Case Report

Nephritic syndrome and acute kidney injury following poststreptococcal glomerulonephritis in pediatric patients: A case report

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ABSTRACT

Acute kidney injury (AKI) is characterized by an abrupt decrease in glomerular filtration rate, manifesting as an increase in serum creatinine or oliguria. Nephritic syndrome, a manifestation of glomerulonephritis, presents with hematuria, hypertension, decreased urine output, and edema. This case report discusses an 11-year-old Asian boy who presented with decreased urination, shortness of breath, hypertension, and bilateral leg edema. Urinalysis revealed hematuria, proteinuria, and dysmorphic erythrocytes, while serum creatinine was elevated with a decreased estimated glomerular filtration rate (eGFR). The patient had a positive ASTO test, indicating poststreptococcal glomerulonephritis as the underlying cause of nephritic syndrome and AKI. Although most cases of poststreptococcal glomerulonephritis in children have a favorable outcome, some cases can develop into a serious, life-threatening condition that requires careful attention. This case highlights the importance of early detection and management of poststreptococcal glomerulonephritis to prevent progression to nephritic syndrome and AKI, especially in resource-limited settings. Modest examination modalities can facilitate early detection and faster patient management, particularly in developing countries, to reduce the risk of mortality associated with severe AKI in pediatric patients.

KEYWORDS

Acute kidney injury, nephritic syndrome, hematuria, dysmorphic erythrocyte, glomerulonephritis

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INTRODUCTION

The primary sign of acute kidney injury is an acute decrease in the glomerular filtration rate, which may manifest as oliguria or an increase in serum creatinine [1], [2]. Hematuria, elevated blood pressure, decreased urine production, and edema are clinical symptoms of nephritic syndrome. The underlying cause of this syndrome is inflammation of the glomerulus, which results in disruption of the glomerular basement membrane. Nephritic syndrome, a manifestation of inflammatory conditions of the glomerulus or glomerulonephritis, is one of the causes of acute kidney injury [3]. The overall mortality rate due to AKI among hospitalized patients is 21%[4]. Pediatric patients with severe AKI have a 1.77 times greater risk of death than those with nonsevere AKI. In children, the mortality rate for severe AKI is 11%, while the mortality rate for nonsevere AKI is 2.5%. Early treatment of underlying conditions can reduce the risk of death in pediatric AKI patients[5]. Here, we present the case of an 11-year-old boy whose main complaint was decreased urination and shortness of breath. Physical examination revealed hypertension and bilateral leg edema. Urinalysis revealed hematuria, proteinuria, and dysmorphic erythrocytes in the urine sediment. Serum creatinine increased with decreasing estimated glomerular filtration rate (eGFR). This article will discuss how to detect poststreptococcal glomerulonephritis leading to nephritic syndrome and AKI in children in a limited setting so that early detection and treatment can prevent mortality.

CASE PRESENTATION

An 11-year-old Asian boy who presented to our hospital with a chief complaint of decreased urination and shortness of breath. One week before admission, the patient complained of decreased urination and a reddish color. The urination was approximately one cup per day. Approximately three days later, the patient started to experience shortness of breath, which worsened, so the patient came to the hospital. The patient's parents stated that the child looked pale and weak. There was no fever. The patient underwent bladder repair surgery because of a congenital anomaly approximately 2 months prior to presentation. The patient was administered paracetamol for pain relief and consumed it for approximately 1 week postoperatively.

There was no history of diabetes, hypertension, kidney disease, or heart disease. On physical examination, the patient was conscious but appeared weak. Vital sign examination revealed a heart rate of 130 bpm, respiratory rate of 32 bpm, blood pressure of 140/90 mmHg, and normal body temperature with an oxygen saturation of 98% with the help of an oxygen mask. Head and neck examination revealed anemic conjunctiva and dyspnea. Thoracic examination revealed that the heart and lungs were within normal limits. Abdominal examination results were also normal. On examination of the extremities, edema, which was pitting in nature, appeared in both legs. The daily urine volume was 100-150 mL/day.

Laboratory examinations were performed regularly as the patient visited the hospital. Serial hematology examinations revealed low hemoglobin and hematocrit levels, while her erythrocyte count decreased. The erythrocyte index was within the normal range, indicating normocytic normochromic anemia. Serial serum examinations revealed hyperkalemia and high blood urea nitrogen and creatinine levels. The estimated GFR was less than 15, indicating kidney failure. Her procalcitonin level was > 2 ng/mL. Hematology and clinical chemistry laboratory examination results are shown in Tables 1 and 2, respectively.

The ASTO test was positive, but the ANA test was negative, the anti-dsDNA antibody was normal, and the C3 and C4 levels were normal. Blood gas examination revealed a decrease in blood pH, PCO_2, and HCO_3^-, with a negative base excess, indicating metabolic acidosis with respiratory compensation. Serial urinalysis was performed to assess disease progression. Urinalysis was performed using random samples. The urinalysis results showed that glucose was 2+, protein was 4+, and erythrocytes were 3+, with an albumin to creatinine (A:C) ratio ≥ 300 and a protein to creatinine (P:C) ratio ≥0.5. The serial urine examination data are shown in Table 3. Urine sediment examination revealed 10-25 erythrocytes/high-power field in renal tubular epithelial and transitional epithelial cells. Granular casts were also observed. Urine sediment

examination revealed dysmorphic erythrocytes in the form of fragmentocytes and acanthocytes (Figures 1 and 2).

Thoracic radiography was performed as a supporting radiological examination and revealed minimal bilateral pleural effusion and lung edema. The patient was diagnosed with acute kidney injury and nephritic syndrome complicated by anemia, pneumonia, and metabolic acidosis. The patient received a packed red cell (PRC) transfusion during hospitalization. The patient was scheduled for hemodialysis twice a week because of renal failure. The patient also received cefoperazone sulbactam for sepsis, furosemide for diuresis, and sodium bicarbonate to slow the decline in kidney function. The patient also received prednisone, amlodipine, sucralfate, and zinc.

The patient's condition, both clinically and laboratory-based, was monitored regularly. The results of laboratory examinations, especially hematological parameters and renal function, were dynamic because of the hemodialysis procedure performed. Hematological parameters, especially hemoglobin levels, which tended to decrease after hemodialysis, were affected. Renal function parameters showed a good response after hemodialysis.

Table 1. Hematology Results

Parameter	28/12/2023	28/12/2023	1/1/2024	Refference Range
WBC (10^3/µL)	4.26	5.68	6.95	3.37-10.0
% Eo	6.6	3.7	3.3	0.6-5.4
% Baso	0.2	0.2	0.3	0.3-1.4
% Neu	63.7	60.0	65.7	39.8-70.5
% Lym	17.1	25.7	21.3	23.1-49.9
% Mo	12.4	10.4	9.4	4.3-10.0
RBC (10^6/µL)	2.12	1.07	2.80	3.69-5.46
HGB (g/dL)	6.0	4.8	8.1	11-14.7
HCT (%)	17.7	14.7	25.0	35.2-46.7
MCV (fL)	83.5	88.0	89.3	86.7-102.3
MCH (pg)	28.3	28.7	28.9	27.1-32.4
MCHC (g/dL)	33.9	32.7	32.4	29.7-33.1
RDW (%)	13.9	15.5	15.2	12.2-14.8
PLT (10^3/µL)	150	150	170	150-450
% IG	1.3	1.8	1.8	0-0.5

WBC, white blood cell; Eo, eosinophil; Baso, basophil; Neu, neutrophil; Lym, lymphocyte; Mo, monocyte; RBC, red blood cell; HGB, hemoglobin; HCT, hematocrit; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin; MCHC, mean corpuscular hemoglobin concentration; RDW, red cell distribution width; PLT, platelet; IG, immature granulocytes.

Table 2. Clinical chemistry laboratory examination results

Parameter	28/12/2023 (Before hemodialysis)	28/12/2023 (after hemodialysis)	Refference Range
K^+ (mmol/L)	6.6	4.0	3.5-5.1
Na^+(mmol/L)	135	136	136-145
Cl^- (mmol/L)	100	103	98-107
BUN (mg/dL)	73	27	7-18
Creat (mg/dL)	8.0	3.3	0.6-1.3
eGFR	6.9	16.8	> 75
Alb	3.45	3.75	3.4-5.0
Ca^{2+}	9.9	9.6	8.5-10.2
Mg^{2+}	2.1	2.0	1.8-2.4
Phos	4.9	2.6	2.5-4.5
CRP	3.9		< 0.3
PCT	4.15		

K^+ = potassium, Na^+= sodium, Cl^- = chloride, BUN = blood urea nitrogen, Creat = creatinine, Alb = albumin, AST = aspartate aminotransferase, ALT = alanine aminotransferase, RBG = random blood glucose, Ca^{2+}= calcium, Mg^{2+}= magnesium, Phos = phosphate, CRP = C-reactive protein, UA = uric acid, PCT = procalcitonin.

Table 3. Urinalysis results

Parameter	28/12/2023	2/1/2024	Reference Values
SG	1.019	1.019	1.003-1.030
pH	7.5	7.5	4.5-8.0
Glucose	+2	+2	Negative
Bilirubin	Negative	Negative	Negative
Keton	Negative	Negative	Negative
Protein	+4	+4	Negative
Urobilinogen	Normal	Normal	< 1.0
Nitrit	Negative	Negative	Negative
Leukosit	Negative	Negative	Negative
Eritrosit	+3	+2	Negative
Color	Yellow	Yellow	Yellow
Clarity	Clear	Clear	Clear
A:C	≥ 300	≥ 300	< 30 mg/gCr
P:C	≥ 0.50	≥ 0.50	< 0.15 g/gCr
RBC	64.9	31.7	0.00-4.36
RBC	11.68	5.7	0-2
WBC	9.0	4.2	0.0-14.0
WBC	1.62	0.76	0-5
Squamous epithelium	7.25	9.15	0-10
Non squamous epithelium	8.1	4.0	0-1
Hyalin cast	6.38	8.15	0-10
Pathologic cast	3.21	2.81	Negative
Yeast	3.45	0.54	Negative
Bacteria	6.08	6.9	0-20
Bacteria	3.4	3.8	0.00-0.99

SG = specific gravity, A:C = albumin to creatinine ratio, P:C = protein to creatinine ratio, RBC = red blood cell, WBC = white blood cell

DISCUSSIONS

The clinical spectrum of poststreptococcal glomerulonephritis can vary from subclinical to systemic complications and life-threatening AKI [6]. In this case, the patient's clinical picture fulfilled the criteria for acute kidney injury. Decreased urination significantly indicated oliguria, and increased serum creatinine levels were observed in this patient. Acute kidney injury is an abrupt decrease in the glomerular filtration rate characterized by an increase in serum creatinine, oliguria, or anuria within a particular time interval according to the Kidney Disease Improving Global Outcome [1]. This decrease in the glomerular filtration rate indicates a decrease in kidney function, including structural damage and loss of function [2], [7]. AKI severity is divided into three stages based on serum creatinine levels and urine volume within a certain period. Based on the eGFR of the patient, this case was assessed as AKI stage III because it fulfilled the criteria of stage III, a decrease in eGFR to less than 35 mL/min per 1.73 m^2. Several biomarkers of AKI have been investigated [8], [9].

Nephritic syndrome criteria were also clearly found in this patient, in which the patient had hematuria, proteinuria, hypertension, and edema. Nephritic syndrome is a manifestation of glomerular disorders, especially acute proliferative glomerulonephritis [10]. In children, the main cause of acute proliferative glomerulonephritis is a streptococcal infection. Nephritic syndrome in this patient was most likely caused by poststreptococcal infection because this patient was found to have positive anti-streptolysin O (ASTO) results [8].. Approximately 20% of patients with glomerulonephritis poststreptococcal infection develop nephritic syndrome [12]. Streptococcus-related skin or throat infection typically occurs a few weeks after the onset of nephritic syndrome poststreptococcal infection [11]. After ear piercings and circumcision, some cases have also been discovered [13], [14]. The results of the complement examination in this patient showed that there was no decrease in complement. In 15–30% of patients with nephritis

syndrome, there is a decrease in complement, whereas in 10% of patients, there are normal complement results [11], [15] Poststreptococcal infection glomerulonephritis can cause AKI through immune complex accumulation, complement activation, and other cellular inflammatory processes [13].

In this case, renal biopsy was not performed because it is typical of glomerular disorders with a clear cause. In addition to the clinical and laboratory features described above, this case also revealed dysmorphic erythrocytes with acanthocyte and fragmentocyte formation as well as granular casts on urine examination. These are pathognomonic signs of hematuria due to glomerular disorders [17]. Renal biopsy examination is also not mandatory in cases of glomerulonephritis post-Streptococcus infection [15].. In the management of glomerular disorders, a biopsy should be performed if the benefits outweigh the risks [19].

Based on this case and the supporting literature, detection of poststreptococcal glomerulonephritis can be performed with minimal workup. The presence of a positive ASTO may indicate the presence of poststreptococcal infection[20]. A sign of glomerulonephritis is the presence of dysmorphic erythrocytes in the urine sediment[17]. In pediatric patients with complaints of decreased urine production or hematuria, this can certainly be a concern. Prompt detection of poststreptococcal glomerulonephritis and appropriate therapy can prevent mortality[21]. Further research related to the sensitivity and specificity of poststreptococcal infection detection based on simple examinations needs to be carried out, especially to assist in diagnosis in developing countries.

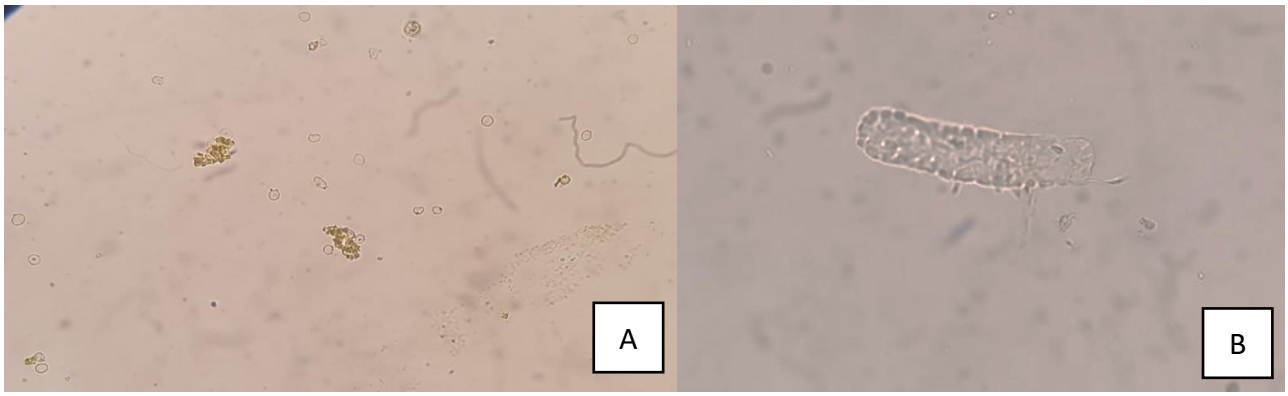

Figure 1. Photograph of the patient's fresh unstained urine sediment on December 28, 2023. a. Erythrocytes are dominated by dysmorphic erythrocytes (acanthocytes and fragmentocytes). b. Granular cast (400x magnification).

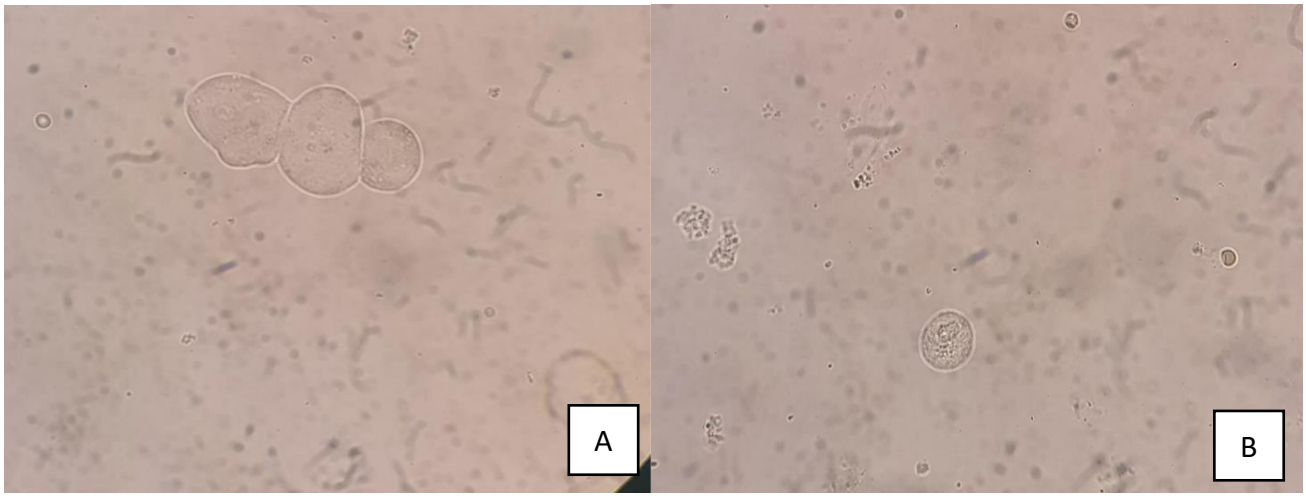

Figure 2. Photograph of the patient's fresh unstained urine sediment on December 28, 2023. Images a and b. Examination of renal epithelial and dysmorphic erythrocytes in urine sediment indicated renal problems (400x magnification).

CONCLUSIONS

Nephritic syndrome is one of the most common forms of acute progressive glomerulonephritis and may lead to AKI in some patients. The most common cause of acute proliferative glomerulonephritis in children is streptococcal infection, which is mostly caused by group A beta-hemolytic Streptococcus. Renal biopsy is not mandatory in typical cases of glomerular disorders with a clear cause. Prompt detection of poststreptococcal glomerulonephritis and appropriate therapy can prevent mortality.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest. The publication of patient data has been authorized.

AUTHOR CONTRIBUTIONS

Conceptualization, Methodology, Software, Validation, Formal analysis, Investigation, Resources, Data Curation, Writing - Original Draft, Writing - Review & Editing, Visualization, Supervision: EI, RYR, and AHK.

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