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Diabetes mellitus as an independent predictor of COVID-19 outcomes
Le diabète sucré en tant que facteur prédictif indépendant du pronostic de l'infection au COVID-19

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Abstract

Introduction: COVID-19 is a respiratory disease that can range from asymptomatic to critical or fatal. The severity of the clinical presentation depends on various factors, including comorbidities such as diabetes, which has been shown to be strongly associated with a more severe course and higher mortality rate.

Objectives: This study aims to describe the particularities of COVID-1 infection in diabetic patients, and analyze its prognostic implications.

Methods: This retrospective cross-sectional study analyzed all admitted patients with confirmed COVID-19 in the emergency department of the Farhat Hached University Hospital in Sousse from April 1, 2020, to December 31, 2021.

Results: Out of the 2106 COVID-19 patients, 688 (32.66%) had diabetes. Among these patients, diabetes was pre-existing in 88.1% of cases, while it was inaugural in 11.9%. Our study revealed that diabetes was a poor prognostic factor in COVID-19 cases, associated with up to 1.72 (95% CI 1.41-2.1) times greater risk of severe or fatal forms. This may be due to several factors associated with the diabetic population, including advanced age (p=0.001), the presence of underlying comorbidities (p=0.001), and the presence of hemodynamic instability upon admission (p=0.001). they also exhibited an increased risk of respiratory acidosis (p=0.001) and AKI (p=0.0001). outcomes were less favorable in diabetic patients, with a final hospital mortality rate of 33.9% vs 22.9% in non-diabetic patients (p=0.0001).

Conclusion: Diabetes is one of the comorbidities most associated with the severity of COVID-19 infection. Careful management of diabetic patients with COVID-19 is essential to prevent complications and reduce adverse outcomes.

Keywords: covid19; outcomes; diabetes mellitus; mortality

Introduction

The COVID-19 pandemic, caused by the novel coronavirus SARS-CoV-2, has significantly affected millions of lives worldwide, with its repercussions extending beyond the realm of public health to encompass socioeconomic, psychological, and healthcare delivery aspects.

The emergence of the pandemic has not only posed unprecedented challenges to global healthcare systems but has also exposed the vulnerability of certain populations, including individuals with pre-existing health conditions such as diabetes.

As the world continues to grapple with the multifaceted impacts of the ongoing pandemic, understanding the intricate relationship between COVID-19 and diabetes has become increasingly imperative.

This heightened vulnerability highlights the need for targeted research to guide effective public health responses and clinical management strategies. While existing studies have shed light on the epidemiology and clinical outcomes of COVID-19 in diabetic patients, many questions remain unanswered—particularly regarding risk factors, disease progression, therapeutic approaches, and long-term sequelae specific to this population.

Therefore, this study aims to fill those knowledge gaps by examining the epidemiological, clinical, paraclinical, therapeutic, and prognostic aspects of COVID-19 in people with diabetes. Through detailed data analysis, it seeks to identify key prognostic factors uniquely affecting this high-risk group, and to support more effective, tailored care strategies that can reduce complications and improve outcomes.

Methods

This is a cross-sectional study designed to investigate the clinical outcomes of patients with RT-PCR-confirmed COVID-19, including those with diabetes, at the emergency department of the Farhat Hached university hospital from April 1, 2020, to December 31, 2021.

Patients aged 15 years or older hospitalized for severe acute respiratory syndrome related to SARS-CoV-2 infection associated with known or newly diagnosed diabetes, confirmed by detection of the SARS-CoV-2 viral genome in the upper airways by RT-PCR and/or chest CT findings suggestive of COVID-19 infection, and requiring hospitalization for the treatment for COVID-19 infection were included in the study. Patients with multiple missing data were excluded.

Data were collected using a data processing form from the patients' medical records.

The study collected data on sociodemographic characteristics (age, sex, comorbidities such as diabetes and hypertension, and lifestyle factors), clinical data (symptoms, physical examination findings and severity scores), paraclinical parameters (laboratory results, imagery findings, and biomarkers), therapeutic interventions (oxygen therapy, intubation, medications, and fluid management), and patient outcomes (length of stay, emergency department course, and final hospital disposition).

Statistical Data Analysis The data was analyzed using IBM SPSS software version 23.0 for windows.

Descriptive analysis included calculating frequencies and percentages for qualitative variables and means, standard deviations, medians, and ranges for quantitative variables. Analytical analysis consisted of Student's t-test for comparing means of two independent groups and Pearson's Chi-square test for frequency comparisons. Multivariate analysis was conducted using binary logistic regression to identify independent risk factors associated with disease severity in diabetic patients, incorporating variables with a univariate p-value < 0.2. The significance threshold for all tests was set at $p < 0.05$.

Results

A total of 2106 patients were enrolled in this study. The mean age was 64.48±13.53 years, with extreme ages ranging from 16-95. The most prevalent age group was that of elderly patients aged >65 years (54.30%).The study population showed a male predominance (sex ratio 1.26) and a high prevalence of comorbidities, particularly hypertension (42.1%) and diabetes (32.8%). (table1)

(54.30%). The study population showed a male predominance (sex ratio 1.26) and a high prevalence of comorbidities, particularly hypertension (41.9%) and diabetes (32.7%). (table1)

Table 1: characteristics of the study population

Age (years)		n(%)
	Mean ± SD	66.25±12.15
	Min-max	25-92
Sex ratio (M/F)		1.11
Comorbidities		1506(74.1)
	Diabetes	606(88.1)
	Hypertension	436(63.4)
	Coronary disease	117(17)
	Obesity	122(17.7)
	Smoking	107(15.6)
	Chronic respiratory failure	91(13.2)
	Chronic kidney disease	69(10)
	Tumors	31(4.5)
	Immunosuppressor therapy	18(2.6)
Presenting symptoms		
	Dyspnea	545(79.2)
	Fatigue	477(69.3)
	Cough	475(69)
Respiratory exam		
RR (cpm)	Mean ± SD	24.24 ± 5.63
	Min-max	13-50
spO2 (%)	Mean ± SD	86.96±10.238
	Min-max	40-100
Hemodynamic assessment		
SAP (mm Hg)	Mean ± SD	132.13±17.675
	Min-max	70-240
HR (bpm)	Mean ± SD	89.77±16.682
	Min-max	54-170
GCS	15-14	648(94.2)
	≤13	40(5.8)
EKG abnormalities		330(15.7)
Gasometrical values		
pH	Mean ± SD	7.4±0.1
	Min-max	6.8-7.6
paO2	Mean ± SD	76.8±37.5
	Min-max	40-217
pCO2	Mean ± SD	30.9±7.5
	Min-max	25-66
HCO3-	Mean ± SD	21.4±5.0
	Min-max	3-35.5
Chest CT lesion extent	50-75%	467(22.20)
	<25%	1339(63.60)
	25-50%	177(8.40)
	>75%	123(5.80)
Oxygen Therapy/Ventilation		
Nasal Cannulas		320 (46.5)
High-Concentration Mask		238 (34.6)
Optiflow		25 (3.6)
Non-invasive Ventilation		231 (33.6)
Intubation		8 (1.2)
ED LOS (days)	Mean ± SD	2.45 ± 2.19
ED mortality		132 (19.2)
In-hospital referral		688(77.2)
ICU need		108 (15.7)
Final Outcome		
Discharge		455 (66.1)
Total in-hospital mortality		233 (33.9)

In a comparative analysis between 688 diabetic and 1418 non-diabetic patients admitted to our emergency department, diabetic individuals tended to be older, while non-diabetics were predominantly male. Moreover, diabetic patients exhibited a higher prevalence of comorbidities (74.1% vs 60.4%), particularly hypertension and renal failure, compared to their non-diabetic counterparts. Symptomatically, diabetics displayed a greater occurrence of respiratory distress such as dyspnea, cough, fever, and fatigue, while non-diabetics reported more issues related to smell and taste. Physiologically, diabetics typically had higher blood pressure levels, whereas non-diabetic patients showed more electrocardiogram abnormalities except for arrhythmias, which were more common in diabetics. Medical complications further distinguished the two groups, with diabetics being more prone to acute renal failure and non-diabetics to respiratory acidosis. Interestingly, imaging findings did not significantly differ between the groups. Treatment-wise, diabetic patients often required higher oxygen flow rates through a high-flow mask and were more likely to need curative and preventive anticoagulation, Calciparin, and antibiotic therapy. The mean and range of emergency department visits were similar between the two groups (p=0.113 and p=0.599, respectively). However, the course of the emergency department hospitalization was less favorable for diabetic patients, with a worsening in diabetic patients (p=0.0001) and a mortality rate of 19.2% compared to 10.4% for non-diabetic patients (p=0.0001). The final outcome showed a higher mortality rate in diabetic patients (33.9%) compared to non-diabetic patients (22.9%) (p=0.0001) (table 2).

In the multivariate analysis, diabetes was associated with up to 1.72 times higher risk of severe or fatal disease when comparing survival and death rates between diabetic and non-diabetic patients (CI95%=1.41-2.10, p=0.001) (table 3).

Discussion

Coronavirus disease (COVID-19), caused by SARS-CoV-2, exhibits a wide spectrum of severity, from asymptomatic to life-threatening respiratory distress. Elderly individuals and those with certain underlying conditions, notably diabetes, face an elevated risk of severe illness and mortality(1,2). Diabetes mellitus is prevalent among COVID-19 patients and is associated with higher rates of hospitalization, ICU admissions, complications, and mortality(3–7). Our study, encompassing 688 diabetic COVID-19 patients, revealed that advanced age, preexisting comorbidities along with clinical indicators are predictive of severity. Comparison with non-diabetic counterparts highlighted that diabetic patients were older with more comorbidities, particularly coronary artery disease , hypertension , and renal failure , and presented with more severe symptoms including dyspnea, cough , fever , and fatigue (8). They also exhibited higher rates of acute renal failure and required more aggressive therapeutic interventions, anticoagulation, and antibiotics. Notably, diabetic patients experienced a significantly higher case fatality rate both in the emergency department and throughout hospitalization, emphasizing the heightened risk associated with diabetes in the.

Table 2: Results of the univariate analysis

			Diabetic patients n= 688 (%)	Non diabetic patients n=1418 (%)	p
Comorbidities			510(74.1)	857(60.4)	0.001
Coronaropathy			117(17.0)	127(9.0)	0.001
Hypertension			436(63.4)	446(31.5)	0.001
CKD			69(10.0)	71(5.0)	0.001
Smoking			107(15.6)	271(19.1)	0.046
		Physical exam			
Dyspnea			545(79.2)	1033(72.8)	0.002
Cough			475(69.0)	910(64.2)	0.027
Fever			379(55.1)	658(46.4)	0.001
Fatigue			477(69.3)	887(62.6)	0.002
Anosmia/Dysgeusia			53(7.7)	169(11.9)	0.003
BP	Mean		132.13±17.675	129.56±15.394	
	Min-max		80-240	90-200	0.001
EKG	Normal		580(84.3)	1137(80.2)	0.022
	Sinus tachycardia		42(6.1)	149(10.5)	
	Repolarization disorders		33(4.8)	65(4.6)	
	Conduction disorders		23(3.3)	51(3.6)	
	Arrythmia		10(1.5)	16(1.1)	
Respiratory acidosis			26(3.8)	64(4.5)	0.001
AKI			198(28.8)	219(15.4)	0.001
Oxygen therapy	HFM		238(34.6)	422(29.8)	0.025
Anti coagulation	No		50(7.3)	151(10.6)	0.007
	Enoxaparin	curative	419(60.9)	850(59.9)	
		preventive	201(29.2)	395(27.9)	
	Calciparin		15(2.2)	11(0.8)	
	HNF		3(0.4)	11(0.8)	
Antibiotherapy	No		67(9.7)	232(16.4)	0.001
	3GC-ofloxacin		363(52.8)	719(50.7)	
	3GC		246(35.8)	455(32.1)	
	Amoxicillin-clavulanic acid		12(1.7)	12(0.8)	
Outcomes	Stable		318(46.2)	604(42.6)	0.001
	Improvement		212(30.8)	575(40.6)	
	Aggravation		158(23)	239(16.9)	
In-hospital referral			351(77.2)	1212(85.4)	0.001
Discharge			25(3.6)	58(4.1)	0.001
Emergency mortality rate			132(19.2)	148(10.4)	0.001
Final outcome	Death		233(33.9)	325(22.9)	0.001
	Discharge		455(66.1)	1093(77.1)	

Table3: Results of the multivariate analysis

	Surviving(%)	Deceased(%)	OddsRatio	IC 95%	P
Age>65	64.5	35.5	5.54	2.07 - 9.10	<10-3
Cardiopathy	64.6	35.4	1.64	1.29-2.09	0.01
Diabete mellitus	65.8	34.2	1.72	1.41 - 2.10	0.01
Choc signs	21.5	78.50	1.32	1.11-2.88	0.01
Glasgow coma score <13	33.9	66.10	2.22	1.71-2.88	0.01
Acidosis	50.9	49.10	1.52	1.37-1.69	0.01
Acute renal failure	49.4	50.60	3.89	3.11-4.87	0.01
Chest CT lesions extent>50%	57.7	42.30	3.88	2.45-6.87	<10-3

context of COVID-19. Multivariate analysis confirmed diabetes as an independent risk factor for severe or fatal disease.

With regard to average age, several studies of the diabetic population reported similar results, with diabetic patients being statistically older than non-diabetic patients(9–11).

Numerous studies have shown advanced age increases the risk of mortality (12–14). In regards to gender, studies show a male predominance(15,16). The male-related severity observed may be attributed to hormone-dependent modulation of ACE2 and TMPRSS2 expression, facilitating SARS-CoV-2 cellular entry, as well as higher prevalence of comorbidities like cardiovascular disease in males(17,18).

When it comes to comorbidities, diabetic patients exhibited higher comorbidity rates across multiple studies, particularly for hypertension and cardiovascular disease (19,20). Our study corroborates these findings, indicating significantly higher rates of hypertension and cardiovascular disease among diabetic patients (p=0.0001).

Numerous studies have highlighted the association between comorbidities and the severity of COVID-19, with diabetes and hypertension being significant predictors of mortality in many cases, with multipliers ranging from 1.2 to 8.96 (21–25).

The initial finger-prick blood glucose levels upon admission in COVID-19 patients have been found to exhibit a range of diabetic decompensations including inaugural diabetes (26–29).

Numerous studies have demonstrated the prognostic significance of glycemic control in COVID-19 patients. Hyperglycemia upon admission is associated with higher mortality rates and increased risk of complications such as acute respiratory distress syndrome(8,28,30).

In our study, diabetic decompensation upon admission was significantly associated with mortality in univariate analysis (p=0.02), consistent with findings from other studies.

The biological data analysis in COVID-19 patients widely reported the presence of lymphopenia (106). Studies have reported varying prevalence rates, ranging from 29.8% to 55.4% in diabetic patients(8,10,31–34). Comparing diabetic and non-diabetic groups, lymphopenia was significantly more prevalent in the diabetic group (8,35).

Gazometric abnormalities, including respiratory alkalosis, respiratory acidosis, and metabolic alkalosis, have been frequently observed in COVID-19 patients. Studies have reported varying distributions of these abnormalities, with respiratory alkalosis being the most common(36–39). However when comparing gazometric values between diabetic and non-diabetic patients, literature results have been inconsistent(19).

Other biological data were analyzed, including renal function, liver function, pancreatic enzymes, and inflammatory markers concluding that the diabetic group had higher rates of AKI compared

to non-diabetics while no statistically significant difference was found in liver function (8,11,12).Elevated inflammatory markers were noted in various studies(32,43,44). Patients with COVID-19 showed higher levels of CRP (p=0.06) and interleukin-6 (IL-6) (p=0.07) compared to non-diabetic patients(35,45).

CT scan findings have reportedly shown more severe lung lesions in diabetic patients(35,44,46–50), however our study did not find a significant difference (p=0.863).

When it comes to oxygenation and ventilation, diabetic patients exhibited higher NIV usage compared to non-diabetics with usage rates ranging from 13.3% to 30.3% across different studies (19,28).Although some studies suggested greater intubation rates in diabetic patients(15), our study found similar rates between the two groups (p=0.944).

Corticosteroid therapy remains controversial in COVID-19 treatment due to concerns about immunosuppression, delayed viral clearance, bacterial infections, and acute hyperglycemia(51,52). Their usage did not significantly differ between diabetic and non-diabetic patients in our study, consistent with findings from previous research(53). However, in diabetic patients, careful monitoring of blood glucose levels is essential due to their hyperglycemic potential (54,55).

Length of hospital stay is an important factor in COVID-19 outcomes, with prolonged stays associated with increased mortality risk(56). Studies differ on this finding , while length of stay was statistically more prolonged in diabetic patients than in non-diabetic patients in some (8,28,57), it was comparable in others(19).

Regarding the outcome of COVID-19, diabetes significantly impacts the prognosis and progression of COVID-19, with studies consistently showing it as one of the most important comorbidities linked to disease severity. Early data from Wuhan, China, and international studies reported a prevalence of diabetes ranging from 12% to 25% in COVID-19 patients, with diabetes being associated with increased morbidity and mortality during previous viral pandemics(8,58).

Diabetes is associated with critical complications of COVID-19, such as acute respiratory distress syndrome (ARDS), the need for ICU admission, mechanical ventilation, and increased mortality rates. Studies comparing diabetic and non-diabetic COVID-19 patients consistently show a higher percentage of severe forms and ICU admissions among diabetics. Additionally, diabetic patients have a higher percentage of mortality following COVID-19 compared to non-diabetic patients(32,33,59–65).

Conclusion

Our study found a substantial increase in the risk of critical COVID-19 infection among individuals with diabetes. The mortality rate was also significantly higher. Therefore, it is crucial to implement customized prevention and control measures to reduce the risk of viral transmission among vulnerable populations, and to tailor in hospital treatments to reduce mortality.

Chatbot use: *An AI program (DeepL write) was used for linguistic correction and improving coherence of the manuscript.*

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The Long-Term Somatic and Psychological Impact of Post-COVID Experience on Infected Patients

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Abstract

Introduction: Many studies have focused on describing the acute phase of COVID-19 infection, but few have addressed the impact of the disease and the potential sequelae it may induce. Survivors of SARS-CoV-2 infection have reported physical and psychological sequelae, ranging from exhaustion to complete functional impairment. The aim of this study was to examine the symptoms experienced by patients affected by COVID-19 post-infection and their associated factors.

Methods: This descriptive longitudinal study involved patients who tested positive for SARS-CoV-2 and contacted EMS 03 between December 1, 2020, and January 31, 2021.

Results: A total of 224 (28.9%) patients were included in the study. The majority of patients continued to experience symptoms in the post-COVID-19 period, with varying durations. Most patients (n=191; 85.3%) exhibited at least one somatic symptom 15 days after the infection, with the percentage decreasing over time. These symptoms ranged from mild discomfort to severe and debilitating complaints. Zinc intake and the duration of remission during the acute phase were identified as independent risk factors associated with persistent symptoms during all follow-up periods. Female gender was found to be an independent risk factor for symptom persistence at 2 months of follow-up.

Conclusion: This study suggests that patients recovering from COVID-19 may manifest multi-systemic symptoms over the long term. Rehabilitation and professional reintegration appear to be crucial, especially for severe COVID-19 survivors.

Keywords: Post-COVID, Long-Term, Psychological impact, Emergency, Outcomes

Introduction

The coronavirus disease 2019 pandemic is a disease linked to the SARS-CoV-2 coronavirus pathogens and is one of the epidemics that have emerged over the last five decades caused by zoonotic viruses; it appeared in November 2019 in Wuhan [1], before spreading around the world to cause a pandemic declared by the WHO on March 11, 2020, either the first pandemic caused by a[2]; on 2021, either one year after the declaration of the pandemic, the cumulative number of cases worldwide exceeded 100 million, including around 2,520,653 deaths (2.2%)[3]. This pandemic also had a disastrous socio-economic impact, with economic growth of -4.4%, compared with the 2.7% growth initially forecast in the 2020 finance law [4];

Since the first case was documented on March 02, 2020, 233 277 cumulative cases and 8051 deaths one year later (3), associated with a huge overload of hospitals and a total saturation of intensive care units, given that acute COVID-19

generally, lasts up to 4 weeks, with an evolution that might involve several complications with variable levels of severity. Beyond this period, the ability of SARS-CoV-2 to replicate has not been proven [5].

Like acute COVID-19, long COVID can have even more harmful clinical, socio-demographic, and economic effects, it can affect multiple organs and systems; these symptoms may appear in both hospitalized and non-hospitalized patients who describe persistent symptoms they are enduring [2]. There is no consensual definition of "long COVID"[6][7]. The literature agrees on using the term "persistent COVID" (Subacute/Ongoing COVID) for symptoms or side effects of COVID-19 that persist for 4 to 12 weeks, while "chronic COVID" or "post-COVID syndrome" (Chronic/Post-COVID) refers to symptoms lasting beyond 12 weeks without any other identifiable cause.

This clinically unspecific syndrome, which is not fully assimilated, needs to be placed in perspective with known and well-defined post-infectious syndromes. This syndrome has yet to be studied in depth, due to a lack of solid evidence concerning its physiopathology. Considering its estimated prevalence, the "long COVID" should be considered as an opportunity to assess the complexity of post-infectious syndromes. In this study, we explore the issue of post-COVID-19 symptoms, commonly referred to as "long COVID" in the literature. Our objective is to study post-COVID-19 symptoms along with their associated factors in patients with COVID-19.

Methods

***Study design**:* We conducted a longitudinal study of the emergency medical services in the Eastern central region of Tunisia over a period of two months (December 2020 to January 2021). EMS manages the pre-hospital medical emergencies. Throughout the coronavirus disease 19 pandemic, a sub-unit was created to receive calls for polymerase chain Reaction (PCR) testing, at the EMS car park.

***Study population and sampling**:* we enrolled all patients who contacted EMS regulation with clinical symptoms related to coronavirus disease 19, confirmed by either a positive PCR or rapid test, between 1st December 2020 and 31st January 2021.

***Data collection**:* Trained research staff collected data through phone calls. Study aims were explained to participants who received assurance regarding data confidentiality. Data was initially collected on the 15th day of infection and subsequently at 1 month, 2 months, and 3 months. A pre-tested questionnaire was used to evaluate socio-demographic characteristics, lifestyle habits, and medical history. The gathered data comprised: age, gender, healthcare occupation, smoking habits, comorbidities, and body mass index (BMI). Additionally, we acquired information about symptoms, prescribed treatments, and recovery process, and evaluated mental health (specifically depression and post-traumatic stress), using validated questionnaires. COVID-19 diagnosis was confirmed through either Rapid Antigen Testing or PCR Testing.

Variable definition: ***Post-coronavirus disease 19 conditions (Long COVID):*** pathological state in which a patient experiences persistent signs or symptoms during or after a COVID-19 infection, which may last for more than four weeks without a clear diagnosis [2][8]. ***Post-traumatic stress disorder (PTSD):*** evaluated by the PCLS [9], includes 17 items; all items are rated on a 5-point Likert scale. Score: From 17 to 33: a low probability of PTSD. More than 44: confirmed PTSD**.** ***Depression:*** assessed with the MDI scale, as suggested by the WHO. It contains 10 items rated on a 6-point Likert scale [10]. The scale score ranges from zero to 50 and higher scores indicate a high level of depression.

A score of 31 or higher indicates severe depression.

Statistical analysis: data analysis was performed using the SPSS statistical package. Continuous variables were described as means ± standard deviations when normally distributed and as medians with their 25th and 75th percentile, when not. Categorical variables were summarized with absolute and relative frequencies. In univariate analysis, we compared categorical variables using chi-square and Fisher's exact tests. We compared continuous variables using the Student t-test and the Mann-Whitney U-test. Logistic regression with the stepwise method of Hosmer and Lemeshow was used to identify independent predictors of post-coronavirus syndrome.

The logistic regression model has included variables whose univariate test value was less than 0.20. Relative risk (RR) and 95% confidence interval (CIs) were calculated and presented to estimate the risk factors. We defined statistical significance at p-value < 0.05.

Ethical considerations: The study population was informed of the objectives of the survey. Oral and informed consent was obtained from the participants. The anonymity of the patients was respected.

Results

A total of 224 patients were included, with a median age of 43 years [33, 58] and with extremes ranging from 15 to 85 years. More than half of the patients were female, with a sex ratio of 0.8**.** ***(Table 1)***

The majority of our patients remained symptomatic after 15 days of coronavirus disease 19 (85.3%), although the duration of their symptoms varied; in fact, 71% and 62.5% had at least one symptom after 2 and 3 months of infection, respectively (the time of PCR positivity). *(Figure 1).*

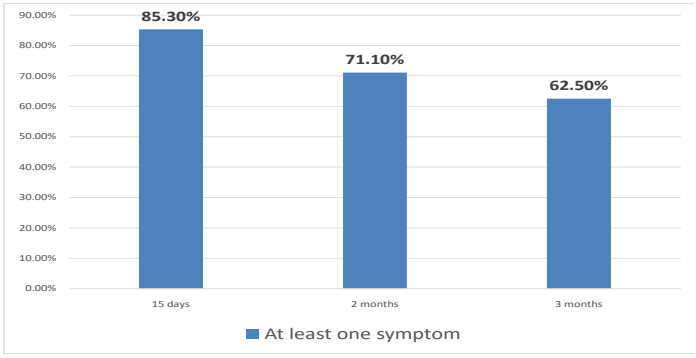

Figure 1: Evolution of somatic symptoms among patients with a COVID-19 infection

The most common systemic symptoms reported by patients were asthenia (25.7% at 3 months), musculoskeletal pain (17.9% at 3 months), and anorexia (5% at 3 months).

Table 1: Socio-demographic characteristics and different patients' treatment with coronavirus disease 19 infections between 01 December 2020 and 31 January 2021

Characteristics		n	%
Age**med[IQ]***		*43 [33.0;58.0]*	
Gender	**Male**	*100*	*44.6*
	Female	*124*	*55.4*
Governorate	**Sousse**	*205*	*91.5*
	Monastir	*006*	*02.7*
	Mahdia	*013*	*05.8*
Comorbidities	**None**	*118*	*52.7*
	Hypertension **	*028*	*12.5*
	Diabetes	*022*	*09.8*
	Dysthyroid	*008*	*03.6*
	Dyslipidemia	*007*	*03.1*
	Asthma	*007*	*03.1*
	Psychiatry	*007*	*03.1*
Life habits	**Current smoker**	*036*	*16.1*
	Smoking cessation	*019*	*08.5*
BMI*****med[IQ]***		*22.55 25.19]*	*[20.22;*
Treatment received	**Vit C**	*174*	*84.1*
	Vit D	*153*	*79.9*
	Zinc	*151*	*73.3*
	Azithromycin	*138*	*66.7*
	LMWH	*044*	*21.3*
	Corticoids	*037*	*17.9*
	Intra venous antibiotic	*028*	*13.5*
	Paracetamol	*082*	*39.6*
	Famotidine	*017*	*08.2*
	other	*037*	*18.0*

Regarding cardiopulmonary symptoms, dyspnea was the most frequent (32.1% at 3 months), whereas only 4.6% of patients reported coughing at 3 months. Palpitations and chest pain were noted for 18.1% and 11.5% of patients respectively at 3 months. Regarding neuropsychiatric symptoms, memory, concentration, and sleep problems were reported by several patients, at rates of 36.7%, 16.9%, and 16.9% respectively after 3 months. Headaches were comparatively less frequent at 11.9% after 3 months. Additionally, depression and post-traumatic stress disorder were diagnosed in 6.9% and 5% respectively after 3 months. Patients also reported ENT symptoms of anosmia and ageusia at 8.2% and 5%, respectively, after 3 months. The incidence of gastrointestinal symptoms was minimal, with only 14.4% of patients registering such complaints at 2 months and 13.1% at the 3-month follow-up *(Table 2).*

We examined the factors linked with symptom persistence following COVID-19 infection. Our analysis identified that persisting symptoms for at least two months after infection correlated with being female (p=0.039), having at least one comorbidity (p=0.010), having a previous history of psychiatric illness, and a longer time to remission (p=0.014). The study investigated the effectiveness of various treatments in managing COVID-19 symptoms. The tested treatments included azithromycin (p=0.005), vitamin C (p=0.021), vitamin D (p=0.039), Zinc (p=0.000), and low molecular weight heparin (LMWH) (p=0.015). After three months of infection, the persistence of one or more symptoms was linked to the presence of comorbidities (p=0.001), a history of psychiatric illness (p=0.037), and time to remission (p=0.004) **(**Table 3). Univariate analysis of the persistence of at least one. The multivariate analysis showed that the independent risk factors associated with the persistence of at least one symptom after 2 months were: zinc intake (p=0.015), female gender (p=0.015), and time to remission (p=0.030) symptom among patients with Coronavirus disease infection)

At 3 months, the factors identified were zinc intake (p=0.018) and time to remission, which was also associated with the persistence of symptoms during the three months of follow-up (p=0.012) *(Table 4).*

Table 2: Evolution of the different symptoms in patients with a COVID-19 infection during the period from 01st December 2020 to 31st January 2021

		At 15 days (%)	At 2 months (%)	At 3 months (%)
No symptoms		033(14.7)	065 (29.0)	084 (37.5)
At least 1 symptom		191(85.3)	159 (71.0)	140 (62.5)
General symptoms	*Asthenia or fatigue*	144 (64.6)	077 (34.4)	056 (25.7)
	Anorexia	079 (35.6)	021 (09.5)	011 (05.0)
	Weight loss	061 (27.6)	011 (05.0)	008 (03.6)
	Myalgia	056 (25.6)	044 (20.2)	039 (17.9)
	Hair loss	017 (07.8)	020 (09.2)	019 (08.8)
Respiratory symptoms	*Dyspnea*	130 (58.3)	086 (38.4)	070 (32.1)
	Palpitations	061(28.0)	054 (24.8)	039 (18.1)
	Cough	058 (26.0)	014 (06.3)	010 (04.6)
	Chest pain	035 (16.1)	031 (14.2)	025 (11.5)
Neurological symptoms	*Memory problems*	092 (42.0)	086 (39.4)	080 (36.7)
	Trouble concentrating	082 (37.1)	073 (33.3)	065 (29.7)
	Troubles sleeping	074 (33.5)	056 (25.5)	037 (16.9)
	Headaches	073 (33.2)	039 (17.7)	026 (11.9)
Digestive symptoms	*Digestive disorders*	047 (21.3)	032 (14.4)	029 (13.1)
	Dysphagia	014(06.3)	09(04.1)	006 (02.7)
ENT symptoms	*Anosmia*	071(32.0)	27(12.2)	018 (08.2)
	Ageusia	053(23.7)	17(07.7)	11 (05.0)
	Dysphonia	035(15.7)	14(06.3)	11 (05.0)
SPUPD		033(14.9)	27(12.2)	25 (11.4)
Psychiatric symptoms	*PTSD possibly probable*	____	194(86.6)	199 (90.9)
	PTSD or other anxiety disorders are quite likely	____	012(05.4)	009 (04.1)
	PTSD confirmed	____	013(05.8)	011 (05.0)
	Depression	033(15.0)	014(06.4)	015 (06.9)
Time to PCR		003 [02; 04]	003[02; 04]	003 [02; 04]
Time to remission		010 [10;15]	13[10;15]	010 [10;15]

SPUPD: polyurea-polydipsic syndrome; **PTSD**: post-traumatic stress disorder

Discussion

Several studies have documented the persistence of COVID-19 sequela and symptoms after its acute phase [1][2]. These studies were difficult to compile due to the wide variability in the patients surveyed, the duration of follow-up after the acute episode, and symptom collection methods.

Table 4: Multivariate analysis of persistence of at least one symptom among patients with COVID-19 infection between 01 December 2020 and 31 January 2021

		p	ORa	[IC95%]
In 15 days	Zinc intake	0.001	4.4	[01.85; 10.62]
	Remission delay	0.021	1.2	[01.30; 01.54]
In 2 months	Zinc intake	0.001	3.2	[01.59; 06.50]
	Gender (female)	0.015	2.2	[01.18; 04.35]
	Remission delay	0.030	2.8	[01.10; 07.56]
In 3 months	Zinc intake	0.018	2.1	[01.13; 03.90]
	Remission delay	0.012	1.1	[01.02; 01.20]

In our study, as in many others worldwide, we found that the majority of patients retained at least one symptom after 1 month (79.5%), this prevalence decreased throughout follow-up. Nevertheless, our patients retained at least one symptom even after three months [11].

However, the severity of the clinical presentation during the acute phase seems to be associated with the prevalence and duration of symptom persistence, which can last up to 9 months [12][13]. The severity of the initial clinical presentation may

Table 3: Univariate analysis of the persistence of at least one symptom among patients with COVID-19 infection between 01 December 2020 and 31 January 2021 (Part1)

Characteristics		In 15 days			In 2 months			In 3 months		
		No symptom n (%)	At least one symptom n(%)	p	No symptom n (%)	At least one symptom n(%)	P	No symptom n (%)	At least one symptom n(%)	p
Age		44 [25.0,75.0]	43 [33.0,43.0]	0.956	39.5 [28,3;58,0]	43.0 [33.0 ;57.0]	0.513	39.0 [34.0 ;57.8]	44.0 [34.0 ;57.8]	0.519
Gender	*Male*	017(48.5)	083(43.5)	0.390	036(55,4)	064(40.3)	**0.039**	041(48.8)	059(42.1)	0.331
	Female	108(87.1)	016(12.8)		029(44,6)	095(59.7)		043(51.2)	081(57.9)	
Healthcare staff		009(28.1)	036(18.8)	0.265	014(21,9)	030(18.9)	0.610	021(25.3)	023(16.4)	0.108
Comorbidity	*At least one*	011(33.3)	095(49.7)	0.081	022(33,8)	084(52.8)	**0.010**	028(33.3)	078(55.7)	**0.001**
	Hypertension	006(18.2)	035(18.3)	0.984	009(13.8)	033(20.8)	0.229	013(15.5)	029(20.7)	0.331
	Diabetes	003(09.1)	023(12)	0.846	006(09.2)	021(13.2)	0.407	006(07.1)	021(15)	0.080
	Dysthyroid	001(03)	008(04.2)	0.750	002(03.1)	008(05.1)	0.516	003(03.6)	007(05)	0.609
	Asthma	000(00.0)	009(04.7)	0.089	001(01.5)	008(05)	0.187	001(01.2)	008(05.7)	0.095
	Psychiatric illness	000(00.0)	007(03.7)	0.264	000(00.0)	007(04.4)	**0.027**	000(00.0)	007(05)	**0.037**
Life hab	*Non-smoker*	012(63.2)	117(70.9)	0.485	030(75)	099(68.8)	0.445	044(78.9)	085(66.4)	0.097
	Current or severe smo	007(36.8)	048(29.1)	0.485	010(25)	045(31.3)		012(21.4)	043(33.6)	0.097
	Current smoker	003(15.8)	033(20)	0.661	006(15)	030(20.8)	0.411	008(14.3)	028(21.9)	0.232
BMI		21,6 [19,5; 25,3]	22,6 [20,3; 25,3]	0.658	22.5 [20,5 ;25,0]	22.6 [20.2 ;25.4]	0.950	22.2 [20.1 ;24.8]	22.8 [20.2 ;25.7]	0.322

BMI: body mass index**:** arterial Hypertension **LMWH:** low molecular weight heparin **ATB:** Intravenous antibiotic

Table 3: Univariate analysis of the persistence of at least one symptom among patients with COVID-19 infection between 01 December 2020 and 31 January 2021 (Part2)

		In 15 days			In 2 months			In 3 months		
Time to PCR		002 [02; 04]	003 [02; 04]	0.336	03.0 [2,0 ;4,0]	03.0 [2.0 ;4.0]	0.331	03.0 [02.0 ;04.0]	03.0 [02.0 ;04.0]	0.958
Time to remission		10 [10.0,10.0]	10 [10.0,15.0]	**0.004**	13.0 [10,0 ;15,0]	**0.007**		10.0 [10.0 ;14.0]	13.0 [10.0 ;15.0]	**0.004**
Hospitalized		002(06.1)	031(16.2)	0.095	0.05(07.7)	028(17.6)	0.057	008(09.5)	027(19.3)	0.051
Treatment received	*None*	009(29)	006(03.1)	**$<10^{-3}$**	012(19)	003(01.9)	**$<10^{-3}$**	012(14.6)	003(02.1)	**$<10^{-3}$**
	Azithromycin	011(35.5)	127(66.5)	**0,001**	030(47.6)	108(67.9)	**0.005**	048(58.9)	090(64.3)	0.394
	Paracetamol	006(19.4)	076(40)	**0.027**	019(30,6)	063(39.6)	0.215	026(32.1)	056(40)	0.241
	Vit C	018(58.1)	156(81.7)	**0.003**	043(68.3)	131(82.4)	**0.021**	059(72)	115(82.1)	0.075
	Vit D	014(54.2)	139(72.8)	**0.002**	037(58.7)	116(73)	**0.039**	053(64.6)	100(71.4)	0.291
	Zinc	011(35.5)	140(73.7)	**$<10^{-3}$**	029(46)	122(77.2)	**$<10^{-3}$**	047(57.3)	104(74.8)	**0.007**
	LMWH	002(06.5)	042(22)	0,044	006(9.5)	038(23.9)	**0.015**	009(11)	035(25)	**0.011**
	Corticoids	003(09.7)	034(17.8)	0.260	007(11.1)	030(18.9)	0.162	009(11)	028(20)	0.082
	IV ATB	001(03.2)	027(14.1)	0.052	005(07.9)	023(14.5)	0.186	007(08.5)	021(15)	0.162
	Famotidine	001(03.2)	016(08.4)	0.269	004(06.3)	013(08.2)	0.644			
Evolution							006 (07.3)	011 (07.9)	0.884	
Improvement		032 (97)	185(96.9)	0.973	063(96.9)	154(96.9)	0.979	082(97.6)	135(96.4)	0.620

contribute to the persistence of symptoms, as shown by certain studies which have found that hospitalized patients, in comparison with those who received ambulatory treatment, retain sequela in around 50% of cases, even after 6 months of evolution [14][15][16].

Our results, like previous studies, suggest that long-term coronavirus disease can be represented by a wide range of physical and psychological symptoms [17], with varying frequencies from one study to another [18]. We were able to identify over 20 somatic symptoms, with the most persistent ones reported being: asthenia, dyspnea, concentration, and memory problems, and others less frequently reported such as sleep disturbances, anorexia, palpitations, headaches; were asthenia, dyspnea, concentration, and memory problems, while others less frequently reported were sleep disorders, anorexia, palpitations, headaches, digestive disturbances, anosmia, anorexia, cough, chest pain, joint pain, loss of taste, dysphonia, weight loss, and dysphagia [18][19][20]. Therefore, the "long Covid", as shown by our study, was essentially manifested by persistent asthenia, dyspnea, but also concentration and memory disorders, raising questions among several authors regarding the relationship between post-COVID asthenia and chronic fatigue syndrome (CFS), which has been defined as a different clinical syndrome, although the symptoms are very similar [21][22]. CFS is often due to an impairment of cardiac, pulmonary, or renal function [23]. Therefore, for patients suffering from persistent and debilitating fatigue following COVID-19, documented organ

damage may be a plausible explanation for their fatigue. Therefore, more detailed longitudinal studies evaluating both symptoms and physiological function are required. In our study, the second most frequently reported symptom was dyspnea. We found a prevalence of 50.2% at 1 month, 38.4% at 2 months, and 32.1% at 3 months. Existing data, although limited, reported that exertional dyspnea without hypoxemia was found, according to some studies, in 15% to 40% of patients with mild-to-moderate COVID-19 nearly 3 months after recovery [11][24]. This persistent dyspnea was significantly correlated with younger age, a more severe form of COVID-19, and the diagnosis of a pulmonary embolism complicating COVID-19[25]. In addition to the symptoms described above, neuropsychiatric manifestations were widely reported by patients in post-COVID. In our study, several symptoms such as memory, concentration, and sleep disorders persisted among patients. Intense headaches, sometimes resistant to treatment, were also reported at a lower frequency. This may be attributed to the neuroinvasive effect of coronaviruses, which can cause further inflammation and neurodegeneration. Coronaviruses can cause demyelination, neurodegeneration, and cellular senescence [26], which accelerates cerebral aging and worsens neurodegenerative pathology [27][28]. These neuropsychiatric manifestations can also be seen following viral infection or may

be due to the host's immune response [29]. It is only during the acute phase that the neuro-invasive properties of SARS-CoV-2 can lead to the senescence of various CNS cell types [28]. Our results indicated that being female is associated with symptom persistence (OR=2.26; p=0.015). This has been proven in the literature, especially regarding the persistence of anxiety, depression, and poor sleep quality [30]. However, other factors may be involved, such as young age, rural area of residency, previous functional limitation, smoking, history of high blood pressure, and, above all, duration of hospitalization[18][31]. In our study, as in others, the delay to remission also appears as a factor associated with the persistence of symptoms after 1 month (OR=1.18; p=0.01), after 2 months (OR=2.89; p=0.030) and even after 3 months (OR=1.108; p=0.012)(19). Zinc sulfate intake was also associated with the persistence of symptoms after 1 month (OR=3.44; p=0.001), after 2 months (OR= 3.21; p=0.001), and after 3 months of follow-up (OR= 2.09; p=0.018). No published study has shown a direct association between the persistence of symptoms and the use of zinc sulfate during the acute phase of COVID-19 infection [32]. At the onset of the pandemic, patients started to overuse treatments such as vitamins, Zinc, and azithromycin, mostly without medical advice. This suggests that patient complaints may be more related to treatment side effects. Given the limited therapeutic options for the prevention and treatment of occasionally severe acute viral infections, further research is required to better understand the action mechanisms of zinc, routes of administration, formulations; optimal doses [32], as well as the earliest time at which zinc should be administered following an acute infection and the duration of this therapy [33].

This study is among the first ones to examine the experience of patients in the post-infection period with COVID-19 in our region. It is distinguished from other studies by its regular follow-up from 15 days after the PCR to 3 months afterward. Many early descriptive studies concerning COVID-19 focused on severe forms among hospitalized patients. Data on outpatients, and their long-term evolution, are more limited. This study included outpatients with mild-to-moderate acute infections as well as hospitalized patients. Our study highlighted a broad range of clinical manifestations reported in post-COVID-19 infection, with respiratory, systemic, and cognitive signs in the first place. As a result, the manifestations of long-term COVID-19 must be detected and treated in optimum time. However, the limitations remain essentially logistical, related to the difficulties of reaching patients by phone; many of the forms missing information; the calls were time-consuming, redundant, and required concentration and effort from the patient, with many of them abandoning the follow-up. We limited this study to a 3-month follow-up, even though, according to the literature, coronavirus disease 19 can persist for up to 1 year or more. Also, we limited the sample to patients contacting the EMS, which may lead to a

selection bias. The questionnaires used were written in French and English, which means that the filling-in of these forms by a different person in Arabic might generate a certain semantic and suggestion bias.

Conclusion

Gaining insight into long COVID provides a chance to improve outcomes for all patients with related conditions. This is why further investigations to understand the mechanisms, risk factors, prognosis, and characteristics of at-risk groups are needed to identify potential therapies for long-term coronavirus disease 19. In addition, several researchers have also noted that research investigating long COVID has so far excluded children and pregnant women. The examination of long COVID among these at-risk populations is essential. At present, rehabilitation and professional reintegration seem to be crucial, especially for severe COVID-19 survivors. “Long COVID” should not fall through the cracks".

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Mortality in Pediatric Intensive Care

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Abstract

Background: Mortality in pediatric intensive care units is a major concern in critical care medicine given the unique physiological and clinical complexities in pediatric patients. Understanding the causes and complications associated with mortality is essential to improve patient outcomes.

Aim: This study aims to evaluate the mortality profile in a pediatric intensive care unit by identifying the main causes of death and associated complications. The objective is to better understand the contributing factors to mortality in order to improve clinical management and care strategies.

Methods: We conducted a retrospective descriptive study including all patients who died in the pediatric intensive care unit at Hedi Chaker University Hospital in Sfax over a one-year period, from September 2023 to September 2024. Demographic data, clinical characteristics, underlying conditions, treatments received, and complications were collected and analyzed.

Results: A total of 41 deaths were recorded, resulting in a mortality rate of 14.08%. The highest mortality was observed in spring (21.8%) and summer (18.18%). The median age of deceased patients was 15.4 months, ranging from 7 days to 11 years, with males representing (65.9%). Most children lived in urban areas (75.6%), and 46.3% came from socioeconomically disadvantaged backgrounds. Underlying conditions were present in 26.8% of patients, and 36.6% were born to consanguineous parents. More than half (51.2%) were referred from pediatric wards. Mechanical ventilation was used in 90.2% of cases, and vasoactive drugs in 70.7%. The most common complications were cardiovascular (68.3%), metabolic (56%), hematological (56%), respiratory (46.3%), infectious (43.9%), and neurological (26.8%). Infectious causes were the leading cause of death (26.82%), including severe acute bronchiolitis (14.63%) and malignant pertussis (22%). Congenital heart diseases accounted for 7.31% of deaths.

Conclusions: This study highlights the principal causes and complications associated with pediatric mortality in intensive care. These findings provide important insights for improving risk stratification, optimizing care strategies, and ultimately reducing mortality in critically ill children.

Keywords: Child mortality, Intensive care units, Pediatrics, Risk factors, Retrospective studies.

Introduction

The study of mortality in pediatric intensive care is a crucial issue in critical care medicine, given the pathophysiological and clinical specificities of children. Thus, children's health remains a major priority for healthcare structures, requiring adapted protocols and continuous improvement of practices in pediatric intensive care. According to the World Health Organization (WHO), global infant mortality reached a historically low level in 2022, with 4.9 million deaths of children under the age of five, representing a 51% reduction since 2000[1]. However, disparities persist, particularly in sub-Saharan Africa[2], where infant mortality remains high. The pediatric mortality rate is a key indicator reflecting a country's level of social and economic development. Analyzing these rates helps assess the population's health status and evaluate the quality of care provided. Thus, the pediatric intensive care unit plays a crucial role in delivering specialized critical care to children in life-threatening conditions, thereby increasing their chances of survival[3]. In Tunisia, child health indicators, particularly under-five mortality and neonatal mortality, have significantly improved over the past decade[4].A better understanding of the circumstances and causes of mortality in pediatric intensive care will enhance patient assessment and management, thereby optimizing their short- and medium-term prognosis.

Methods

We conducted a retrospective and descriptive study on all pediatric patients who died in the intensive care unit (ICU) of Hedi Chaker Hospital between September 2023 and September 2024. The unit includes eight beds equipped with multiparametric monitors and ventilators. Medical coverage is ensured around the clock by a rotating team of physicians and nurses.

The study included all children who were hospitalized and died in our pediatric intensive care unit during the study period. Data were collected using a standardized form including demographic, clinical, and hospitalization information (age, sex, socio-economic status, origin, medical history, admission pathway, and reason for admission).

Patients were admitted through various sources, including the pediatric emergency department, other hospital wards, postoperative units, and external referrals. Clinical condition at admission, main investigations, treatments administered, and major complications were documented.

Mortality was analyzed in terms of frequency, seasonality, timing, and underlying causes. Data analysis was performed using SPSS version 20, with descriptive statistics applied to both qualitative and quantitative variables.

Results

During the study period from September 2023 to September 2024, a total of 291 children were admitted to the pediatric intensive care unit of Hedi Chaker Hospital, with 41 recorded deaths, corresponding to an overall mortality rate of 14.08%.

The median age of the deceased patients was 15.4 months (range: 7 days to 11 years), and 82.9% were under two years of age. Males accounted for 65.9% of the cases, with a male-to-female ratio of 1.9. Among these patients, 75.6% came from urban areas, 46.3% belonged to a low socio-economic background, and 36.6% were born to consanguineous parents. Pre-existing conditions were identified in 26.8% of cases, including chronic respiratory diseases (40%), congenital heart disease (20%), prematurity (20%), neurological diseases (10%), and autoimmune diseases (10%). No history of previous surgery was reported.

The majority of patients (52.9%) were admitted to the unit within 2 to 12 hours following referral. The main sources of admission were pediatric departments (51.2%), pediatric emergencies (24.4%), and transfers from other hospitals (19.5%). The average duration of illness before admission was 7.8 days (range: 1 to 30 days). Admission was for medicalreasonsin 97.6% of cases (n=40).

Reported reasons for admission included respiratory distress (51.2%), multiple combined organ failures (17.07%), and cardiocirculatory arrest (9.8%). At admission, respiratory instability was observed in 68.3% of cases, while neurological and cardiocirculatory instability were present in 34.14% of patients (Figure 1). Laboratory results revealed anemia in 48.8% of children, thrombocytopenia in 17.1%, leukopenia in 9.8%, hyponatremia in 29.3%, hypernatremia in 7.3%, hypokalemia in 26.8%,

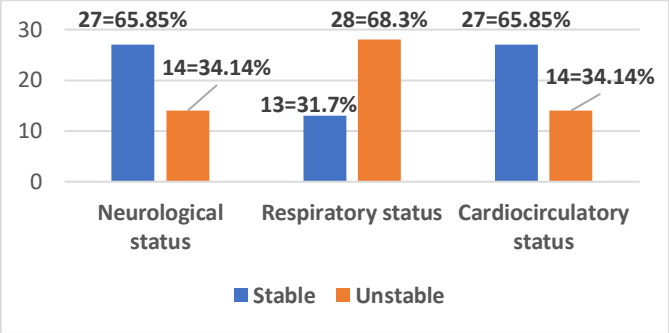

Figure 1: Clinical condition of patients upon admission.

hyperkalemia in 17.1%, metabolic acidosis in 36.8%, respiratory acidosis in 15.8%, renal

failure in 22%, liver cytolysis in 29.3%, and low prothrombin levels in 14.6%. Radiological exams included chest X-rays in 51.2% of patients, with abnormalities noted in 80.95%, such as thoracic distension, cardiomegaly, alveolar syndromes, bronchial syndromes, atelectasis, pneumonia, and pneumothorax. Transthoracic echocardiography was performed in 21.95% of cases. Brain CT scans were done in 21.95% and showed abnormalities in 55.5%, including subdural hematoma, cerebral venous thrombosis, cerebral edema, brain herniation, and cortico-subcortical atrophy. Brain MRIs were performed in 7.3% of cases and revealed cerebral atrophy, suppurative compartmentalized meningitis, and cerebral edema.

Regarding management, 68.3% of the patients required immediate intubation, and 90.2% were placed on mechanical ventilation (Table 1).

Hemodynamic support was necessary in 70.7% of cases, with the administration of adrenaline (41.4%), norepinephrine (39%), and dobutamine (24.3%). Antibiotic therapy and sedation were each administered in 92.7% of cases. Blood

transfusion was given to 48.8%, anticonvulsants to 19.5%, corticosteroids to 17.1%, and exchange transfusion was performed in 9.7%. Central venous access was placed in 75.6% of patients, urinary catheterization in 70.7%, gastric tubing in 95.1%, and chest drainage in 7.3%.

Table 1: Distribution of the population based on the type of ventilatory support.

Ventilatory support	Number	Percentage (%)
Intubation	28	68.3
NIV followed by intubation	2	4.9
Tracheostomy	1	2,4
High-flow [Airvo] followed by intubation	6	14.6
Low-flow oxygentherapy	1	2,4
Nasal cannula	3	7.3
Total	34	100,0

Complications were recorded in several domains: cardiocirculatory (68.3%), metabolic (56%), hematological (56%), infectious (43.9%), respiratory (46.3%), and neurological (26.8%). We have detailed all the complications in the following table(2).

Deaths occurred throughout the year, with seasonal peaks observed in spring (21.8%) and summer (18.18%). A significant proportion of deaths (43.9%) occurred during on-call hours (between 8 PM and 8 AM). The length of hospitalization ranged from 24 hours to 40 days, with an average stay of 11 days; five patients died within the first 48 hours. Most patients (48.78%) died after 48 hours to 14 days of hospitalization. The initial causes of death included infectious diseases (26.82%), severe acute bronchiolitis (14.63%), malignant pertussis (22%), and congenital heart disease (7.31%) (Table 3). Immediate causes of death were primarily multiorgan failure (34.1%) and septic shock (26.8%).

Table 2: Distribution of the population according to different complications.

Type of complication	Complications	Number	Percentage (%)
Respiratory	ARDS (acute respiratory distress syndrome)	*6*	*14.6*
	Ventilatory disorder	*7*	*17*
	Pneumothorax	*4*	*9.7*
	Pulmonary Hypertension (PH)	*5*	*12.2*
	Pleurisy	*3*	*7.3*
Infections	Sepsis	*4*	*9.7*
	Healthcare-associated infection	*11*	*26.8*
	Ventilator-associated pneumonia (VAP)	*3*	*7.3*
Metabolic	Renal failure	*13*	*31.7*
	Hyperglycemia >1.8g/l	*3*	*7.3*
	Hypoglycemia <0.6 g/l	*2*	*4.87*
	Hypokalemia < 3.5 mmol/l	*4*	*9.75*
	Hyperkalemia > 5.5 mmol/l	*2*	*4.87*
	Hyponatremia < 135 mmol/l	*3*	*7.3*
	Hypernatremia > 145 mmol/l /Hypercalcemia > 2.75 mmol/l	*1*	*2.4*
	Hepatic-cytolysis	*9*	*21.9*
Cardiovascular	Recovered cardiac arrest (ACR)	*13*	*31.7*
	Septic shock	*12*	*29.2*
	Cardiogenic shock	*3*	*7.3*
	Venous thrombosis	*2*	*4.8*
	Hypertensive crisis	*2*	*4.8*
Neurological	Status epilepticus	*9*	*21.9*
	Confusion	*1*	*2.4*
Hematologic disorder	Anemia	*18*	*43.9*
	SAM/DIC/Alveolar hemorrhage	*1*	*2.4*
	Thrombocytopenia	*5*	*12.2*
Pressure ulcers		*2*	*4.8*

Table 3: Analysis of Causes of Death

Causes of death	*N*	Percentage (%)
Infectious diseases	12	26.82
Severe acute bronchiolitis	6	14.63
Malignant pertussis	9	22
Respiratory causes	2	4.87
Congenital heart diseases	3	7.31
Congenital conditions	1	2.43
Neurological diseases	2	4.87
Liver diseases	2	4.87
Surgical conditions	1	2.43
Others	4	9.75
Total	41	100

Discussion

The mortality rate in pediatric intensive care units (PICU) is an essential indicator of the quality and efficiency of care. In our study, the mortality rate was 14.08%, which shows a significant improvement compared to earlier rates in our department: 34.4% in 2019 and 20.4% in 2020. However, despite this reduction, the mortality rate remains high, primarily due to limited resources, a challenge that is common in developing countries[5]. These resource constraints significantly affect patient outcomes, as seen in other studies conducted in similar settings.

A significant issue in our unit is the lack of resources, such as dialysis and extra-corporeal-membrane-oxygenation (ECMO), which limits our ability to treat critically ill patients. Infections related to care, particularly hospital-acquired infections, are exacerbated by a lack of essential medical equipment. Furthermore, transfers from other hospital departments introduce additional pathogens, contributing to increased mortality.

Our unit does not practice patient selection when PICU beds are available, meaning all children requiring intensive care are admitted regardless of severity. This approach may impact mortality rates but ensures that all children have access to the care they need.

Across many developing countries, the PICU mortality rate remains high and varies widely, ranging from 8% to 40%[10,12]. This is often due to limited access to healthcare, insufficient medical equipment, and delays in patient management[13,14]. For example, in Ethiopia, a study found the highest mortality rate at 41.7%. Other studies conducted in India, Pakistan, and Côte d'Ivoire also highlight similar challenges with high mortality rates in PICUs (Table 4). These countries struggle with the lack of specialized healthcare infrastructure, shortages in trained medical personnel, and the inability to provide comprehensive treatment. Additionally, high rates of infectious diseases, malnutrition, and socioeconomic disparities further contribute to the high mortality[15].

To reduce mortality, it is crucial to invest in improving healthcare infrastructure, equipping PICUs with necessary medical resources, and providing specialized training to healthcare staff. In contrast, developed countries report significantly lower mortality rates in PICUs. The availability of advanced medical equipment and specialized care has led to a steady decrease in mortality rates over time. In the United States, mortality rates range from 1.85% to 3.38%, and

countries like Sweden have reported as low as 1.1%. These countries benefit from well-established healthcare systems that provide timely and efficient care, which directly improves patient outcomes. Moreover, the use of advanced technologies such as ECMO, dialysis, and other critical interventions in these regions contributes to lower mortality rates.

Table 4: Comparison of Pediatric Intensive Care Unit (PICU) Mortality Rates Between Developing and Developed Countries

Study	Developing Country	Year	Mortality Rate [%]
El Halal at al [16]	**Brazil**	2002-2005	10.3
Dendir et al [10]	**Ethiopia**	2018-2020	41.7
Daher et al [7]	**Amman, Jordan**	2015-2020	6.7
Valavi et al [19]	**Iran**	2017	16.5
Josiane et al [21]	**Ivory Coast [Côte d'Ivoire]**	2019-2021	15.5
Nguefack et al [23]	**Cameroon**	2010-2014	16.6
Punchak et al [25]	**Mozambique**	2013	25
Siddiqui et al [27]	**Pakistan**	2007-2012	12.9
Burns et al [17]	**United States**	2010	2,39
Pollack et al[18]	**United States**	2014	2
Moynihan et al [8]	**Australia and New Zealand**	2006-2016	2.6
Larsson et al [20]	**Sweden**	2008-2012	1.1
Ishihara et al [22]	**Japan**	2014-2017	2.1
Ten Berge et al[24]	**Amsterdam, Netherlands**	2000-2005	4.6
Botan et al [26]	**Ankara, Turkey**	2015-2019	9.13
Li et al [28]	**China**	2015	4.9

The median age in our study was 15.4 months, with 82.9% of deaths occurring in children under 2 years, including newborns. Similar trends were observed in studies from India[6], Jordan[7], and Australia[8], where infants had the highest mortality rates. Infants are particularly vulnerable due to the immaturity of their immune and organ systems, requiring specialized care that poses risks.

In our study, 46.3% of deaths occurred in patients from low socioeconomic backgrounds. Additionally, 26.8% had underlying medical conditions, a factor associated with increased mortality[7,9,10]. Comorbidities complicate health management, leading to more frequent complications and worse outcomes.

The higher incidence of congenital abnormalities in our study, linked to consanguinity (36.6%), may also contribute to increased mortality, as in the study of Benkou and al [11]. Public and healthcare professional awareness is needed to improve prevention.

Our study found that the highest mortality rates were observed in the spring (21.8%) and summer (18.18%), despite the highest number of admissions occurring in the winter. This discrepancy can be explained by the nature of the admissions: winter admissions are mainly related to bronchiolitis, which typically has a favorable prognosis and low mortality. In contrast, the spring and summer months saw more severe cases that contributed to higher mortality rates such as neurological-diseases. In many developing countries, seasonal outbreaks of infectious diseases like malaria or respiratory infections exacerbate mortality. For example, in Niger, the rainy season leads to a surge in malaria cases, significantly increasing PICU admissions and mortality[29]. Similarly, in France, the winter flu season is associated with higher PICU

admissions and mortality, particularly in vulnerable populations[30].

In our study, the average length of stay in the PICU before death was 11.25 days, which is higher than the median lengths reported in other studies[31,32]. This prolonged stay is often associated with severe underlying conditions such as multiple organ failure, severe infections, or unresponsive conditions to initial treatments. Prolonged stays in the PICU are a significant risk factor for increased mortality[10,19], as children often experience complications like nosocomial infections, metabolic imbalances, and physical deterioration caused by prolonged use of medical devices. Additionally, prolonged hospitalizations may reflect poor prognoses and progressive organ dysfunction, further increasing the risk of death.

In our study, the majority of deaths occurred between 8:00 PM and 8:00 AM, which aligns with findings from other studies that suggest mortality rates can be influenced by healthcare staff work shifts[33]. This period typically coincides with reduced staffing and limited access to critical resources and emergency medications. During night shifts, fewer medical staff are available, which may affect the quality of care, particularly for patients in critical conditions. Additionally, some medications and diagnostic tests are less accessible during these hours, which can further hinder patient management and negatively impact clinical outcomes.

Infectious diseases were the leading cause of death in our study, accounting for 26.82% of cases. Among these, severe acute bronchiolitis and malignant pertussis were separately analyzed, representing 14.63% and 22% of deaths, respectively. While bronchiolitis generally has a favorable prognosis, during epidemic periods, it can still contribute to significant mortality in our department. Malignant pertussis, however, has a much worse prognosis, with mortality rates exceeding 70%. This emphasizes the importance of vaccination for preventing pertussis, especially in neonates and young infants.

In addition to infections, congenital heart diseases were another significant cause of death in our study, accounting for 7.31% of fatalities. Congenital heart conditions are common in both developing and developed countries and are often associated with high mortality rates. Similarly, other studies have found that cardiac diseases, particularly congenital heart anomalies, are frequent causes of death in PICUs[12,34]. Limited access to pediatric cardiac surgery in developing countries contributes to the higher mortality rates for these conditions.

In our hospital, the absence of a liver transplant program limits our ability to provide critical care for children with severe liver conditions, and this significantly impacts the prognosis of these patients.

Overall, the causes of mortality in PICUs vary between countries depending on factors such as medical infrastructure, the availability of specialized treatments, and the prevalence of specific diseases. In countries with limited resources, infections, malnutrition, and congenital diseases are leading causes of death,

while in developed countries, advanced medical care can reduce the mortality associated with these conditions.

Study limitations

This retrospective study provides valuable insights into pediatric intensive care unit (PICU) mortality and highlights key factors potentially associated with poor outcomes. Its strength lies in the detailed review of real-world clinical data. However, limitations include the incomplete documentation of some medical records and the inherent selection bias of retrospective designs. Moreover, causal relationships cannot be established, emphasizing the need for prospective studies to validate these findings.

Conclusion

Pediatric intensive care is a crucial discipline dedicated to managing children in life-threatening conditions. A thorough understanding of the epidemiological profile of patients admitted to pediatric intensive care units (PICUs) is essential for tailoring interventions to the specific needs of this population. The establishment of dedicated pediatric units, separate from adult services, has significantly improved the quality of care, thereby reducing complications related to intensive care.

A detailed analysis of mortality causes and rates in pediatric intensive care helps optimize therapeutic strategies and strengthen care protocols, ultimately improving patient survival. Identifying mortality risk factors in PICUs is a key step in ensuring high-quality care, maximizing survival chances, and preventing complications. This enables clinicians to adopt targeted approaches adapted to each patient's specific needs.

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Vascular causes of acute ischemic stroke in the pediatric population: The crucial role of imaging

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Abstract

Background: Acute ischemic stroke (AIS) in a pediatric patient is a rare but life-threatening medical emergency. Unlike adults, pediatric strokes result from a diverse array of etiologies, with arteriopathies and cardiac anomalies playing major roles. Given the time-sensitive nature of stroke treatment, prompt identification and rapid imaging in the emergency setting are critical to improving prognosis in pediatric patients. We aimed to enumerate the principal vascular causes of pediatric AIS and to determine the specific contribution of different imaging modalities in the etiological evaluation.
Methods: We conducted a prospective study including all children aged less than 18 years who presented with AIS between January 2020 and December 2024. The study was carried out at Hedi Chaker University Hospital in Sfax.
Results: We included 22 patients (12 boys and 10 girls). Our patients were aged between one month and 9 years. Seven patients underwent ultrasonography with Doppler, seventeen patients underwent magnetic resonance imaging and eleven patients underwent computed tomography angiography. We noted arterial dissection in 8 cases, Moyamoya disease in 8 cases, hypoplasia of the internal carotid artery in 5 cases and fibromuscular dysplasia in one case. Imaging modalities provided critical diagnostic information, with Doppler ultrasound detecting flow abnormalities in arterial dissection and hypoplasia, magnetic resonance imaging delineating vascular occlusions and stenoses, and computed tomography angiography assisting in anatomical assessment. Representative cases illustrated the spectrum of vascular pathologies and imaging findings.
Conclusion: Pediatric AIS is frequently caused by a variety of vascular disorders that require multimodal imaging for accurate diagnosis. Early recognition and targeted imaging are crucial for timely intervention and improving outcomes in this vulnerable population.

Keywords: Ischemic stroke, Pediatric stroke, vascular diseases, Neuroimaging, Arterial dissection

Introduction

Acute ischemic stroke (AIS) in a pediatric patient is defined as a stroke occurring between the ages of one month and 18 years. It is a rare but serious medical emergency, with an estimated incidence of 2.69 per 100,000 children annually [1]. Unlike adults, in whom atherosclerotic disease is the predominant cause, pediatric strokes result from a diverse array of etiologies, with arteriopathies and cardiac anomalies playing major roles [2,3]. AIS accounts for nearly half of all strokes in children [4]. The early recognition of stroke symptoms in children is often delayed due to atypical presentations and a lower clinical suspicion, which can lead to delayed intervention and worse outcomes [5]. In contrast, 80 to 85% of strokes in adults are ischemic and more readily diagnosed due to more consistent clinical patterns [6]. Given the time-sensitive nature of stroke treatment, prompt identification and rapid imaging in the emergency setting are critical to improving prognosis in pediatric patients. Emergency physicians thus play a vital role in early diagnosis and coordination of care.

Among the vascular causes in children, focal cerebral arteriopathy, moyamoya disease, and arterial dissection are increasingly recognized contributors, often requiring targeted neurovascular imaging for accurate diagnosis [7,8]. Neuroimaging plays a central role not only in confirming the diagnosis of AIS but also in uncovering underlying vascular abnormalities. Magnetic resonance imaging (MRI), magnetic resonance angiography, computed tomography angiography (CTA), and digital subtraction angiography (DSA) are pivotal in establishing an etiological diagnosis and guiding management [9,10].

In this perspective, our work aims to enumerate the principal vascular causes of pediatric AIS and to determine the specific contribution of different imaging modalities in the etiological evaluation.

Methods

We conducted a prospective study including all children aged less than 18 years who presented with AIS between January 2020 and December 2024. The study was carried out at Hedi Chaker University Hospital in Sfax.

Inclusion criteria consisted of patients under 18 years of age with AIS confirmed by neuroimaging. Patients with hemorrhagic stroke, transient ischemic attacks, or incomplete imaging were excluded.

Clinical data including demographic information, clinical presentation, vascular risk factors, and relevant past medical history were collected.

Imaging protocol involved the use of MRI with diffusion-weighted imaging (DWI) or CTA when MRI was contraindicated or unavailable. Ultrasonography with Doppler was performed when vascular flow abnormalities or arterial dissections were suspected, providing a non-invasive initial assessment of cervical vessels.

All imaging studies were independently reviewed by two experienced neuroradiologists who classified vascular abnormalities according to standardized criteria. Discrepancies were resolved by consensus.

Primary outcomes included identification and characterization of vascular etiologies of AIS and evaluation of the diagnostic yield of each imaging modality in determining stroke cause.

Results

We included 22 patients (12 boys and 10 girls). Our patients were aged between one month and 9 years. Seven patients underwent ultrasonography with Doppler, seventeen patients underwent MRI and eleven patients underwent CTA.

We noted arterial dissection in 8 cases, Moyamoya disease in 8 cases, hypoplasia of the internal carotid artery (ICA) in 5 cases and fibromuscular dysplasia in one case.

Case 1

A six-year-old boy suffering from neck pain and a motor deficiency after rapid movement of his head. Ultrasonography of the cervical portions of the right arterial carotid showed intraluminal hyperechogenic linear image at the origin of the artery (Figure 1). An MRI was performed showing dissection of the right primitive carotid artery (Figure 1). The final diagnosis was arterial dissection.

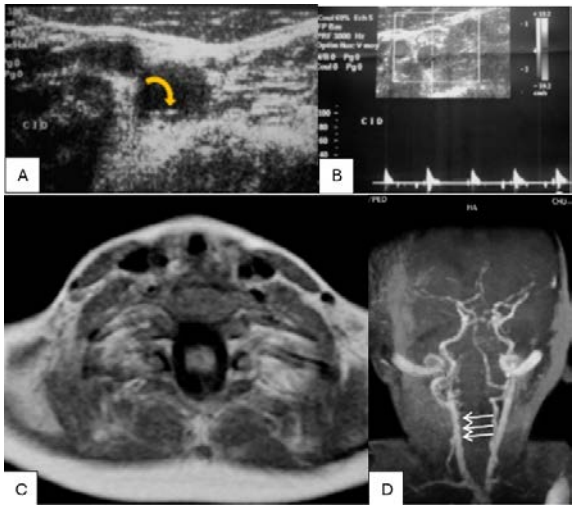

Figure 1: Ultrasonography of the cervical portions of the right arterial carotid showing intraluminal hyperechogenic linear image (arrow) at the origin of the artery: intimal flap *(A) and resistive spectrum, amortized at the origin of the right internal carotid artery (B). MRI showing dissection of the right primitive carotid artery, parietal hematoma in discreet hypersignal isosignal T1 (C) and parietal irregularity of the right primary carotid artery (arrows) (D).*

Case 2

A 4-year-old boy suffering from right hemiparesis. A cerebral angiography was performed showing important bilateral collateral circulation with filiform aspect of the left internal carotid and the sylvian arteries and occlusion of the left posterior cerebral artery (Figure 2). The final diagnosis was Moyamoya disease.

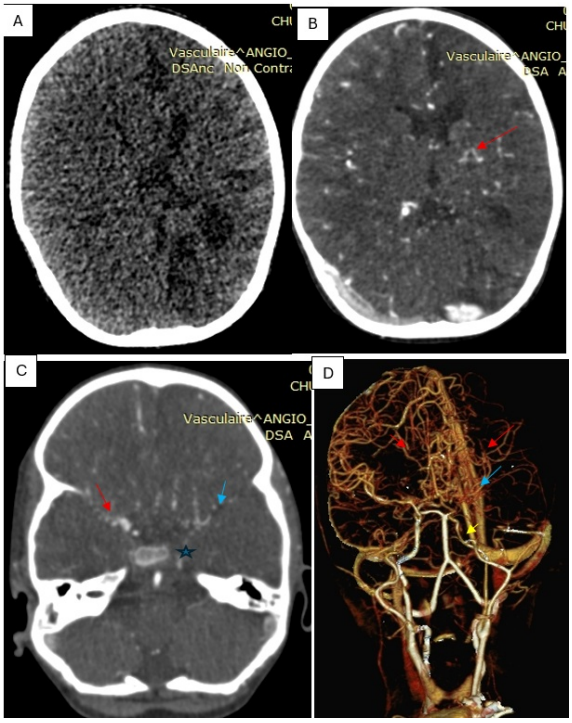

Figure 2: Computed tomography brain scan, axial section in parenchymal window without *(A) and after injection of contrast (B,C) and 3-dimensional reconstructions cerebral angiography (D) showing important bilateral collateral circulation (red arrow) with filiform aspect of the left internal carotid (yellow arrow) and the sylvian arteries (blue arrow) and occlusion of the left posterior cerebral artery (blue star).*

Case 3

Infant of 18 months, hospitalized for disorder of the state of consciousness. Computed tomography scan with MIP showed stenosis of the right internal carotid artery with development of vascular supplementation (Figure 3). The final diagnosis was Moyamoya disease.

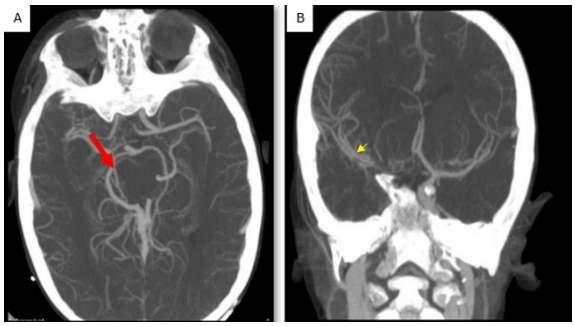

Figure 3: Computed tomography scan with MIP: showing stenosis of the right internal carotid artery (arrow)
(A) with development of vascular supplementation (yellow arrow) (B)

Case 4

7-year-old child suffering from generalized convulsions. MRI angiographic sequence showed progressive bilateral occlusion of bilateral internal carotid arteries with development of vascular supplementation. The final diagnosis was Moyamoya disease.

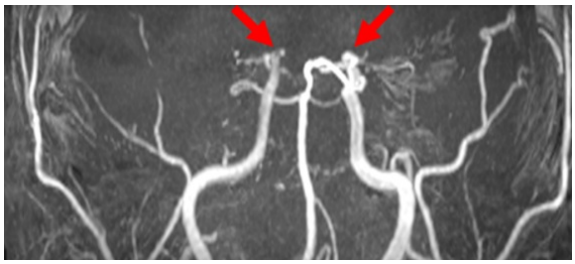

Figure 4: MRI angiographic sequence showing progressive bilateral occlusion of bilateral internal carotid arteries (arrows) with development of vascular supplementation.

Case 5

4-year-old girl, with a previous medical history of Minkowski Chauffard's disease, hospitalized for paresis of right arm of brutal installation. Computed tomography scan showed left frontal and parietal ischemic lesions. MRI angiographic sequence showed hypoplasia of the left internal carotid artery with obliteration in its distal portion. (Figure 5). Doppler ultrasound was performed. Ot showed acceleration of velocities (280 cm/s) with visible aliasing phenomenon in color coding in the right internal carotid artery without image of thrombosis or stenosis (Figure 6). An intravascular aliasing phenomenon in the right internal carotid artery with decreased flow in the left internal carotid artery (85 cm/s) were noted. The final diagnosis was hypoplasia of the internal carotid.

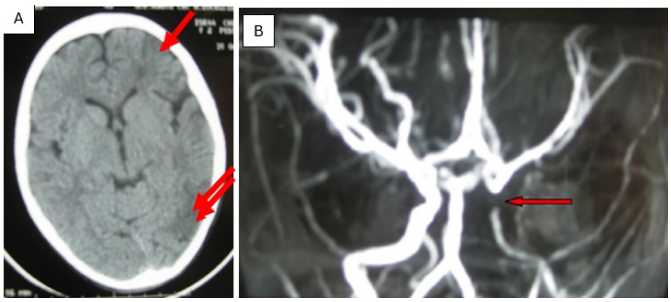

Figure 5: Computed tomography scan showing left frontal and parietal ischemic lesions
(A) and hypoplasia of the left internal carotid artery with obliteration in its distal portion (arrow) (B: MRI angiographic sequence)

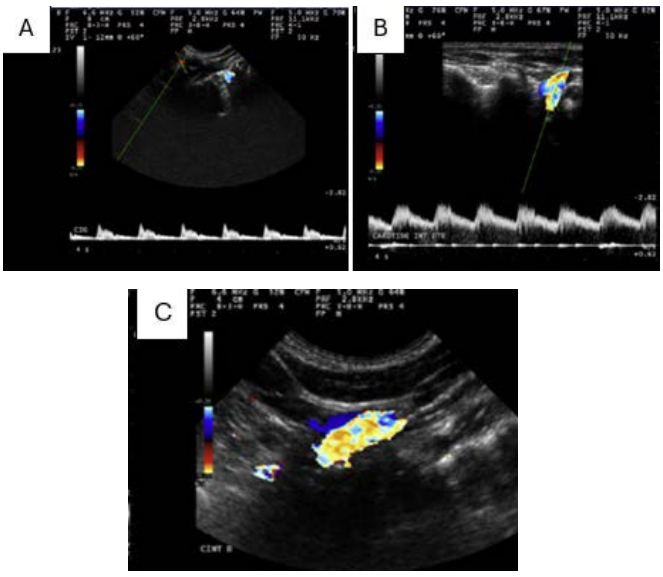

Figure 6: Doppler ultrasound showing acceleration of velocities (280 cm/s) with visible aliasing phenomenon in color coding in the right internal carotid artery without image of thrombosis or stenosis.

Case 6

A girl aged 8 years consulting for multiple strokes in the vertebral basilar territory. Computed tomography scan with injection showed pearled appearance at the origin of the right posterior cerebral artery. MRI angiographic sequence revealed short stenosis at basal trunk termination (Figure 7). The final diagnosis was fibromuscular dysplasia.

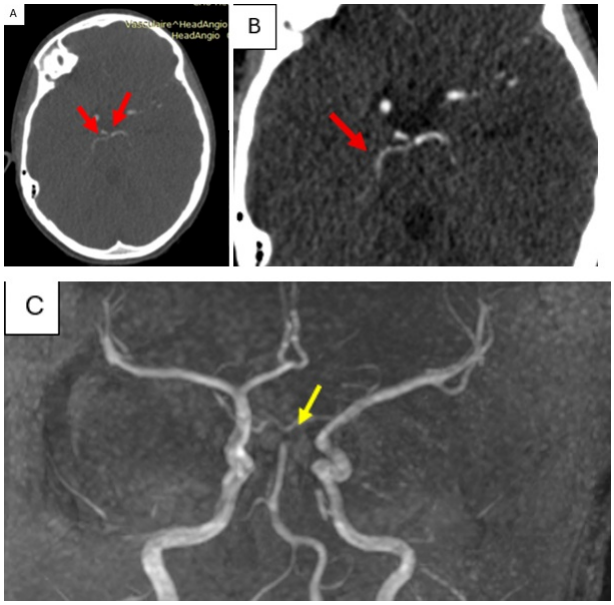

Figure 7: Computed tomography scan with injection showing pearled appearance at the origin of the right posterior cerebral artery (red arrows) *(A, B) and short stenosis at basal trunk termination (MRI angiographic sequence yellow arrow) (C)*

Discussion

Our study highlights the diverse vascular etiologies underlying pediatric AIS, with arterial dissection and Moyamoya disease being the most frequent diagnoses. Our findings emphasize the critical role of multimodal imaging in accurately identifying these vascular abnormalities, which is essential for timely diagnosis and management. The risk factors for stroke in children are congenital heart disease, infection, prothrombotic disorders, trauma, acquired and congenital vascular disease, metabolic disorders, and mitochondrial disease [11,12,13,14].

The clinical presentation is useful for localizing the lesion. The majority of pediatric ischemic strokes occur in the distribution of the middle cerebral artery, which results in hemiplegia with upper limb predominance, hemianopsia, or dysphasia [15,16]. Primarily lower extremity weakness would suggest anterior cerebral artery involvement, whereas vertigo, ataxia, and nystagmus are consistent with an ischemic event in the posterior circulation [13].

Vascular diseases alone account for one-third of cases. They are varied, including vasculitis, post-infectious causes, arterial dissection, arteriopathy (Takayasu arteritis, Moyamoya disease, cryptogenic arteriopathy), fibromuscular dysplasia, hypoplasia of the internal carotid artery, connective tissue diseases, and metabolic vasculopathy (e.g., Fabry disease) [11,17,18].

A. Arterial Dissection

Carotid or vertebral artery dissection results from a tear in the vessel lining wherein the intima separates from the media, creating a false or pseudo lumen, often accompanied by hemorrhage into the arterial wall [19,20]. Its annual incidence is 1–1.5 per 100,000 persons [14]. It can be traumatic or iatrogenic. Traumatic dissections may result from blunt trauma or rapid movement of the head in relation to the neck in any axis. While most dissections occur in the internal carotid artery, children may dissect

intracranially [21,19]. It accounts for 7% to 20% of all cases of childhood AIS [11,13].

Iatrogenic dissection may result from catheter or surgical manipulation of vessels in procedures such as angiography and endarterectomy. In rare cases, it may be related to underlying connective tissue disorders [11,19].

Ultrasonography of the cervical portions of the carotid and vertebral arteries can be useful in detailing flow aberrations, intramural hematoma, luminal thrombus, and mobile flaps [20]. It shows that velocities within the carotid bulb may decrease and are accompanied by high resistance due to stenosis that yields a biphasic pattern.

Cerebral angioscan is the most efficient modality for diagnosing dissection. An intimal tear within the vessel is often accompanied by formation of a medial or subendothelial hematoma that is readily identifiable [20]. An intramural hematoma usually manifests as a crescentic hyperdensity or suboccipital rim with thickening of the vascular wall without a change in the vessel caliber.

MRI with fat saturation has replaced conventional imaging as the gold standard for diagnosing craniocervical arterial dissection [19,20]. MR evaluation consists of three components: DWI and FLAIR for infarction, T1/T2 imaging for intramural hematoma, and MRA for vascular lumen evaluation. The classic MRI dissection finding is an eccentric periluminal rim indicative of intramural hematoma [19,20].

B. Moyamoya Disease

Moyamoya ("puff of smoke" in Japanese) is a chronic cerebrovascular disorder characterized by progressive stenosis or occlusion of the intracranial internal carotid artery and its proximal branches, accompanied by a basal collateral network [17,22,23]. Generalized cerebral atrophy is a common finding [23]. Diagnosis relies exclusively on imaging, as pathological correlation is difficult [23,22].

Pathologically, moyamoya disease is characterized by intimal thickening of the terminal portions of the internal carotid bilaterally [17,23]. Although classically described in the ICA, over 50% of patients also have involvement of the posterior cerebral arteries [22].

C. Hypoplasia of the Internal Carotid Artery

Carotid dysgenesis is classified into agenesis, aplasia, and hypoplasia. Agenesis is complete failure of development; aplasia is failure despite a precursor structure; hypoplasia is incomplete development [24,25]. In the study by Taşar et al., the prevalence of ICA aplasia or hypoplasia was 0.13% [24]. Hypoplasia is characterized by narrowing of the ICA along its entire course due to incomplete development. Diagnosis is made by identifying the absence or reduced size of the bony carotid canal on skull base CT, confirming congenital rather than acquired pathology [24,25].

D. Fibromuscular Dysplasia (FMD)

FMD is a segmentary, non-atherosclerotic, non-inflammatory vascular disease that may result in stenosis, occlusion, aneurysms, or dissection of medium-sized arteries [18,26]. It is classified into three forms: intimal (10%), medial (80–90%), and adventitial (<5%) [18]. FMD predominantly affects women (9:1 ratio) aged 15 to 50 [18]. It is suspected in hypertension before age 30, refractory hypertension, or when associated with small kidney size. Carotid and vertebral involvement is less frequent than renal (10–35%) [26].

On angio-MRI or angio-CT, characteristic findings include focal or tubular stenoses and multifocal stenoses with a "string of beads" appearance, often complicated by aneurysms [18,26]. Surgical management is less common now due to the efficacy of percutaneous transluminal angioplasty [26].

Conclusion

Pediatric arterial ischemic stroke, though rare, constitutes a true neurological emergency that demands rapid recognition and diagnostic precision. Vascular pathologies—including arterial dissection, Moyamoya disease, fibromuscular dysplasia, and congenital anomalies—are among the most important causes and may not be immediately apparent in the emergency setting. Early neuroimaging, particularly with MRI and angio-CT, is crucial not only for confirming ischemia but also for identifying the underlying vascular etiology. Strengthening awareness of pediatric stroke presentations and vascular mimics in emergency departments is essential to reduce diagnostic delays and facilitate early intervention in this vulnerable population.

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Pregabalin Toxicity-Induced Posterior Reversible Encephalopathy Syndrome

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Abstract

Posterior reversible encephalopathy syndrome (PRES) is a neurological phenomenon in which vasogenic edema most commonly accumulates in the posterior parieto-occipital white matter. It was caused by some drugs such as opioids methadone or gabapentin.

Rare cases of PRES-related pregabalin were reported. It was typically used to treat neuropathic pain. We present a unique case of a 23-year-old patient without any previous history admitted to intensive care for quadriplegic paralysis with Guillain-Barre syndrome. His neuropathic pain was treated with pregabalin. He presented poorly balanced hypertension and a worsening of renal function due to colistin toxicity. On day 52, he presented a sudden drop in visual acuity without altering his consciousness. Cerebral MRI revealed subcortical white matter edema in the bilateral parietal and occipital lobes with T2 and Flair hyper signals without diffusion restriction suggestive of PRES. He was treated by controlling hypertension and by stopping pregabalin. The clinical course was favorable after 5 days, with a recovery of visual acuity.

This case indicates that physicians must be aware of potential PRES-related Pregabalin toxicity especially when increasing its doses in patients presenting worsening of renal function and in association with opioids.

Keywords: Pregabalin, Poisoning, Intensive care, Outcomes, Pres Syndrome

Introduction

The clinical radiographic syndrome known as posterior reversible encephalopathy syndrome (PRES) is characterized by diffuse structural changes in the cerebral white matter that are caused by bilateral vasogenic edema, which is usually observed in the posterior region of the hemispheres [1,2]. People at risk for presenting PRES have several risk factors including hypertension, preeclampsia, renal failure, kidney illnesses that cause secondary hypertension and hypovolemia, liver disease, exposure to cytotoxic or immunosuppressive medicines[2], autoimmune disorders, and sepsis [2,3]. Few cases had been reported to pregabalin [4,5]. We hereby report a rare case of pregabalin-induced PRES in a 23-year-old patient.

Case report

We report a pregabalin-induced PRES in a 23-year-old patient without any previous history admitted in intensive care with Guillain-Barre syndrome. He was quadriplegic, requiring invasive mechanical ventilation and tracheostomy. His neuropathic pain was treated with pregabalin 150 mg per day, and then increased to 300 mg per day, tramadol hydrochloride 200 mg per day, and morphine 3 mg per day. He also presented with poorly balanced hypertension up to even on nicardipine, clonidine hydrochloride, amlodipine, and methyldopa. He was tachycardic with a pulse of 120 and hypertensive with a blood pressure of 220/110 mm de Hg. It should be noted that the patient presented worsening renal function due to colistin toxicity following a nosocomial infection with creatinine at 200 µmol/l. On day 52, he presented a sudden drop in visual acuity without altering his consciousness. An emergency cerebral MRI revealed bilateral parietal and occipital areas with T2 and Flair hypersignals without diffusion restriction and enhancement after injection of Gadolinium (Figure). Because of hypertension and cerebral MRI findings, PRES was diagnosed. An antihypertensive drug by an electric syringe pump including nicardipine, isosorbide dinitrate, and clonidine hydrochloride was conducted. The blood pressure control was achieved with a target blood pressure of less than 140/90 mmHg. Pregabalin, tramadol hydrochloride, and morphine were discontinued. The clinical course was favorable after 5 days, with a recovery of visual acuity.

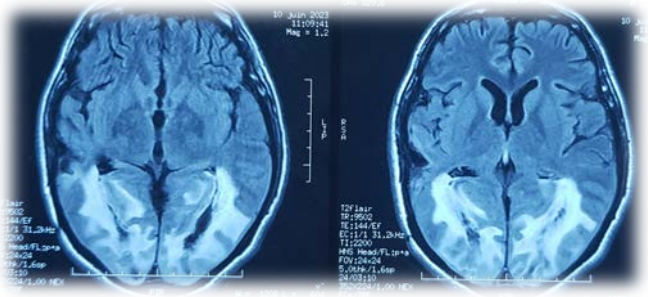

Figure 1 : MRI brain T2 flair: bilateral parietal and occipital areas with T2 Flair hyper signals without diffusion restriction and enhancement after injection of Gadolinium

Discussion

This case indicates that physicians must be aware of potential PRES-related Pregabalin toxicity especially when increasing its doses in patients presenting worsening of renal function and in association with opioids. Pregabalin is used as an adjuvant medication for partial seizures, and the treatment of diabetic neuropathy, fibromyalgia, and neuropathic pain [5]. Few cases have raised concern about the abuse potential of pregabalin

which has increased substantially over the last decade[6]. This medication can intensify the effects of opioids, methadone [5,7], and benzodiazepines leading to neurological disorders [8,9]. Pregabalin acute toxicity has been linked to several occurrences of neuropsychiatric symptoms [10,11]. Two cases study was described: an older patient who had a history of diabetic nephropathy and hypertension who inadvertently overdosed on pregabalin and a patient who developed prerenal azotemia and had years of pregabalin treatment experienced mental changes. In the two cases, the electroencephalogram shows continuous triphasic waves [4,11]. The most likely cause of intoxication in both cases was impaired renal clearance of pregabalin, and after stopping the offending medication, the patient's mental condition completely recovered [4,11] as in our patients who presented worsening renal function leading to a decrease in clearance of pregabalin. In the literature, PRES can occur with some neuromodulating medicines, such as gabapentin and duloxetine, but there is no documented documentation of PRES caused by acute pregabalin poisoning [12,13]. Because both pregabalin and gabapentin belong to the same class of medications called gabapentinoid medications, their pharmacodynamic profiles are similar. Since pregabalin is 2.5 times more effective than gabapentin and has a higher absorption. Uncertainty surrounds the physiopathology of PRES [5]. Hypertension is not always present in cases with PRES. It can cause endothelial injury, and flare vasogenic edema[14] leading to cerebral auto-regulation loss. Another theory holds that endothelial dysfunction is caused by a variety of factors such as infections, autoimmune illnesses, and chemotherapy, which compromises the blood-brain barrier's integrity and thus results in vasogenic edema [15].

The brain barrier is known to be compromised by prevalent drugs of abuse including cocaine,and opioids, which may account for reports of opioids, including methadone, causing PRESS [8,16]. Given his history of renal failure and the rather

large dose of pregabalin he had taken, our patient's toxicity was exacerbated by the opioids (morphine and tramadol hydrochloride). It is challenging to determine whether the acute pregabalin overdose that generated his clinical symptoms and MRI data suggesting PRES was due to the drug's pharmacological action or the potentiating effect of opioids [5,11].

Conclusion: We present a unique instance of pregabalin-induced PRES. Physicians should be mindful of the possibility of pregabalin-induced PRES, particularly when titrating the medication in patients who exhibit decreasing renal function and in combination with opioids.

Conflict of interest

All authors certify that they have no affiliations

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A Wandering Atrial Pacemaker in Inferior Wall Infarction. Escape or Survival Rhythm? A Case Report

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Abstract

Coronary sinus rhythm is an ectopic atrial rhythm supposedly originating from a pacemaker at the mouth of the coronary sinus; it is recognized in the electrocardiogram by P-waves that are inverted in leads II, III, and VF with a normal or prolonged P-R interval. In myocardial infarction, this presentation can reveal a wandering atrial pacemaker. We present a case of a wandering atrial pacemaker with inferior wall myocardial infarction complicated by complete atrio-ventricular block.

Keywords : Atrial pacemaker, Myocardial infarction, Emergency, Complication

Introduction

Coronary sinus rhythm is an ectopic atrial rhythm supposedly originating from a pacemaker at the mouth of the coronary sinus; it is recognized in the electrocardiogram by P-waves that are inverted in leads II, III, and VF with a normal or prolonged P-R interval. In myocardial infarction, this presentation can reveal a wandering atrial pacemaker.

We present a case of a wandering atrial pacemaker with inferior wall MI complicated by complete atrio-ventricular block.

Case report

An 86-year-old woman was admitted to the emergency department of a comminatory hospital due to persisting angina for an hour and syncope. The pain was 4/10 on the scale. She had no previous medical history and was a non-smoker. The electrocardiogram (ECG) showed ST segment elevation in leads II, III, and VF and reciprocal ST segment depression in leads V1–V6. She was treated before the arrival of our pre-hospital team with dual oral anti platelets such us aspirin 250 mg and clopidogrel 300 mg, intravenous loading doses of unfractionated heparin 50 mg, and atropine (0,5 mg) for brady arrhythmia.

On physical examination by our prehospital physician, the cardiac sounds and breathing were normal on auscultation. The patient was dizzy and somnolent. Her pulse was irregular at 50 bpm, her blood pressure was 50/30 mm Hg. The ECG showed ST elevation in leads II, III, Vf, V3, V4, V3R, and V4R. An inverted P wave was noted in inferior leads, consistent with coronary sinus rhythm complicated by a complete atrio-ventricular dissociation (Figure 1). She was medicated by Dobutamine at 10 γ/Kg/min with Nor-epinephrine at 0,5 mg/h. The patient was transferred to the Cath lab for primary cutaneous Coronary Intervention (PCI).

On the way, the ECG has changed and demonstrates Second Degree Heart Block (Mobitz type 2), ST segment elevation in leads II, III, Vf, V1, V3, V4, and V6 with low atrial rhythm (Figure 2).

On admission, she was conscious, her heart rhythm was irregular at 65 bpm, and her blood pressure was 80/50 mmhg. Serum troponin 0.30 ng/mL (normal range (NR) 0–0.14 ng/mL). Hiselectrocardiogram showed sinus tachycardia with a decrease in ST segment elevation (Figure 3).

After an initial evaluation, coronary angiography (CAG) was immediately performed and revealed total occlusion with a thrombus in the proximal segment of the right coronary artery (RCA) with a TIMI 0 flow. A Laying bare stent of (3 * 15mm) was placed with good result. During the course, several ventricular fibrillations occurred and were treated by electrical shock.

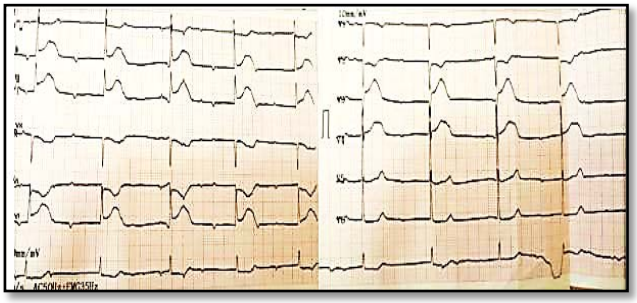

***Figure 1: ECG showed ST elevation in leads II, III, Vf, V3, V4 and an inverted P wave in inferior leads consistent with coronary sinus rhythm complicated by a complete atrio-ventricular dissociation and complete* atrioventricular block.**

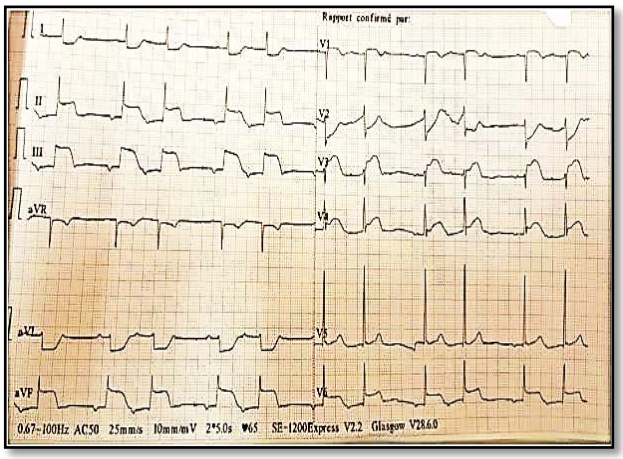

Figure 2: ECG showed Second Degree Heart Block (Mobitz type 2), ST segment elevation in leads II, III, Vf, V1, V3, V4 and V6 with reciprocal ST depression in I, VL and V2. P wave inverted in inferior leads corresponding to low atrial rhythm.

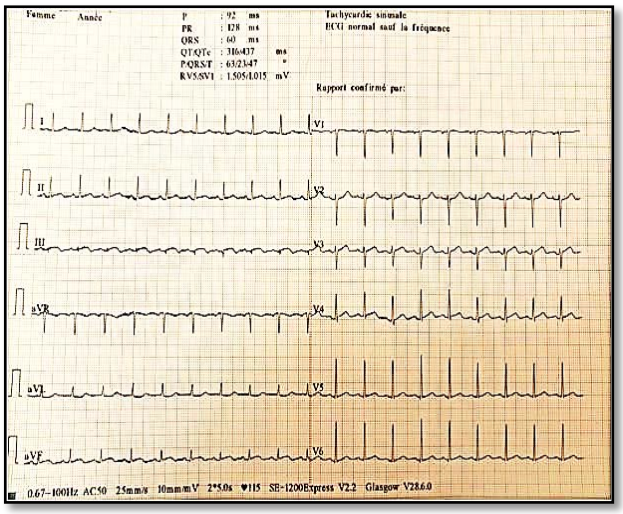

Figure 3: At admission, ECG showed sinustachycardia

After coronary angioplasty, the ECG showed new-onset atrial fibrillation (AF) (Figure 4). The transthoracic echocardiography Performed two days later revealed hypokinesia of the inferior wall with a good left ventricular ejection.

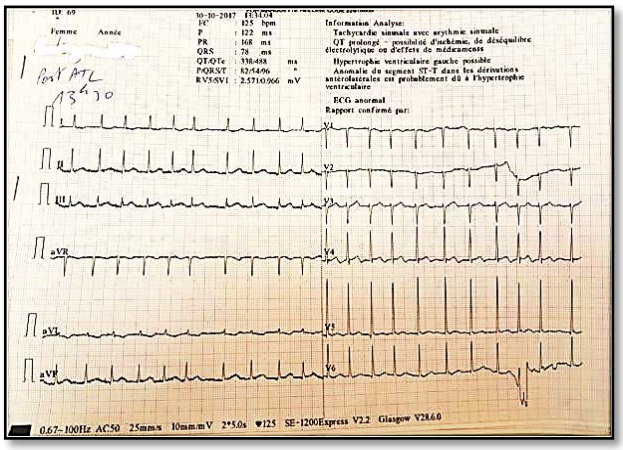

Figure 4: ECG post PPCI showed new-onset atrial fibrillation (AF) and minor ST segment elevation in inferior leads.

Discussion

A wandering pacemaker is a sign of cardiac irritability in the atrial. This dysrhythmia may occur in normal hearts as a result of fluctuations in vagal tone. Schamroth and Goldberg [2] attempted to clarify the definition of a wandering pacemaker in 1972. They explained the mechanism of the wandering pacemaker as an escape rhythm overloaded with extreme bradycardia. They postulated that the sinus bradycardia was considered to be the main cause of the escape beat, which occurs in the first place, and it is a benign physiological condition. New theories concerning the wandering pacemaker have been described following the more in-depth studies of the anatomy and physiology of the sinoatrial node [2]. A recent review of physiology suggests two theories for P-wave changes morphology in the wandering stimulator. The variation of the initial stimulation signal in the sinoatrial node causes the change of the morphology of the p-wave. The theory holds that two or more physiological pacing sites (leading and subsidiary) within the structure alternate the role of the primary pacer during episodes of WAP. Following the change of the site of the first stimulator, the wave of the action potential changes and, consequently, the axis of the P wave.

The other modern theory that could account for P-wave morphology changes is that the action potential comes from a very extended area: The sinoatrial node is a more extensive tadpole-shaped structure that includes a paranodal area and articulations into the atrial muscle structure. The potential action can come from a different location, but the pacemaker site is stable, which explains the change of the P-wave axis in a single lead.

It has also been shown that a wandering atrial pacemaker is a potential long-term complication of high-dose sympathomimetics at toddler [5].

In other studies, the authors described the possibility of atrial infarction considering inferior and/or posterior infarctions with atrial arrhythmias, hypotension, and a cardiac output status. Atrial infarction is frequently accompanied by a variety of complications, including arrhythmia, rupture, loss of atrial 'kick', and thromboembolic phenomena. A wandering atrial pacemaker is not quite common in the setting of atrial infarctions [1]. In our case, the WAP was associated with MI and cardiac output status. It's unfortunately possible to miss an association with atrial infarction, which has been a relatively understudied entity.

Conclusion

This case is presented to highlight the possibility of WAP and hypotension and a

cardiac output status with inferior myocardial infarction. PAW occurs on the occasion of a change of balance between sympathetic and parasympathetic tone during this con- sequent rhythm as Benin can indicate a different speech. This may be a most enriching contribution when future studies are needed to determine if WAP in MI was B flat or a benign heart rate note.

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Beyond the Rash: The Fatal Consequences of Lyell Syndrome

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Abstract

Lyell syndrome is a rare, unpredictable, severe, and potentially fatal disease. Diagnosis is primarily clinical, confirmed by pathological examination, and lacks specific biological abnormalities. Several drugs, including allopurinol, are implicated in its onset. Therapeutic management requires admission to an intensive care unit, ideally a specialized burns resuscitation unit, and is essentially symptomatic. Treatment focuses on analgesia, hydro electrolytic resuscitation, nutritional support, wound care, infection prevention, psychological support, and social reintegration.

Keywords: Lyell Syndrome, Necrosis, Outcomes, Necrosis

Introduction

Toxic epidermal necrolysis (TEN), also known as Lyell syndrome (LS), is a rare, unpredictable, severe, and potentially fatal form of toxidermia [1]. It is the most severe form of drug-induced skin reaction, with a mortality rate of up to 25% and long-term sequelae affecting 80% of survivors, primarily involving ocular, genital, cutaneous, and bronchial complications [2]. LS is characterized by extensive epidermal necrolysis affecting at least 30% of the skin surface, often associated with erosive mucosal damage. The most commonly implicated drugs include trimethoprim, sulfamethoxazole, allopurinol, anticonvulsants, and penicillins [3]. Management requires admission to an intensive care unit, preferably a burns resuscitation unit, and is predominantly symptomatic, focusing on pain control, fluid and electrolyte management, nutritional support, wound care, and infection prevention [4]. We report a case of Lyell syndrome secondary to oral allopurinol.

Case Report

A 59-year-old woman with a history of arterial hypertension for over ten years was referred to the Emergency Department for extensive skin detachment (Figure 1).

Initially, the patient had consulted for polyarthralgia, prompting laboratory investigations that revealed hyperuricemia. Consequently, she was prescribed allopurinol for a suspected gout attack. On the fifth day of treatment, she developed body aches and erythema (Figure 2),

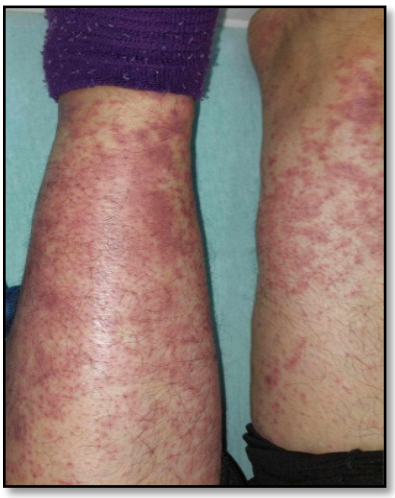

Figure 1: Extensive skin detachment

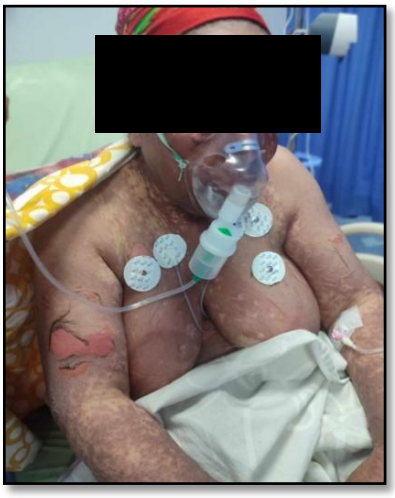

Figure 2: Pigmentation and skin eruptions

which progressed to diffuse pruritic skin eruptions, epidermal detachment, dysphagia, hypersalivation, and fever. She presented to the Emergency Department and was subsequently admitted.

Upon admission, the patient was in an altered state, tachycardic (110 beats/min), tachypneic (22 breaths/min), and had an oxygen saturation of 94%. Her blood pressure was 130/80 mmHg, and she was febrile at 38.9°C. Dermatological examination revealed extensive epidermal detachment resembling wet linen over a mildly erythematous base, covering more than 70% of the body surface. The Nikolsky sign was positive, and there were erosions of the ocular, buccal, genital, and anal mucosa (Figures 1, 2, 3, and 4).

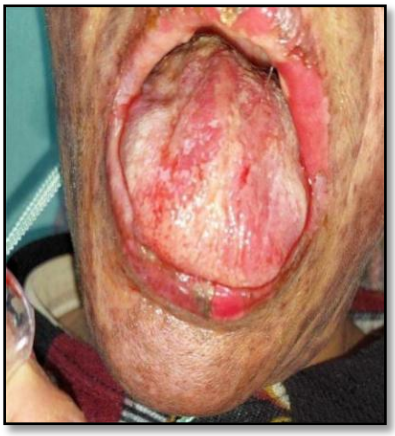

Figure 3: Buccal eruptions

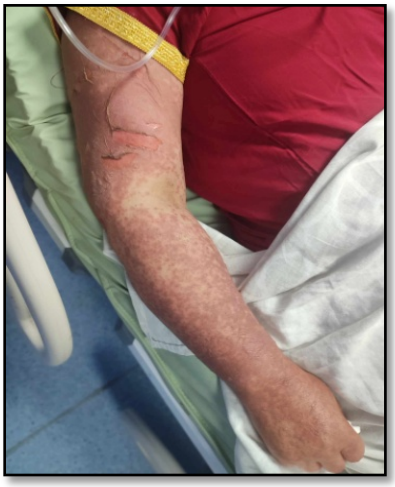

Figure 4: Extensive skin detachment

Laboratory investigations showed an inflammatory response with a C-reactive protein (CRP) level of 190 mg/L. Blood glucose was 10.9 mmol/L, urea 19 mmol/L, and bicarbonate 26 mmol/L. The case was reported to the regional pharmacovigilance center. Blood cultures were positive for Staphylococcus aureus, while urine cytobacteriological examination (UCE) was negative. The patient received appropriate antibiotic therapy. Despite ten days of intensive

resuscitation, daily dermatological care with silver sulfadiazine, Vaseline ointment, and ocular and oral care, the patient's condition deteriorated, and she ultimately succumbed to the disease.

Discussion

Allopurinol is a uricostatic agent that inhibits xanthine oxidase, an enzyme responsible for uric acid biosynthesis. It is metabolized to oxypurinol, which also inhibits xanthine oxidase, contributing to its therapeutic effect [5]. Allopurinol is one of the most frequently implicated drugs in Lyell syndrome. In our patient, its causative role was supported by the chronological sequence of events and the absence of other drug exposure in the two months preceding symptom onset.

Lyell syndrome is a rare disease, and its diagnosis is primarily clinical, confirmed by pathological examination, with no specific biological markers [6]. Histopathological analysis is essential to confirm the diagnosis, which has significant medical and legal implications. Due to the disease's rarity, it is often underrecognized, leading to delayed diagnosis and management [7]. Our patient met the widely accepted diagnostic criteria and had a SCORTEN score of 3, indicating a 35% risk of mortality.

Visceral involvement is a severe prognostic factor, manifesting as congestive erythema, erosions, and ulcerations of the digestive tract mucosa, pseudomembranous colitis, or respiratory mucosal involvement with acute respiratory distress syndrome, potentially complicated by infections. Fatal outcomes are typically associated with multiorgan failure, including pulmonary, cardiac, hepatic, and gastrointestinal failure. Early and multidisciplinary management can significantly improve outcomes [6].

For survivors, long-term sequelae are common and can be aesthetic, functional, psychological, and social. These sequelae affect approximately half of all patients [6,7] and may include cutaneous (dyschromia and superinfection-related pigmentary changes), ophthalmological (xerophthalmia, photophobia, keratitis, and potential visual impairment), genital (dyspareunia, synechiae, dryness, persistent erosions), sensory (taste disturbances, sweating abnormalities, nail disorders), and psychological (drug phobia) complications. Our patient experienced dysphagia, eye pain, and photophobia prior to her deterioration.

Conclusion:

Lyell syndrome remains a rare but severe condition with high morbidity and mortality rates. Early management in an intensive care unit, ideally a specialized burns resuscitation unit, is crucial. Treatment is primarily symptomatic, focusing on analgesia, fluid and electrolyte resuscitation, nutritional support, wound care, infection prevention, psychological support, and social reintegration.

Conflicts of interest: The authors have no conflicts of interest to declare.

Right to Privacy and Informed Consent: The authors have obtained the written informed

consent of the patients or subjects mentioned in the article.

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Emphysematous pyelonephritis with infected abdominal aorta pseudoaneurysm among a diabetic man

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Abstract

Background: Emphysematous pyelonephritis (EPN) is an acute necrotizing infection of the kidney that generates gas within the renal parenchyma/collecting system, or perinephric space. It requires aggressive medical management, often involving surgery. To our knowledge, its association with an infected abdominal aorta pseudoaneurysm has never been documented. We report the case of a diabetic patient with concomitant infected abdominal aortic pseudoaneurysm with EPN.

Case Report: A 63-year-old man with a history of uncontrolled diabetes mellitus type 2 presented with a fever, abdominal pain, dysuria, and malaise. Physical examination revealed signs of moderate shock. Ultrasound showed the absence of the left kidney, which is replaced by a structure containing several echogenic foci mimicking left colic flexure and a normal-sized right kidney. An urgent computed tomography (CT) scan revealed the presence of air as of the scout CT image, then confirmed during the CT scan by demonstrating intraparenchymal, perinephric, and pararenal air, consistent with EPN. In addition, it showed the presence of voluminous pseudoaneurysm arising from the left lateral wall of the abdominal aorta, with alteration of the left renal artery. Emergent nephrectomy and open repair of the large pseudo-aneurysm were strongly considered. In the operating room, upon initiating anesthesia, a cardiopulmonary arrest has occurred. Despite the resuscitation, the patient passed away.

Conclusion: Our case highlights a rare and fatal association between EPN and an infected abdominal aortic pseudoaneurysm. Early recognition and prompt imaging are essential in diabetic patients presenting with signs of sepsis and abdominal symptoms. The coexistence of these two severe infections presents significant diagnostic and therapeutic challenges, emphasizing the need for rapid multidisciplinary intervention to improve outcomes.

Keywords: Aorta, Pseudoaneurysm, Emphysematous pyelonephritis, Diabetes mellitus

Introduction

Emphysematous pyelonephritis (EPN) is an uncommon and highly fatal condition (1, 2). It is an acute necrotizing infection of the kidney that generates gas within the renal parenchyma/collecting system, or perinephric. It requires aggressive medical and often surgical management. To our knowledge, its association with an infected abdominal aorta pseudoaneurysm has until now never been documented. The mechanism of pseudoaneurysm formation is thought to be related to infected emboli, bacteriemia, and contiguous infection. We report the case of a diabetic patient with concomitant infected abdominal aortic pseudoaneurysm with EPN.

Case presentation

A 63-year-old man with a history of uncontrolled type 2 diabetes mellitus has presented with a fever, abdominal pain, dysuria, and malaise, which had increased in severity over the last 2 days. He was a great smoker and had an ancient travel history. On admission, he was febrile (38.5°C). Physical examination found early signs of shock: pallor, mottled skin, tachycardia, and decreased systolic blood pressure of 90 mmHg. His white blood cell count was elevated at 28000/mm^3. C-reactive protein level was 340 mg/L. Ultrasound didn't find the left kidney, which was replaced by a structure containing several echogenic foci mimicking left colic flexure and a normal-sized right kidney. There was no evidence of urinary tract obstruction.

An urgent computed tomography (CT) scan revealed the presence of air, as shown on the scout CT image (Figure **1**)

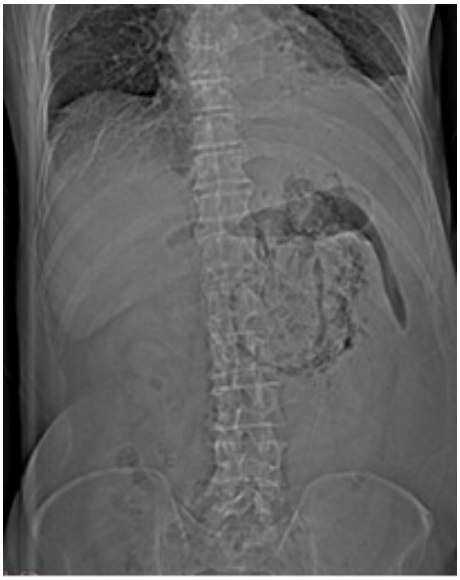

Figure 1: Scout computed tomography image shows air in the projection of the left renal space, suggestive of emphysematous pyelonephritis with extension to pre-vertebral space. It seems to surround a pre- and latero-vertebral structure.

and confirmed the diagnosis of EPN by showing intraparenchymal, perinephric, and pararenal air (**Figures 2, 3**).

In addition, it showed the presence of voluminous pseudoaneurysm (**Figures 2, 3**) arising from the left lateral wall of the abdominal aorta, with alteration of the left renal artery. Air was also present in peri-aortic spaces and surrounding the pseudoaneurysm. There was no drainable abscess or obstructive uropathy. No signs of active bleeding were present during the CT scan.

Initial treatment consisted of urgent fluid resuscitation, control of diabetes with insulin, and antibiotics. The patient was hemodynamically stabilized, but he continued to have severe, progressive abdominal pain. Urgent

nephrectomy and open repair of the large pseudo-aneurysm were strongly considered. In the operating room, after initiating anesthesia, a cardiopulmonary arrest has occurred. Despite the resuscitation, the outcome was fatal.

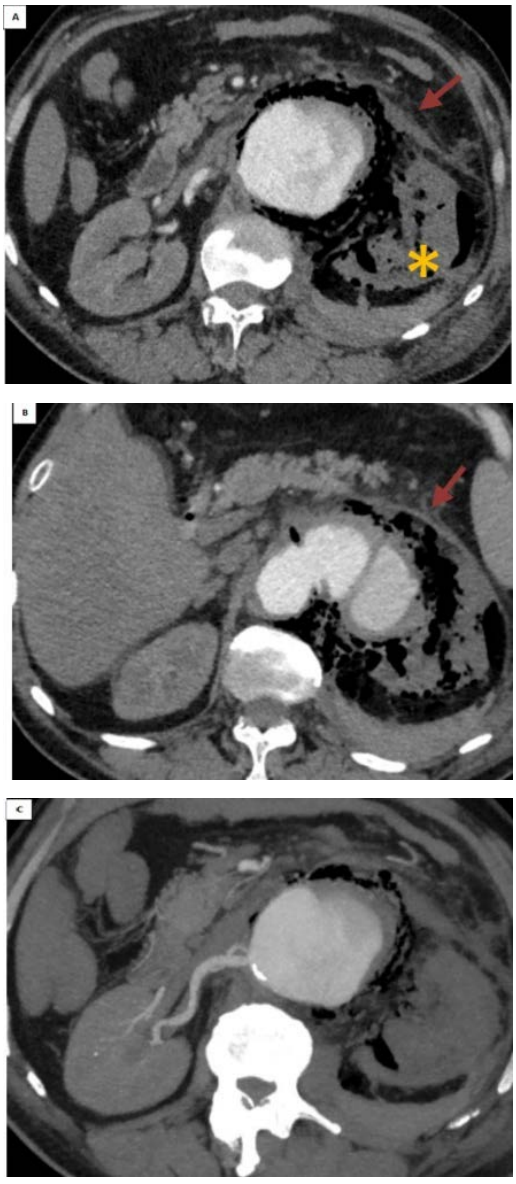

Figure 2: Axial enhanced abdominal computed tomography scan (A, B) shows free and extensive air in the left renal bed (asterisk), retroperitoneum, pararenal, peri-aortic spaces, and surrounding the voluminous pseudoaneurysm associated with fatty infiltration (arrow). Axial thin maximum intensity projection (MIP) computed tomography image (C) illustrating vascular alteration by showing the absence of left renal artery visualization

DISCUSSION

EPN is a rare disease defined by the acute necrosis and presence of gas within the renal parenchyma, collecting system, or perirenal tissue (1, 2). Many factors for the development of EPN are intricate and suggested to be uncontrolled tissue glucose level, favoring bacterial growth, renal tissue ischemia and necrosis secondary to compromised renal perfusion, immunodeficiency, and diabetes (3). In our case, the development of abdominal aorta pseudoaneurysm affecting the left renal artery origin has decreased arterial flow to the left kidney. Therefore, a vicious circle has been installed. Indeed, pseudoaneurysm participated in association with diabetes and prolonged sepsis in EPN development, and EPN, in its turn, as a contiguous infection, enhanced pseudoaneurysm formation. This association between pseudoaneurysm and EPN is an exceptional clinical entity, and to our knowledge, it has until now never been documented.

Numerous clinical presentations have been described for EPN, but the most common features are the classic signs of urinary tract infections, or due to other complications such as thrombocytopenia, neurological disturbances, and shock. However, none of these findings help to differentiate EPN from other diseases, demonstrating the importance of early imaging investigation.

The diagnosis of EPN may be suggested by the presence of gas in the renal area on plain X-ray. Also, ultrasound is not sensitive enough to diagnose the presence of gas in the kidney.

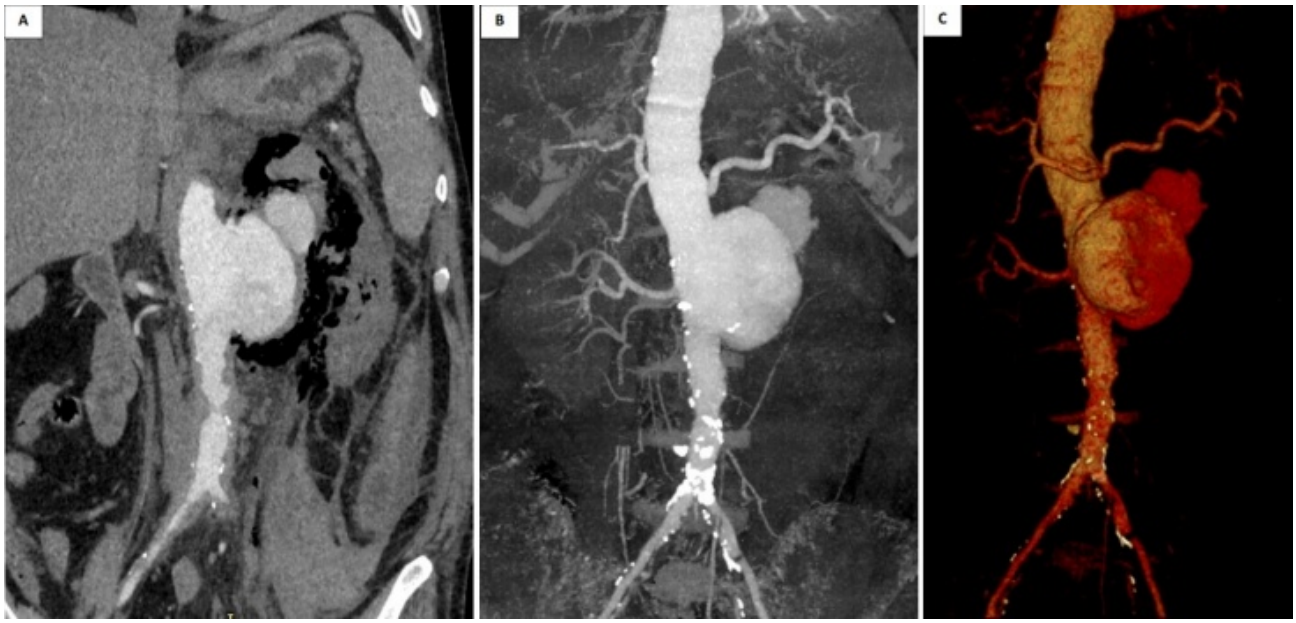

Figure 3: Coronal reconstruction of enhanced abdominal computed tomography scan (A) shows a free gas collection outlining the pseudoaneurysm. There are calcified plaques in the aorta with an irregular fringe. Coronal thin maximum intensity projection (MIP) computed tomography images (B) and volume rendered images (VRT) (C) showing saccular shape of the pseudo-aneurysm, partially calcified aortic wall, and a normal right renal artery

Detection of renal parenchymal gas on ultrasound requires a high index of suspicion. Gas appears as echogenic foci with “dirty”

shadowing in the non-dependent position. The appearance can change with the position of the patient. The initial ultrasound in our patient showed the absence of the affected kidney because of air (gassed-out kidney).

The CT scan picked up the emphysematous destruction of the kidney. It not only confirms the diagnosis but can also show the extent of the disease. The Huang classification system, based on CT findings of gas collection, is described as the most useful diagnostic and prognostic factor for EPN (4). Class 1 involves gas in the

collecting system only; Class 2 involves parenchymal gas only; Class 3 involves the extension of gas into the perinephric (3a) or

pararenal (3b) spaces; and Class 4 occurs in

patients with a solitary kidney or those presenting with bilateral disease. In our patient with class IIIb EPN, mortality rates of up to 50% have been reported even after early nephrectomy.

In our case, CT was not only useful for EPN but also to make an incidental diagnosis of abdominal aorta pseudoaneurysm, which is a serious and life-threatening disease. As a result, the therapeutic conduct can be affected.

Management of EPN is multidimensional, initially requiring vigorous resuscitation, fluid and electrolyte replacement, glucose control, and antibiotic treatment. Traditionally, radical nephrectomy was the primary approach to EPN. In recent studies, conservative management is as effective as nephrectomy (5). However, it is prudent to consider surgical intervention if a

patient presents with severe disease, as in our case. Our patient had an additional imminent and infected aorta pseudoaneurysm requiring open surgery. Traditionally, pseudoaneurysm treatment has been surgery, but in recent years, minimally invasive interventions, including percutaneous, transcatheter management, and endovascular stent grafts, have been developed as alternatives to surgery. In our case, the decision to be adopted was difficult, due to the patient's poor functional condition and risk of intra-operative hypotension and death, but endovascular treatment was also not suitable because of the possibility of aortic wall rupture and the presence of a contaminated field that could lead to infection of the graft. Our patient was operated on while recognizing the high operative risk, and he unfortunately passed away during anesthesia.

Conclusion

Our case highlights a rare and fatal association between EPN and an infected abdominal aortic pseudoaneurysm. Early recognition and prompt imaging are essential in diabetic patients presenting with signs of sepsis and abdominal symptoms. The coexistence of these two severe infections presents significant diagnostic and therapeutic challenges, emphasizing the need for rapid multidisciplinary intervention to improve outcomes.

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