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ORIGINAL ARTICLE

Assessment and follow up of renal function in patients with common types of mucormycosis

Osama Ahmed Abdesattar Mohamed[1*], Hassan Mahmoud Hassanin[1], Abdalla M. Nawara[1]
[1] Department of Internal Medicine, Faculty of Medicine, Zagazig University, Egypt.

***Corresponding author:**
Osama Ahmed Abdesattar Mohamed
Email:
oa4107810@gmail.com

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ABSTRACT:

Background: Mucormycosis is an infrequent illness, even in high-risk cases, and accounts for 8.3%-13% of all fungal infections found in such individuals. This study aimed to assess and follow up on the renal function in patients with common types of mucormycosis in two central hospitals at Sharqia Governorate (Zagazig University Hospitals and El Ahrar Educating Hospital).

Subjects and methods: A Cohort study was conducted on 36 patients with mucormycosis which was confirmed or suspected infection based on EORTC/MSG parameters by a positive Mucorales quantitative polymerase chain reaction (qPCR). Patients were categorized into three groups: 36 Patients admitted with a diagnosis of mucormycosis in the two hospitals were divided into three groups: Group 1: 12 Patients with normal kidney function. Group 2: 12 Patients with elevated serum creatinine on conservative treatment. Group 3: 12 Patients with renal failure (on regular hemodialysis). All cases were conducted to complete history taking, clinical assessment, laboratory, and radiological examination.

Results: There was a highly significant difference between groups regarding Lymph count, albumin, random blood sugar, and HbA1C (0<0.001). Also serum creatinine, blood urea nitrogen, urea, K, Ca, Ph, PT, and sodium level on admission, Middle time (3rd to 4th months from start of the study), and Last time (5th and 6th months) differed significantly between the groups (P<0.05). There was a significant difference between groups according to level at admission, Middle time, and Last time (P<0.05).

Conclusion: Infection with mucormycosis is associated with a risk factor that is renal impairment or failure. Additionally, renal function affects the prognosis of the disease, which is described as morbidity and mortality.

Keywords: Renal function, Mucormycosis, Follow up.

INTRODUCTION

Mucormycosis is an aggressive microbial infection caused by fungi of the zygomycete family that can result in various illnesses. In most situations, underlying problems promote hosts to infection. Because the fungi involved are common environmental microbes, they are generally non-pathogenic in immunocompetent people [1].

The most prevalent clinical manifestation of mucormycosis is a rhino-cerebral infection, thought to begin with individual inhalation of spores into the paranasal sinuses. The most prevalent underlying disorder is hyperglycemia, which is typically coupled with metabolic acidosis [2,3].

Pulmonary mucormycosis (PM) is a fast-progressing infection caused by inhaling spores into the alveoli and bronchioles, causing pneumonia resulting in necrosis and infarction. Diabetic Mellitus (DM) is less

likely to have pulmonary infections than rhino-orbital-cerebral infections [4].
GI mucormycosis (GIM): Although uncommon, mucormycosis of the gastrointestinal system may arise due to intake of spores [5].
Cutaneous mucormycosis (CM) is caused by the injection of spores into the dermis. Consequently, cutaneous mucormycosis is usually invariably linked to wounds or trauma [6].
The organism's angio-invasive propensity causes frequent dissemination throughout the body. Kidney impairment is observed in the disseminated type of the disorder [4].
Renal isolated involvement with mucormycosis has been documented, and it is thought to arise through kidney seeding throughout the fungemia phase. Nearly all individuals with isolated kidney mucormycosis have indicators of risk for fungemia, such as intravenous drug intake, catheter, or HIV. Cases with renal mucormycosis (RM) typically have flank pain and fever. The infection might be unilateral or bilateral [6].
Mucormycosis has been described as a consequence or final event in cases with chronic kidney disease undergoing therapy. However, it is uncommon in cases with undetected renal failure. Cases with chronic renal failure on continuous hemodialysis and those using deferoxamine medication for aluminum toxicity have been observed to be more prone to mucormycosis [7].
Several studies examined the possible correlation between kidney functions and mucormycosis, So the present work aimed to assess and follow up on the renal function in patients with common types of mucormycosis in two central hospitals at Sharqia Governorate (Zagazig University Hospitals and El Ahrar Educating Hospital).

Subjects and methods

Patients:

This Cohort study was conducted at Zagazig University Hospital and El Ahrar Educating Hospital in Sharqia Governorate. We selected 36 patients admitted with confirmed mucormycosis infection for at least two weeks to assess renal function during the disease course. Twelve patients with normal kidney function (Group 1), 12 patients with renal impairment on conservative treatment (Group 2), and 12 patients with renal failure on regular hemodialysis (Group 3).

Verbal and written informed consent was obtained from all participants after explaining the procedure and medical research. The research was conducted under the World Medical Association's Code of Ethics (Helsinki Declaration) for human research. This study was carried out after the approval of the Institutional Review Board (IRB#943317-4-2022).
Cases with confirmed mucormycosis were included in the current study. Patients (or Relatives) refusing participation were excluded. Diagnosis of mucormycosis was established either a confirmed or suspected infection based on EORTC/MSG criteria [8] or a likely diagnosis of mucormycosis only if accompanied by a positive Mucorales quantitative polymerase chain reaction (qPCR).Briefly, patients with hematological malignancies, who had been on chemotherapy for at least 3 months before enrolment, transplant recipients including bone marrow, liver, lung and kidney, patients with neutropenia (<500 neutrophils/mm^3) for >10 days, patients with long-term use of corticosteroids for >3 weeks and immunosuppressive drugs in the past 90 days and patients with uncontrolled diabetes or histologically proven mucormycosis.

Methods:

All cases were subjected to complete history taking and clinical and local assessment (chest, heart, abdomen, musculoskeletal system, and CNS).
Laboratory investigations included erythrocyte sedimentation rate (ESR), complete blood picture (CBC), arterial blood gases (ABG), blood sugar level (HA1C, postprandial blood sugar test, fasting blood sugar test, and random blood sugar test), liver function, renal profile including (creatinine, blood urea nitrogen, urea, uric acid, Na, K, Cl, Ca and Ph), Bleeding profile including (PT, PTT and INR).
Radiological investigations, including computerized tomography (CT) plus magnetic resonance imaging (MRI), will done to diagnose mucormycosis, pelviabdominal ultrasound (PAUS), chest x-ray, and ECG.

Statistical Analysis:

Data were analyzed with SPSS version 23.0 (SPSS Inc., Chicago, Illinois, USA). Quantitative data were reported as mean, standard deviation, and ranges for parametric distributions, whereas non-normally distributed variables were provided as median with an interquartile range. In addition,

qualitative characteristics were reported as numbers and percentages. The Kolmogorov-Smirnov and Shapiro-Wilk tests were used to determine the normality of the data. When comparing two or more means, employ a one-way analysis of variance (ANOVA) and a post-hoc test. Tukey's test was employed for multiple comparisons between variables. Chi-square and Fisher's exact tests were used to compare groups using qualitative data. The Chi-square test was only used when the anticipated count in any cell was <5. A P-value <0.05 was considered significant.

RESULTS

Regarding G1, the mean age was 50.42±10.45, and the mean BMI was 24.33±5.57. While in G2, the mean age was 51.92±11.09, the mean BMI was 23.42±3.85. In addition, G3 mean age was 50.42±8.41. The mean BMI was 24.67±4.54. There was no significant difference between groups regarding demographic data and comorbidities (Table 1).

There was a highly significant difference between groups respecting the presentation of renal mucormycosis ($p<0.05$) (Table 2). There was a significant difference between groups regarding symptoms of renal mucormycosis ($p<0.001$) (Table 3).

Lymph count, albumin, random blood sugar, and HbA1C doddered significantly between the studied groups ($p<0.001$) (Table 4).

There was a highly significant difference between groups respecting S.Creatinine, blood urea nitrogen, urea, and sodium level on admission, Middle time (3^{rd} to 4^{th} months from start of the study), and Last time (5^{th} and 6^{th} months) ($P<0.05$) (Table 5).

There was a significant difference between groups respecting K, Ca, Ph, and PT levels On admission, Middle time, and Last time (Table 6). The mortality rate was 50, 58.3, and 83.3% in G1, G2, and G3 respectively (Table 7).

Table (1): Comparison between groups according to Demographic data.

Demographic data	Group 1 (n=12)	Group 2 (n=12)	Group 3 (n=12)	Test value	p-value	P1	P2	P3
Age (years)	50.42±10.45 (36-68)	51.92±11.09 (38-67)	50.42±8.41 (38-65)	0.089	0.915	0.736	1.000	0.712
Gender Female Male	 4 (33.3%) 8 (66.7%)	 5 (41.7%) 7 (58.3%)	 3 (25.0%) 9 (75.0%)	0.750	0.687	0.677	0.661	0.396
BMI [wt/ (ht)^2]	24.33±5.57 (18-34)	23.42±3.85 (18-32)	24.67±4.54 (20-34)	0.227	0.798	0.646	0.871	0.475
DM	3 (25.0%)	4 (33.3%)	4 (33.3%)	0.262	0.877	0.661	0.661	1.000
HTN	4 (33.3%)	5 (41.7%)	4 (33.3%)	0.241	0.887	0.677	1.000	0.677

BMI: body mass index, wt: weight, ht: height, DM: diabetes mellitus, HTN: Hypertension

Using: One way Analysis of Variance test was performed for Mean±SD & Multiple comparison between groups through Post Hoc test: Tukey's test

Chi-square test for Number (%) or Fisher's exact test, when appropriate

p-value >0.05 is insignificant; p-value <0.05 is significant; p-value <0.001 is highly significant

P1: Comparison between group 1 and group 2

P2: Comparison between group 1 and group 3

P3: Comparison between group 2 and group 3

Table (2): Comparison between groups according to Presentation of mucormycosis.

	Group 1 (n=12)	Group 2 (n=12)	Group 3 (n=12)	Test value	p-value	P1	P2	P3
Presentation of Rhinoorbito cerebral mucormycosis								
Intranasal painless ulcerations	6 (50.0%)	5 (41.7%)	4 (33.3%)	0.686	0.710	0.689	0.416	0.677
Exudate necrotic tissue	6 (50.0%)	5 (41.7%)	4 (33.3%)	0.686	0.710	0.689	0.416	0.677
Orbital oedema	6 (50.0%)	5 (41.7%)	4 (33.3%)	0.686	0.710	0.689	0.416	0.677
Black discolouration	6 (50.0%)	5 ((41.7%)	4 (33.3%)	0.686	0.710	0.689	0.416	0.677
Presentation of pulmonary mucormycosis								
Decreased air entry	4 (33.3%)	4 (33.3%)	3 (25.0%)	0.262	0.877	1.000	0.661	0.661
Wheezy chest	4 (33.3%)	4 (33.3%)	3 (25.0%)	0.262	0.877	1.000	0.661	0.661
Coarse crepitations	4 (33.3%)	4 (33.3%)	3 (25.0%)	0.262	0.877	1.000	0.661	0.661
Desaturation	4 (33.3%)	4 (33.3%)	3 (25.0%)	0.262	0.877	1.000	0.661	0.661
Presentation of cutaneous mucormycosis								
Cellulitis	0 (0.0%)	0 (0.0%)	1 (8.3%)	2.057	0.358	1.000	0.318	0.318
Skin abscesses	0 (0.0%)	0 (0.0%)	1 (8.3%)	2.057	0.358	1.000	0.318	0.318
Skin swelling then necrotic tissue	0 (0.0%)	0 (0.0%)	0 (0.0%)	<0.001	1.000	1.000	1.000	1.000
Presentation of gastrointestinal mucormycosis								
Abdominal tenderness	1 (8.3%)	2 (16.7%)	0 (0.0%)	2.182	0.336	0.542	0.318	0.147
Hematemesis and melena	1 (8.3%)	2 (16.7%)	0 (0.0%)	2.182	0.336	0.542	0.318	0.147
Presentation of disseminated mucormycosis								
Orbital oedema	7 (58.3%)	6 (50.0%)	7 (58.3%)	0.225	0.894	0.689	1.000	0.689
Intranasal painless ulcerations	7 (58.3%)	6 (50.0%)	7 (58.3%)	0.225	0.894	0.689	1.000	0.689
Black discolouration	7 (58.3%)	6 (50.0%)	7 (58.3%)	0.225	0.894	0.689	1.000	0.689
Wheezy chest	5 (41.7%)	5 (41.7%)	6 (50.0%)	0.225	0.894	1.000	0.689	0.689
Crepitations	5 (41.7%)	5 (41.7%)	6 (50.0%)	0.225	0.894	1.000	0.689	0.689
Decreased air entry	5 (41.7%)	5 (41.7%)	6 (50.0%)	0.225	0.894	1.000	0.689	0.689
Presentation of renal mucormycosis								
Muddy Face	0 (0.0%)	0 (0.0%)	12 (100.0%)	36.000	<0.001	1.000	<0.001	0.002
L.L oedema	0 (0.0%)	0 (0.0%)	12 (100.0%)	36.000	<0.001	1.000	<0.001	0.002
Chest shows bilateral basal crackles	0 (0.0%)	7 (58.3%)	12 (100.0%)	24.297	<0.001	0.002	<0.001	0.013

L.L: lower limb

Using: One way Analysis of Variance test was performed for Mean±SD & Multiple comparison between groups through Post Hoc test: Tukey's test

Chi-square test for Number (%) or Fisher's exact test, when appropriate

p-value >0.05 is insignificant; p-value <0.05 is significant; p-value <0.001 is highly significant

P1: Comparison between group 1 and group 2

P2: Comparison between group 1 and group 3. P3: Comparison between group 2 and group 3

Table (3): Comparison between groups according to Symptoms of renal mucormycosis.

Symptoms of renal mucormycosis	Group 1 (n=12)	Group 2 (n=12)	Group 3 (n=12)	Test value	p-value	P1	P2	P3
Irritability	0 (0.0%)	0 (0.0%)	12 (100.0%)	36.000	<0.001	1.000	<0.001	<0.001
Anorexia	0 (0.0%)	0 (0.0%)	12 (100.0%)	36.000	<0.001	1.000	<0.001	<0.001
Nausea	0 (0.0%)	7 (58.3%)	12 (100.0%)	24.297	<0.001	0.002	<0.001	0.013
Vomiting	0 (0.0%)	7 (58.3%)	12 (100.0%)	24.297	<0.001	0.002	<0.001	0.013
Generalized Fatigue	0 (0.0%)	0 (0.0%)	12 (100.0%)	36.000	<0.001	1.000	<0.001	<0.001
Oliguria	0 (0.0%)	7 (58.3%)	3 (25.0%)	10.246	0.006	<0.001	<0.001	<0.001
Anurea	0 (0.0%)	0 (0.0%)	9 (75.0%)	24.000	<0.001	1.000	<0.001	<0.001

Using: One way Analysis of Variance test was performed for Mean±SD & Multiple comparison between groups through Post Hoc test: Tukey's test
Chi-square test for Number (%) or Fisher's exact test, when appropriate
p-value >0.05 is insignificant; p-value <0.05 is significant; p-value <0.001 is highly significant
P1: Comparison between group 1 and group 2
P2: Comparison between group 1 and group 3
P3: Comparison between group 2 and group 3

Table (4): Comparison between groups according to laboratory data

	Group 1 (n=12)	Group 2 (n=12)	Group 3 (n=12)	Test value	p-value	P1	P2	P3
Lymph count *absolute number* (1-3.5)^1000	3232.8±1099.6 (1096-4712)	946.7±141.8 (781-1170)	1015.4±139.3 (829-1228)	48.760	<0.001	<0.001	<0.001	0.244
Lymph count *relative number* (20-45)%	34.42±8.84 (23-50)	36.17±7.64 (25-48)	35.42±7.59 (26-49)	0.143	0.867	0.609	0.769	0.812
ESR (<20 mm|h)	38.58±10.08 (20-50)	37.33±11.27 (22-50)	33.42±6.87 (23-48)	0.949	0.397	0.777	0.157	0.316
CRP (<5 mg|l)	37.08±15.72 (13-61)	60.17±23.13 (22-98)	54.33±28.69 (18-93)	3.231	0.052	0.009	0.081	0.589
Albumin (3-5.2) g|dl	2.49±0.27 (2.1-2.9)	4.10±0.52 (3.5-5)	4.00±0.55 (3.2-4.9)	45.614	<0.001	<0.001	<0.001	0.652
Random Blood sugar (70-160) mg|dl	190.50±44.2 (146-234)	138.75±32.9 (90-195)	142.17±38.4 (87-192)	109.616	<0.001	0.004	0.009	0.817
HbA1C (<5.7%)	7.64±0.31 (7.1-8.1)	5.5±0.75 (4.5-6.4)	5±0.91 (4.1-6)	76.718	<0.001	<0.001	<0.001	0.156

ESR: erythrocyte sedimentation rate, CRP: C- Reactive protein, HBA1c: hemoglobin A1c
Using: One way Analysis of Variance test was performed for Mean±SD & Multiple comparison between groups through Post Hoc test: Tukey's test
Chi-square test for Number (%) or Fisher's exact test, when appropriate
p-value >0.05 is insignificant; p-value <0.05 is significant; p-value <0.001 is highly significant
P1: Comparison between group 1 and group 2
P2: Comparison between group 1 and group 3
P3: Comparison between group 2 and group 3

Table (5): Comparison between groups according to S.Creatinine, blood urea nitrogen, uric acid, and sodium levels.

	Group 1 (n=12)	Group 2 (n=12)	Group 3 (n=12)	Test value	p-value	P1	P2	P3
Creatinine								
On admission	0.90±0.19 (0.6-1.2)	3.75±1.48 (2-6)	9.42±2.31 (7-13)	89.084	<0.001	<0.001	<0.001	<0.001
Middle time	1.35±0.68 (0.6-2.5)	5.83±2.72 (2-9)	9.42±2.31 (7-13)	44.412	<0.001	<0.001	<0.001	<0.001
Last time	2.01±1.4 (0.6-4)	8.58±5.3 (2-15)	12.75±3.4 (7-18)	25.250	<0.001	<0.001	<0.001	0.032
Blood urea nitrogen								
On admission	36.33±7.89 (22-47)	79.58±10.65 (62-97)	110.58±14.13 (91-130)	133.465	<0.001	<0.001	<0.001	<0.001
Middle time	46.42±17.85 (22-68)	112.67±39.29 (62-170)	123.00±19.02 (95-148)	27.952	<0.001	<0.001	<0.001	0.421
Last time	54.75±26.21 (22-84)	157.75±82.67 (62-298)	166.83±64.98 (92-245)	11.880	<0.001	<0.001	<0.001	0.767
Uric acid								
On admission	4.70±0.42 (4.1-5.3)	7.30±0.17 (7-7.5)	7.05±0.36 (6.5-7.6)	222.008	<0.001	<0.001	<0.001	0.041
Middle time	5.83±1.55 (4.1-7.4)	7.43±0.27 (7-7.8)	7.05±0.36 (6.5-7.6)	9.670	<0.001	0.002	0.007	0.319
Last time	5.90±1.48 (4.2-7.4)	7.52±0.37 (7-8)	7.25±0.55 (6.5-8)	10.291	<0.001	<0.001	0.007	0.172
Na level								
On admission	139.67±3.37 (135-145)	139.67±3.37 (135-145)	136.00±3.44 (130-140)	4.678	0.016	1.000	0.015	0.015
Middle time	139.75±3.25 (136-145)	135.50±3.61 (130-141)	134.83±4.26 (128-140)	6.138	0.005	0.006	0.004	0.682
Last time	140.00±3.05 (136-145)	138.75±4.88 (131-145)	134.83±4.26 (128-140)	5.103	0.012	0.459	0.003	0.047

Na: Sodium, Middle time: 3rd to 4th months, Last time: 5th to 6th months

Using: One way Analysis of Variance test was performed for Mean±SD & Multiple comparison between groups through Post Hoc test: Tukey's test

Chi-square test for Number (%) or Fisher's exact test, when appropriate

p-value >0.05 is insignificant; p-value <0.05 is significant; p-value <0.001 is highly significant

P1: Comparison between group 1 and group 2

P2: Comparison between group 1 and group 3

P3: Comparison between group 2 and group 3

Table (6): Comparison between groups according to K, Ca, Ph, and PT level.

	Group 1 (n=12)	Group 2 (n=12)	Group 3 (n=12)	Test value	p-value	P1	P2	P3
K level								
On admission	4.08±0.40 (3.5-4.7)	4.13±0.54 (3.5-5.5)	5.15±0.43 (4.5-5.8)	21.081	<0.001	0.799	<0.001	<0.001
Middle time	4.43±0.67 (3.7-5.8)	4.43±0.87 (3.5-5.7)	5.15±0.43 (4.5-5.8)	4.472	0.019	1.000	0.005	0.017
Last time	4.44±0.80 (3.6-5.8)	4.51±1.03 (3.5-6.2)	5.61±0.41 (5-6.2)	8.257	0.001	0.854	<0.001	0.002
Ca level								
On admission	9.15±0.36 (8.6-9.7)	7.55±0.36 (7-8.1)	7.43±0.68 (6.5-8.5)	46.480	<0.001	<0.001	<0.001	0.594
Middle time	8.58±0.40 (8-9.2)	7.85±0.36 (7.3-8.4)	7.83±0.53 (7.1-8.6)	11.469	<0.001	<0.001	<0.001	0.915
Last time	9.55±0.36 (9-10.1)	8.05±0.36 (7.5-8.6)	7.85±0.52 (7-8.6)	58.441	<0.001	<0.001	<0.001	0.285
Ph level								
On admission	7.40±0.03 (7.35-7.45)	4.55±0.36 (4-5.1)	4.74±0.44 (4-5.4)	279.019	<0.001	<0.001	<0.001	0.259
Middle time	7.40±0.03 (7.35-7.45)	4.55±0.36 (4-5.1)	4.83±0.38 (4.2-5.4)	322.308	<0.001	<0.001	<0.001	0.077
Last time	7.40±0.03 (7.35-7.45)	4.55±0.36 (4-5.1)	4.78±0.39 (4.2-5.4)	320.838	<0.001	<0.001	<0.001	0.147
PT								
On admission	10.86±0.80 (10-12.5)	10.92±0.85 (10-11.8)	11.55±0.36 (11-12.1)	1.965	0.093	0.860	0.012	0.027
Middle time	10.94±0.75 (10.1-12.5)	10.96±0.49 (10.3-11.8)	11.64±0.35 (11.1-12.1)	6.226	0.005	0.939	0.007	<0.001
Last time	10.98±0.77 (10.1-12.5)	11.00±0.47 (10.3-11.8)	11.55±0.36 (11-12.1)	3.995	0.028	0.939	0.0298	0.004

Na: Sodium, K: potassium: phosphorus, CA: Calcium, PT: Prothrombin time, Middle time: 3rd to 4th months, Last time: 5th to 6th months

Using: One way Analysis of Variance test was performed for Mean±SD & Multiple comparison between groups through Post Hoc test: Tukey's test

Chi-square test for Number (%) or Fisher's exact test, when appropriate

p-value >0.05 is insignificant; p-value <0.05 is significant; p-value <0.001 is highly significant

P1: Comparison between group 1 and group 2

P2: Comparison between group 1 and group 3

P3: Comparison between group 2 and group 3

Table(7): Comparison between groups according to CT finding and outcome.

CT finding	Group 1 (n=12)	Group 2 (n=12)	Group 3 (n=12)	Test value	p-value	P1	P2	P3
CT findings								
Rhino-orbitocerebral	6 (50.0%)	5 (41.7%)	4 (33.3%)	0.686	0.710	0.689	0.416	0.677
Pulmonary mucormycosis	4 (33.3%)	4 (33.3%)	3 (25.0%)	0.262	0.877	1.000	0.661	0.661
Gastrointestinal	1 (8.3%)	2 (16.7%)	0 (0.0%)	2.182	0.336	0.542	0.318	0.147
Disseminated mucormycosis	1 (8.3%)	1 (8.3%)	3 (25.0%)	1.858	0.395	1.000	0.282	0.282
Renal mucormycosis	0 (0.0%)	0 (0.0%)	1 (8.3%)	2.057	0.358	1.000	0.318	0.318
Outcome								
Mortality	6 (50.0%)	7 (58.3%)	10 (83.3%)	3.130	0.209	0.689	0.090	0.187

CT: Computed Tomography

Using: One way Analysis of Variance test was performed for Mean±SD & Multiple comparison between groups through Post Hoc test: Tukey's test

Chi-square test for Number (%) or Fisher's exact test, when appropriate

p-value >0.05 is insignificant; p-value <0.05 is significant; p-value <0.001 is highly significant

P1: Comparison between group 1 and group 2

P2: Comparison between group 1 and group 3

P3: Comparison between group 2 and group 3

DISCUSION:

PM is a fast-progressing infection caused by inhaling spores into the alveoli and bronchioles, leading to pneumonia that provokes necrosis, and the infection may migrate to adjacent tissues, such as the mediastinum and heart, or spread in blood flow to other organs [9].

This study aimed to assess and follow up on the renal function in patients with common types of mucormycosis in two central hospitals at Sharqia Governorate (Zagazig University Hospitals and El Ahrar Educating Hospital). Assessing and monitoring renal function in common mucormycosis patients is crucial. It's also essential since renal function can alter outcomes in patients with mucormycosis. To our knowledge, this study is the first to assess renal function in patients with mucormycosis. Thus, we will gain a valuable scientific understanding of renal affection in mucormycosis patients. Many cases of renal insufficiency go unnoticed.

This study revealed no significant difference between groups regarding demographic data and co-morbidities.

In line with our findings, Bellazreg et al. [10] reported between 2000 and 2013, there were five instances of mucormycosis in hospitalized cases. One case was female, and four were males, with a mean age of sixty. Three individuals had DM, while one had acute leukemia. The regions of mucormycosis were pulmonary mucormycosis (PM), rhino-cerebral mucormycosis (RCM), rhino-orbital mucormycosis (ROM), auricular mucormycosis (AM), and cutaneous mucormycosis (CM).

Also, Patel et al. [2] aimed to characterize mucormycosis cases' demographics, risk factors, and outcomes. DM, with or without ketoacidosis, was the most incident risk factor. Nearly 40% of DM cases during mucormycosis diagnosis did not know about their condition. Other comorbidities were found in six cases: two had tuberculosis and ischemic heart disease (IHD) with end-stage renal failure (ESRD), and one had chronic obstructive pulmonary disease (COPD) and hypertension.

The current study reported no significant difference between groups according to the

presentation of Rhino-orbit-cerebral mucormycosis.

RCM is the most prevalent type, affecting mostly uncontrolled DM cases. It affects the orbits, sinuses, eyes, cranial nerves, brain, mandibles, soft and hard palates, and the face [11].

The current findings supported the result of Bellazreg et al. [10] as they showed that clinical symptoms included fever, peripheral facial palsy, orbital swelling, subcutaneous frontal abscess with mental disorientation, ear pain with purulent otorrhea, productive cough with dyspnea, left-sided hearing loss, and left leg necrotizing fasciitis. Ketotic decompensation was observed in three diabetic cases. All cases had antibiotics before mucormycosis diagnosis. Mucormycosis was diagnosed after an average of 17 days of hospitalization period (2-57 days).

Out of all the mucormycosis cases, Pandit et al. [12] showed that all cases had nasal involvement; 41.18% had ROM, and 53.57% had ROM. Intracranial infection was seen as meningitis, infarction, abscess, hemorrhage, or thrombosis.

The present findings illustrated a nonsignificant difference between groups according to the presentation of pulmonary mucormycosis.

PM is the second most prevalent kind type in cases with hematological cancers. It develops by breathing, lymphatic, or blood route [11].

This study demonstrated a nonsignificant difference between groups according to the presentation of cutaneous mucormycosis.

Skin maceration, burns, or trauma can all damage the intact skin barrier, resulting in CM [11].

The present study showed a nonsignificant difference between groups according to the presentation of gastrointestinal mucormycosis.

GIM is quite rare and suspected to be triggered by zygospore ingestion, especially among underweight and alcoholics [11].

Our study demonstrated a nonsignificant difference between groups according to the presentation of disseminated mucormycosis.

Regarding clinical presentation, Khaba et al. [13] showed that isolated disseminated and/or renal illness with renal involvement has been reported in both immunocompromised and immunocompetent people. An elevated level of suspicion in this population is prudent since early diagnosis aids in efficient and correct therapy. To lower the high fatality rate linked to this infection, multimodal treatment includes antifungal medicine, surgical debridement, and reversal of predisposing factors.

The present findings showed that there was a significant difference between groups respecting the symptoms of renal mucormycosis and a highly significant difference according to the presentation of renal mucormycosis.

Najjar et al. [14] showed that Several reported RM cases have been managed with a combination of unilateral or bilateral nephrectomy, posaconazole, and amphotericin B.

One systematic review by Didehdar et al. [15] analyzed 60 instances of RM and revealed that 60% received treatment with surgery and antifungal drugs, 12% with surgery alone, and 13% with antifungal medication alone. Only 2 of these eight patients received therapy with isavuconazole, which is not widely available in developing countries.

Najjar et al. [14] showed that cases with bilateral RM that survive nearly invariably require surgical debridement or nephrectomy and strong antifungal treatment with amphotericin B with or without posaconazole. The first known surviving instance of bilateral RM was in an individual who had bilateral nephrectomy and received amphotericin B deoxycholate, leaving the patient reliant on dialysis.

This study demonstrated a highly significant difference between groups regarding Hb and lymph count.

In accordance with the current results, Pandit et al. [12] showed that there was a significant relationship between increased age, DM, oxygen inhalation, a lower frequency of vaccination, elevated total leukocyte count (TLC), increased neutrophil count, increased eosinophils, creatinine, urea, ferritin, and D-dimer values resulting in the development of mucormycosis in COVID-19 cases, which was investigated in different suggested models.

The current findings reported a significant difference between groups respecting albumin, random blood sugar, HbA1C, serum creatinine, and blood urea nitrogen at admission, middle time, and last time.

Regarding laboratory assessment, Najjar et al. [14] showed that a case developed severe hypervolemia, oliguria, and hyperkalemia, with Cr peaking at 8.37 mg/L due to amphotericin B's nephrotoxicity. After six days of amphotericin B, isavuconazole was given to preserve renal function. After two hemodialysis treatments, hyperkalemia and urine output improved.

Nevertheless, Bavadiya et al. [16] showed The total number of individuals with aberrant values in various RFT report components and their proportions. Of 64 identified cases, 21 (32.8%) had urea levels over normal in RFT 1 (for the first time). 73.3% of cases in RFT 2 (second time) and 67.8% in RFT 3 (third time) had higher urea values than normal. 9.4% of cases (9.4%) had creatinine values exceeding normal in RFT 1. Amphotericin B administration causes a rise in creatinine levels in 31.25% of cases in RFT 2 and 34.38% of cases in RFT 3. In RFT 1, 32.8% of cases had reduced sodium concentrations, 40.26% in RFT 2, and 34.38% in RFT3. An elevated value of potassium was found in 6.25% of cases in RFT 1, 12.5% in RFT 2, and 7.8% in RFT 3.

A study in Ethiopia by Kene et al. [17] showed that cases with DM for >10 years were twice as likely to have impaired blood creatinine values as those with DM <10 years. Thus, long-term hyperglycemia may cause elevated serum creatinine concentrations in hospitalized mucormycosis cases.

In addition, Deitelzweig et al. [18] showed that in RFT 1, 32.8% of cases showed lower sodium values. Hyponatremia is thought to be prevalent among medical ward cases. They may appear at admission or increase throughout hospitalization.

This study agreed with Madduri et al. [19] as they reported 11 cases with RM. There have been cases of RM managed effectively with intravenous medication, although it was frequently linked with morbidity and the influence of adjacent tissue. RM is commonly detected in disseminated mucormycosis and has been linked to mortality rates of up to 75-100%. Survival rates for RM with a combination of antifungals and surgical debridement have been estimated to be 65%.

Our study demonstrated a significant difference between groups respecting uric acid, Na, and K at admission, Middle time, and Last time.

Interestingly, Najjar et al. [14] showed that hyperkalemia and cardiac arrest made her case challenging, but CPR saved her. To treat AKI, bilateral percutaneous nephrostomy tubes were inserted after hemodynamic stabilization. Right nephrostomy urine cultures produced Rhizopus species during this hospitalization, while blood cultures were negative. During her 10-day stay, she needed intermittent hemodialysis. She was discharged with the idea to continue isavuconazole after numerous later admissions for flank pain or leaking around her percutaneous nephrostomy tubes when she had ureteral stents removed and tubes exchanged. The case finished a six-month course of isavuconazole without interruption 18 months after his first presentation.

Our study demonstrated no significant difference between groups according to CT findings.

This study results aligned with Bellazreg et al. [10], who showed that pansinusitis was found in two cases on CT of the facial bones, with one patient also having a subcutaneous frontal abscess. A CT scan revealed pebbles filled a case's mastoid cells. A chest CT showed bilateral alveolar-interstitial infiltration and alveolar consolidation in the right lower lobe. A case's MRI revealed a bilateral, primarily frontal right lesion that was hyperintense on T2-Flair.

Our study reported a nonsignificant difference between groups in terms of mortality.

Mucormycosis has a poor prognosis with a mortality rate of 17–51%, as reported by Chamilos et al. [20]. Mortality is increased in individuals with active malignant blood disorders who had a diagnostic delay of more than five days and monocytopenia. Surgical therapy with antifungals enhances the prognosis [1]. The genus Mucorales offending did not affect the outcome. In a previous study by Anane et al. [21], mortality was

65%.

Pandit et al. [12] showed that 90-day poor clinical outcomes in cases were 32.66% higher than in the healthy individuals with 5.13% (p = 0.001) and significantly greater death rate in cases; 30.61% increased.

The study's strengths points include being one of the updated studies to the renal function in patients with common types of mucormycosis in two central hospitals at Sharqia Governorate at 2 centers (Zagazig University Hospitals and El Ahrar Educating Hospital). The investigations inside the lab were carried out by one person. There was a high selectivity of cases, and their samples were collected and stored very carefully.

Limitations of this study include a small sample size (total of 36 subjects); and its limited follow-up duration, which limited the study's ability to generalize to longer postoperative outcomes. Further larger studies are needed for validation of the current study findings.

Author contribution: OAAM for collected patients' samples and clinical data from outpatient clinic and hospitalized patients of Internal Medicine Departments of Zagazig University Hospital and Al Ahrar Teaching Hospital and prepared sample for laboratory investigations. All laboratory investigations were supervised by AMN. Statistical analysis, interpretation of data, and writing the manuscript were done by OAAM. Critical revision of the manuscript was performed by HMH & AMN. All authors have read and approved the final manuscript.

CONCLUSION

Infection with mucormycosis is associated with a risk factor that is renal impairment or failure. Additionally, renal function affects the prognosis of the disease, which is described as morbidity and mortality.

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