pm$ 2,79
Nephrotic syndrome	3	24,47 $\pm$ 4,55	2,58 $\pm$ 1,65	13,01 $\pm$ 3,32	3,03 $\pm$ 2,65	1,03 $\pm$ 1,57	5,93 $\pm$ 1,65
Hypo α 1-globulinemia	2	40,47 $\pm$ 0,65	0,97 $\pm$ 0,15	6,97 $\pm$ 0,95	6,97 $\pm$ 3,65	3,47 $\pm$ 1,65	13,47 $\pm$ 3,65
Other conditions	13	-	-	-	-	-	-

Table 2: Electrophoretic pathological pattern in study group.

Six fractions are visualized by electrophoresis: serum albumin, alpha-1-globulin, alpha-2-globulin, beta-1-globulin, beta-2-globulin and gamma globulin. The interpretation of electrophoretic serum protein patterns was conducted following the guidelines provided by the National College of Biochemistry of Hospitals (NCBH), which included pre-prepared interpretative comments for serum protein electrophoresis 2006 [11].

The results concerning clinical and paraclinical parameters, as presented in Table 2, indicate wide variation limits for each analyzed parameter. A total of 79 patients exhibited abnormal electrophoretic patterns, with serum levels of albumin, total protein and globulins, not falling within the recommended reference ranges for children.

The decrease in total protein levels primarily corresponded to reductions in albumin levels, with less influence from changes in globulin levels. Specifically, decreases in serum albumin levels were observed in 59 cases, whereas elevated gamma globulin levels were noted in 24 cases and lower levels in 7 cases. The predominant clinical presentation among patients was inflammatory response, observed in 36 cases, followed by polyclonal hypergammaglobulinemia in 24 cases.

In certain diseases and nutritional disorders, the appearance of the electrophoretic profile can be altered. This alteration typically involves an increase or decrease in specific protein fractions. A decrease in albumin levels primarily results from a reduction in its synthesis rate, which can be further influenced by inflammation known to suppress the transcription of the albumin gene [12,13].

The inflammatory protein profile showed a level of 4.66 ± 1.27 g/L for the alpha-1 globulin fraction and 10.12 ± 2.19 g/L for the alpha-2 globulin fraction. This indicates that protein levels associated with inflammation increase proportionally with the severity of inflammation. Gamma globulins were recorded at a level of 13.51 ± 6.07 g/L. During an inflammatory reaction, certain serum proteins undergo slight imbalances, either through loss or increased synthesis. In acute inflammation, the liver produces specific proteins known as Acute Phase Reactants (APRs) [14]. These include alpha-1 antitrypsin, alpha-1 acid glycoprotein (orosomucoid) and alpha-1 antichymotrypsin, which migrate in the alpha-1 globulin fraction. Haptoglobin and ceruloplasmin migrate to the alpha-2 globulin fraction, while C-Reactive Protein (CRP) migrates to the gamma globulin fraction [15]. These fractions increase proportionally during the inflammatory syndrome [16,17]. Hypoalbuminemia is often observed during inflammatory syndromes. It is an underrecognized and variable risk factor that contributes to the development of pulmonary diseases and cardiovascular. Assessing serum albumin levels is crucial and can serve as a diagnostic tool for cardiovascular and pulmonary diseases [18].

In children with hypergammaglobulinemia, albumin levels were measured at 33.12 ± 8.58 g/L. The values of α globulins and β -globulins were within normal ranges, while there was an increase in the γ -globulin fraction to 24.10 ± 7.87 g/L. A study conducted in Romania among pediatric cases reported a slightly lower increase in γ -globulins, averaging 18.4 ± 4.9 g/L [19]. Among the study participants, the highest concentration of γ -globulins was recorded in girls, at 24.35 g/L, compared to 21.81 g/L in boys. This gender difference in the protein profile indicating hypergammaglobulinemia was statistically significant. ($p=0.005$), consistent with findings from Gurau, et al., in 2016, which showed higher γ -globulin levels in girls (24.9 g/L) compared to boys (21.9 g/L) [19]. Lo, et al., suggest that girls with elevated IgG levels are three times more likely to develop autoimmune diseases than boys [20]. Polyclonal hypergammaglobulinemia results from the activation of numerous plasma cell clones releasing immunoglobulins. This condition manifests on a serum protein profile as a homogeneous and symmetrical separation of gammaglobulins, resembling a Gaussian curve [21]. In our series, the hypergammaglobulinemia serum protein profile observed in 24 cases was associated with specific clinical conditions among the pediatric patients. Specifically: 15 children presented with nonspecific fever, 6 children exhibited digestive disorders and functional abdominal pain, 3 children showed signs of liver damage. Hypogammaglobulinemia is a form of primary immune deficiency characterized by low levels of gammaglobulins, particularly IgA and IgG, in the blood [22].

In our study, hypogammaglobulinemia was identified in 4 children with an average age of 0.19 ± 0.08 years. The average level of γ -globulin was measured at 5.05 ± 0.13 g/L, which falls below the minimum limit expected for this age group. Gurau's study reported a similar finding with hypogammaglobulinemia levels averaging 4.1 ± 1.5 g/L [19]. Children diagnosed with hypogammaglobulinemia often have a history of recurrent infections, particularly associated with primary immunodeficiency conditions [23].

It is possible for patients to exhibit transient hypogammaglobulinemia, where levels of IgA and IgG remain low during the first six months after birth. This condition may occur because these antibodies are either not yet produced or their formation is hindered due to factors such as malnutrition [24]. Hypogammaglobulinemia is associated with many different pathological disorders, including digestive function disorders, gastroenteritis, malnutrition, intestinal and urinary infections, allergies, jaundice, nonspecific fever and liver damage [25].

Serum protein electrophoresis, while typically considered a secondary diagnostic test, plays a crucial role in identifying various pathological serum protein profiles. These include inflammatory protein profiles, immunological protein profiles, nephrotic protein profiles, hypoalbuminemia profiles and cirrhotic protein profiles, through the analysis of different proteins. Despite its importance, serum protein electrophoresis is not widely recognized as a critical diagnostic method in clinical routine. The serum contains thousands of proteins, but only around 22, including alpha-1-antitrypsin, have levels significant enough to affect the electrophoretic profile. Interestingly, our study did not identify any cases of alpha-1 antitrypsin deficiency among the pediatric patients observed.

Indeed, the variability in the concentration of individual proteins in serum, including considerations regarding alpha-1 antitrypsin deficiency, cannot be conclusively determined solely based on electrophoretic patterns. Specific confirmation methods are necessary to accurately diagnose conditions like alpha-1 antitrypsin deficiency. Electrophoresis provides valuable initial insights into protein profiles, but definitive diagnoses often require further specialized testing and clinical correlation. Therefore, while electrophoresis is informative, it is essential to employ additional specific confirmation methods to ensure accurate diagnosis and appropriate management of conditions affecting protein concentrations in the serum.

Conclusion

Serum protein electrophoresis serves as a valuable tool for pediatricians to identify various serum proteins, aiding in diagnosis, evaluating disease progression and assessing therapeutic efficacy. It should be considered a routine laboratory test for all pediatric cases upon admission. This test provides crucial insights into the severity, underlying causes and localization of pathology, thereby facilitating informed clinical decisions and improving patient care. By incorporating serum protein electrophoresis into standard practice, pediatricians can enhance diagnostic accuracy and optimize treatment strategies tailored to individual patient needs.

Conflict of Interests

The author has no conflict of interest to declare.

Data Availability

All data generated or analyzed during this study are included within the article and in supplementary information files.

Ethical Approval

The Research Ethics Committee of the Faculty of Medicine and Pharmacy, Hassan II University, Casablanca, has approved this study (registration no. 26/18). The study was conducted within Biochemistry laboratory, CHU Ibn Rochd of Casablanca, Morocco.

Authors' Contributions

Safaa Hadrach, conceived and designed this study. Safaa Hadrach, performed data collection. performed statistical analyses for this study reviewed data selection, the study process and analysis of the data. S.H. drafted the article. reviewed for the improvement of the overall quality. Both authors agreed to submit the manuscript.

Acknowledgments

This study was supported by the Laboratory of Chemistry-Biochemistry, Environment, Nutrition and Health, Faculty of Medicine and Pharmacy, Hassan II University, Casablanca and Biochemistry laboratory, CHU Ibn Rochd of Casablanca, Morocco.

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