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ORIGINAL PAPER

Covid-19 in recipients of living donor liver transplantation: a worse or an equivalent outcome?

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Summary

Background: Coronavirus disease 2019 (Covid-19) pandemic is representing a massive burden to the community with the new virus. There is few data regarding Covid-19 in liver transplant patients. Concerns were raised regarding the course of the disease in transplanted patients due to immunosuppression and risk of hepatic injuries.
Aim: To describe the outcomes of Covid-19 infection in recipients of living-donor liver transplantation (LDLT).
Methods: Retrospective analysis of 41 recipients of LDLT diagnosed with Covid-19 by real-time PCR or CT chest criteria of Covid-19 between April 2020 and April 2021. This Cohort was derived from Ain Shams Center for Organ Transplantation database, Ain Shams Specialized Hospital, Cairo, Egypt, which is considered one of the largest centers of LDLT in the Middle East. Patients were classified to mild, moderate, severe and critics according to clinical classification released by the National Health Commission of China.
Results: A total of 41 patients and 2 patients with reinfection were included in this cohort with mean age 54 years with 74% male and 26% female. The body mass index ranged from 19.3 to 37. About 30% were described as a mild case, 46.5% were moderate, 14% were severe and 9% were critical cases. Two cases developed infection twice. Total of 20 patients (46.5%) were managed in home isolation setting, 17 patients (39.5%) needed admission to ward, 4 patients (9%) in intermediate care unit and 2 patients (4%) admitted to intensive care unit. About 60% of cases were on room air, only 3 patients needed invasive methods, 2 patients needed face mask and 1 case needed invasive CPAP. In total, 41 patients recovered (95%) and 2 patients (5%) died; 1 was Covid related and the other one was non-Covid related. Female gender, higher BMI and hypertension were associated with severe course of the disease.
Conclusion: In the setting of LDLT, the possibilities of catching Covid-19 infection are high due to chronic immunosuppression use. Yet, the outcome of infection in term of morbidity and the needs for hospital admission or intensive care is generally matched to general population.

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Core tip:

Concerns were raised regarding the course of Covid-19 in recipients of liver transplantation due to immunosuppression and risk of hepatic injuries. We analyzed the outcome of 41 recipients of living-donor liver transplantation (LDLT) infected with Covid-19 from April 2020 to April 2021. The possibilities of contracting Covid-19 infection are high in recipient of LDLT due to chronic immunosuppression use. However, the outcomes of infection in term of morbidities and the need for hospital admission or intensive care are generally matched to general population. Female gender, higher BMI and hypertension were associated with severe course of the disease.

Introduction

Coronavirus disease 2019 (Covid-19) is a serious respiratory illness caused by the Covid-19 virus.[1] The recent outbreak of Covid-19 since December 2019 has caused more than 20 million infection and 700 000 death.[2] The incidence and outcomes of Covid-19 in immune-compromised patients are a matter of debate.[3] It has been hypothesized that Covid-19 has two phases of the disease, first, an earlier phase of viral replication and a second phase of deregulation of CD4+ T cells, activation of CD8+ T cells and macrophages and a cytokine storm.[4] There is tremendous concern in the liver transplant community about the coronavirus disease. Outcomes of Covid-19 in liver transplantation (LT) recipients are not yet well known and scares data are available to guide the management of recipients of liver transplant infected with Covid-19. No clear policy for LT program adjustment during this critical period of time. Data reported a higher mortality among LT recipients but attributed this to comorbidities.[5] As in general population. Older age and chronic comorbidities as hypertension and diabetes are considered the most serious risk factors for severe clinical form of Covid-19.[6]

Objectives

This study aims to describe the outcomes of Covid-19 infection in recipients of living-donor liver transplantation (LDLT).

Materials and methods

This Cohort was derived from Ain Shams Center for Organ Transplantation database, Ain Shams Specialized Hospital, Cairo, Egypt that is considered one of the largest centers of LDLT in the Middle East. We retrospectively analyzed data of recipients of LDLTs who had Covid-19 infection. Patients who received LT undergo lifelong surveillance by the transplantation team and they are instructed to make contact for any health-related issue.

All liver transplant recipients with known Covid-19 from April 2020 and April 2021 were enrolled, Covid-19 was confirmed by a real-time reverse transcriptase polymerase chain reaction (RT-PCR) assay of nasal and pharyngeal swab or typical computed tomography (CT) chest finding of Covid-19. All clinical information was collected. Demographic data, comorbidities, clinical features, laboratory parameters and transplant-related information including baseline immunosuppression (IS) (drugs and trough concentrations) were recorded. Modifications of IS therapy were registered as well as specific drugs prescribed for Covid-19.

Patient were classified into mild, moderate, severe and critics according to clinical classification released by the National Health Commission of China:[7]

a. Mild: mild clinical manifestation, none imaging performance.
b. Moderate: fever, respiratory symptoms, pneumonia performance on X-ray or CT.
c. Severe: meet any of the followings:
   1. Respiratory distress, RR≥30/min.
   2. Oxygen saturation ≤93% at rest state.
   3. A ratio of arterial partial pressure of oxygen to fraction of inspired oxygen (PaO_2/FiO_2) <300 mm Hg.
d. Critics: meet any of the followings:
   1. Respiratory failure needs mechanical ventilation.
   2. Shock.
   3. Multiple organ failure.
   4. Patients need intensive care unit (ICU) monitoring and treatment.

Management protocols for Covid-19 were broadly according to the national Ministry of Health recommendations, which were updated frequently according to available guidelines. Patients were admitted to hospital if they had hypoxemia (arterial oxygen partial pressure <70 mmHg) and/or radiological chest X-ray abnormalities. Patients with significant comorbidities or who were over the age of 60 years were also admitted at the discretion of the responsible clinician even if they did not fulfill the above-mentioned criteria.

Recovery was defined according to Center of disease control, which recommended that for those home isolated; isolation, and precautions was discontinued 10 days after symptom onset and after resolution of fever for at least 24 h and improvement of other symptoms and for severely ill (i.e. those requiring hospitalization, intensive care or ventilation support) extension of isolation and precautions up to 20 days after symptom onset and after resolution of fever and improvement of other symptoms.[8]

This study was approved by the Ethical Committee of Ain Shams University Hospitals (Cairo, Egypt) in accordance with the local research governance requirements.

The collected data were revised, coded, tabulated and introduced to a PC using Statistical package for Social Science (SPSS 25). Data were presented and suitable analysis was done according to the type of data obtained for each parameter.

Descriptive statistics:

1. Mean, standard deviation (± SD) and range for parametric numerical data, while median and interquartile range (IQR) for non-parametric numerical data.
2. Frequency and percentage of non-numerical data.

Analytical statistics:

1. 'ANOVA test' was used to assess the statistical significance of the difference between more than two study group means.
2. 'The Kruskal–Wallis test' was used to assess the statistical significance of the difference between more than two study group ordinal variables.
3. '*Post hoc* test' is used for comparisons of all possible pairs of group means.
4. 'Chi-square test' was used to examine the relationship between two qualitative variables.

5. 'Fisher's exact test' was used to examine the relationship between two qualitative variables when the expected count is <5 in more than 20% of cells.

P-values <0.05: significant (S).

Results

A total of 41 patients and 2 cases of reinfection were included in this cohort with mean age 54 years with 74% male and 26% female, and the body mass index (BMI) ranged from 19.3 to 37, the main etiology for LT was HCV in 53%, time from date of transplantation and infection ranged from 0.27 to 134.73 month with mean of 54.26 and 5 patients had unstable graft function in terms of elevated liver enzymes with 11.9% as shown in Table 1.

Including the 2 state of reinfection with a total 43 cases (The number of cases is 41, 2 cases had infection twice and so the total number is considered to be 43), 26 patients (60.5%) were on multiple IS eith CNI (calcineurin inhibitors)+ [everolimus/mycophenolate mofetil (CellCept) and mycophenolate sodium (myfortic)/steroid] while 17 (39.5%) as described in Table 1.

About 30% were described as a mild case, 46.5% were moderate, 14% were severe and 9% were critical cases, two cases catched infection twice. The main presenting symptom was fever in 86% and sore throat in 32%, CT chest was bilateral in 51% and free in 30% as shown in Table 2.

The mean white blood cell count in the studied group was 5.4, the mean of absolute lymphocyte count was 1.1, the mean of C-reactive protein (CRP) was 28.59, the mean for ferritin was 491.64 and the mean of D-dimer was 1.07 as shown in (Table 3).

Table 2. Course of disease in the studied group

		N	%
Severity	Mild	13	30.2
	Moderate	20	46.5
	Severe	6	14.0
	Critical	4	9.3
Symptoms	Fever	37	86.0
	Sore throat	14	32.6
	Diarrhea	7	16.3
	Fatigue	23	53.5
	Headache	9	20.9
	Cough	25	58.1
	Loss of smell	5	11.6
	Abdominal pain	3	7.0
	Loss of taste	5	11.6
	Vomiting	5	11.6
	Dyspnea	15	34.9
	Neurological manifestation	2	4.7
	Nausea	1	2.3
CT chest	Free	13	30.2
	Unilateral	4	9.3
	Bilateral	22	51.2
	Generalized	4	9.3
O_2 saturation		95.44 (86–99)[a]	3.41[b]

[a]Mean.
[b]SD.
Range in parenthesis.

Table 1. Characteristics of the whole study group

		Mean/N	SD/%
Age		54.47 (27–68)[a]	8.18
Sex	Male	32	74.4%
	Female	11	25.6%
BMI		28.65 (19.3–37)[a]	3.96
Smoking	No	41	95.3%
	Yes	2	4.7%
DM		21	48.8%
HTN		26	60.5%
Other co-morbidity		13	30.2%
Etiology for LTX	HCV	23	53.5%
	HBV	1	2.3%
	HCC	12	27.9%
	Autoimmune	3	7.0%
	Others	4	9.3%
MELD score		16.07 (8–26)[a]	3.82
Time between transplantation and infection (months)		54.26 (0.27–134.73)	40.61
Stable graft function before infection	No	5	11.6%
	Yes	38	88.4%
Multiple IS	Single	17	39.5%
	Multiple	26	60.5%
Type of IS	Cyclosporine	18	41.9%
	Tacrolimus	24	55.8%
	Everolimus	3	7.0%
	MMF	23	53.5%
	Steroids	4	9.3%
Long-term anticoagulation pre-Covid-19 infection		11	25.6%
Long-term antiplatelet pre-ovid-19 infection		40	93%

[a]Range.
IS, immunosuppression; LTX, liver transplantation; MMF, mycophenolate mofetil.
The number of cases is 41 ,2 cases had infection twice and so the total number is considered to be 43

Table 3. Laboratory investigation of the studied group pre- and post-Covid-19 infection

	Mean	SD	Median (IQR)	Range
WBC count (thousands/cm)	5.54	3.97	4 (2.8–6.5)	(2–16)
Absolute lymphocyte count (10^9/l)	1.10	0.63	1 (0.7–1.3)	(0.2–3)
Absolute neutrophil count (10^9/l)	98.82	452.27	2.2 (1.55–5)	(1–2600)
HBG (g/dl)	11.88	1.98	12 (11–13)	(6–15.3)
Platelet (thousands/cm)	151.84	48.17	152 (124–183)	(52–267)
AST (pre)	40.53	27.92	34 (23–46)	(9–135)
ALT (pre)	38.26	29.08	27 (20–45)	(11–140)
T.bil (pre)	1.17	0.96	0.9 (0.7–1.4)	(0.3–5.9)
Creatinine	1.38	1.08	1.2 (1–1.4)	(0.4–7)
CRP	28.59	29.52	17 (6.7–35)	(0–96)
Ferritin	491.64	371.34	412 (231–670)	(46–2000)
D-dimer	1.07	1.08	0.8 (0.5–1.3)	(0.2–5.6)
AST (post)	33.84	25.74	24 (16–44)	(11–135)
ALT (post)	39.28	36.07	24 (18–54)	(3–195)
T.bil (post)	1.19	1.31	1 (0.7–1.2)	(0.2–8.9)
Alk.p	203.30	189.65	120 (83–256)	(28–756)
GGT	172.35	241.35	65 (34–227)	(11–1057)
Cyclosporin level	122.63	72.82	102 (83–143)	(45–363)
Tacrolimus level	4.34	2.45	4 (2.94–5)	(0–10)

Regarding management of the cases, 20 patients (46.5%) were managed in home isolation, 17 patients (39.5%) needed admission to ward, 4 patients (9%) in intermediate care unit and 2 patients (4%) in ICU, 60% of cases were on room air, only 3 patients needed invasive methods, 2 patients needed face mask and 1 case needed invasive CPAP (Table 4). IS was stopped in 76% of cases, the range for hospital stay was (0–90) with mean of 7.33 and the range for ICU stay was (0–7) and the mean was 0.79, 41 patients recovered (95%) and 2 patients (5%) died 1 from Covid related and the other 1 was non-Covid related (Table 4). Disease course was more severe in female gender (*P*-values =0.016), in higher BMI ($P = 0.046$) and hypertensive, no statistical significance was found between age, diabetes (DM), other comorbidities (rather than diabetes and hypertension) and any type of treatment and the severity of disease as shown in Table 5.

Neither the use of multiple IS drugs before infection with Covid-19 nor steroid use were correlated significantly with disease severity as highlighted in Table 5.

No statistical significance was found between total white blood cell count, lymphocytic count, D-dimer or ferritin and disease severity as shown in Table 6.

No statistical significance was found between use of multiple IS drugs and steroid before catching Covid-19 infection and disease outcome in term of recovery or death this is shown in Table 7.

Discussion

We presented our data of 41 adult recipients of LDLT who were diagnosed of Covid-19 by testing positive via respiratory swab of RT-PCR with two cases developed Covid-19 infection twice. At the beginning of the pandemic, a great concern has been raised regarding the virus affection toward recipients of LDLT and potential morbidities and mortalities of liver transplant recipients.

This analysis confirmed the favorable outcomes and low mortality of LDLT recipients following Covid-19 infection, besides suggestions that patients did not develop poor early liver outcomes during the Covid-19 infection.

Predominant AST elevation has been reported frequently but not severe in Covid-19[9] likely due to the direct virus-induced hepatotoxicity, drug induced liver injury, sepsis and hemodynamic instability in severe cases.[10] In the present cohort study liver dysfunction was mild in most of the cases presented by post-infection AST, ALT, total bilirubin, alkaline phosphatase and GGT values. None of the cases developed liver failure. One case of Covid-related mortality was due to respiratory failure and multi-organ failure not as a sequalae of liver dysfunction. The illness course showed stable graft function, median AST, ALT; 34/27, total bilirubin 0.9, ALP, GGT were 120, 65, respectively.

Kidney function was stable in 41 (98%) of the patients with median Creatinine value post-Covid-19 infection of 1.2 mg/dl (IQR 1–1.4 mg/dl).

No liver dysfunction symptoms have been reported in our study, such as; Jaundice, tremors and encephalopathy, all the report symptoms were along the usual Covid-19 symptoms.[11] The reported symptoms in our cohort of 41 patients included fever (86%), sore throat (32.6%), fatigue (53.5%), diarrhea (16.3%), cough (58.1), loss of smell and taste (11.6%) and abdominal pain (7%).

Management of recipients who develop Covid-19 and their prognosis is still not well understood. A study from Lombardy (Italy) reported 3 deaths from Covid-19 out of 111 recipients.[12] The deceased patients were males with cardiovascular risk over 60 years old and high BMI over 28 kg/m^2, Covid-19 deaths among general population were associated with presence of old age, cardiovascular risk and obesity.[13]

At the beginning of the Covid-19 era, there were scares data regarding IS stoppage post-transplant during Covid-19 infection, the fear of flaring of the infection drive us to discontinue IS in 76% of patients especially severely ill and hospitalized ones but with advancement of information and the appearance of guidelines that reported that IS containing tacrolimus was associated with better survival in liver transplant recipients with Covid-19[14] while those containing mycophenolate was a predictor of severe Covid-19 in liver transplant recipients,[3] we started to follow international recommendations.

Table 4. Management of the studied groups

		N/mean	%/SD
Setting of treatment	Home isolation	20	46.5
	Ward	17	39.5
	Intermediate care	4	9.3
	ICU	2	4.7
O_2 treatment	Room air	26	60.5
	Nasal O_2 2–6l	14	32.6
	Face mask	2	4.7
	Invasive CPAP	1	2.3
Antiviral	None	16	37.2
	Hydroxychloroquine	17	39.5
	Iverzine	5	11.6
	Remdesivir	5	11.6
Anti-inflammatory/immunomodulator	None	9	20.9
	Methylprednisolone	17	39.5
	Solumedrol	13	30.2
	Dexamethasone	4	9.3
Antibiotic	Azithromycin	22	51.2
	Meropenem	8	18.6
	Meropenem + linezolid	10	23.3
	Meropenem + azithromycin	3	7.0
Anticoagulant	None	2	4.7
	Prophylaxis	21	48.8
	Therapeutic	20	46.5
Type of anticoagulation post	None	2	4.7
	LMWH	22	51.2
	DOACs	19	44.2
Antifungal		5	11.6%
IS stoppage	No	10	23.3
	Yes	33	76.7
Type of IS stopped	CNI	9	27.3
	MMF	7	21.2
	CNI and MMF	17	51.5
Hospital stay in days		7.33[a] (0–90)	14.54[b]
ICU stay in days		0.79[a](0–7)	1.87[b]
Outcome	Recovered	41	95.3
	Death	2	4.7

[a]Mean.
[b]SD.
Range in parenthesis.
LMWH, low molecular weight heparin; DOACS, direct acting oral anticoagulation; IS, immunosuppression; CNI, calcineurin inhibitors; MMF, mycophenolate mofetil.

In our study, we reported two mortality cases (Covid-19 related). The clinical presentation of both cases was rapidly deteriorating with initial inflammatory markers (CRP, Ferritin) levels were highly elevated. That was in association with severe pneumonia and presence of Klebseilla in bronco-alveolar culture, which led to septic shock and patient's death. Some authors hypothesized that the Covid-19 pneumonia initiated the course toward mortality of the cases.[15] We disagree with this theory, as it did not explain the rapid deterioration of the cases, in which the cases were treated with aggressive antibiotic coverage, steroids and hydroxychloroquine.

Hyperinflammatory status resulting in acute respiratory distress syndrome is commonly seen among Covid-19 severe and critical cases[16] resulting in cytokine storm and elevated levels of IL-6, IL-12 and tumor necrosis factor alpha.[17] Tocilizumab (a monoclonal antibody) binds to IL-6 receptor inhibiting its signal transduction. The REMAP-CAP adaptive trial produced preliminary results of the efficacy of tocilizumab 8 mg/kg on 353 critically ill patients in addition to corticosteroids therapy. The hospital mortality at Day 21 was 28% (98/350) for tocilizumab.[18] These data favor the blockage of pro-inflammatory mediators resulting in better therapeutic outcomes in severe and critical cases, even before invasive mechanical ventilation. On the contrast, a randomized trial involving the hospitalized patients with severe Covid-19, it did not result in better clinical outcomes and lowering mortality after usage of tocilizumab only.[19]

Antiviral usage in solid organ transplant recipients with Covid-19 was widespread in the early months of the pandemic,[20] as LPV/R, and was recommended as a line of therapy in many centers. Recent trials showed no effect on mortality and hospital stay regarding the administration of remdesivir, hydroxychloroquine and LPV/R.[21] In our opinion, we noticed a clinical impact of remdesivir therapy in improving the outcome in our cohort similar to the general population guided by the recommendations of NIH and IDSA Covid-19 guidelines, which should be applied on these patients as well.[22,23]

The liver transplant recipients have peculiar course. Boyarsky *et al.*[13] described that more than half of the infected recipients developed severe form of the disease. These results

Table 5. Relation between socio-demographic data and type of treatment with severity of the disease

		Group			Test of significance		
		Mild	Moderate	Severe and critical			
		Mean±SD N (Row %)	Mean±SD N (Row %)	Mean±SD N (Row %)	Value	P-value	Sig.
Age		51.92 ± 10.52	54.7 ± 6.66	57.3 ± 7.26	f=1.251	0.297[a]	NS
Sex	Male	11 (34.38%)	11 (34.38%)	10 (31.25%)		0.016[d]	S
	Female	2 (18.18%)	9 (81.82%)	0 (0%)			
BMI		26.4 ± 3.17	29.62 ± 4.13	29.62 ± 3.64	f=3.336	0.046[c]	S
Smoker	No	13 (31.71%)	18 (43.9%)	10 (24.39%)		0.487[d]	NS
	Yes	0 (0%)	2 (100%)	0 (0%)			
DM	No	10 (45.45%)	7 (31.82%)	5 (22.73%)	5.549[b]	0.062	NS
	Yes	3 (14.29%)	13 (61.9%)	5 (23.81%)			
HTN	No	9 (52.94%)	7 (41.18%)	1 (5.88%)	8.617[b]	0.013	S
	Yes	4 (15.38%)	13 (50%)	9 (34.62%)			
Other co-morbidity	No	9 (30%)	12 (40%)	9 (30%)		0.246[d]	NS
	Yes	4 (30.77%)	8 (61.54%)	1 (7.69%)			
Multiple IS	Single	6 (46.15%)	10 (50%)	1 (10%)	X^2 =4.804	0.091[e]	NS
	Multiple	7 (53.85%)	10 (50%)	9 (90%)			
Steroids	No	12 (92.31%)	19 (95%)	8 (80%)		0.433[d]	NS
	Yes	1 (7.69%)	1 (5%)	2 (20%)			
Long-term anticoagulant pre-COVID-19 infection	No	10 (31.25%)	14 (43.75%)	8 (25%)		0.908[d]	NS
	Yes	3 (27.27%)	6 (54.55%)	2 (18.18%)			
Long-term antiplatelet pre-COVID-19 infection	No	2 (66.67%)	1 (33.33%)	0 (0%)		0.434[d]	NS
	Yes	11 (27.5%)	19 (47.5%)	10 (25%)			
IS stoppage	No	2 (20%)	7 (70%)	1 (10%)		0.274[d]	NS
	Yes	11 (33.33%)	13 (39.39%)	9 (27.27%)			
Type of IS stopped	CNI	4 (44.44%)	4 (44.44%)	1 (11.11%)		0.057[d]	NS
	MMF	3 (42.86%)	4 (57.14%)	0 (0%)			
	CNI and MMF	3 (17.65%)	5 (29.41%)	9 (52.94%)			
Antiviral	None	7 (43.75%)	7 (43.75%)	2 (12.5%)		0.164[d]	NS
	Hydroxychloroquine	5 (29.41%)	6 (35.29%)	6 (35.29%)			
	Iverzine	0 (0%)	5 (100%)	0 (0%)			
	Remdesivir	1 (20%)	2 (40%)	2 (40%)			
Anti-inflammatory/ immunomodulators	None	4 (44.44%)	5 (55.56%)	0 (0%)		0.244[d]	NS
	Methylprednisolone	5 (29.41%)	9 (52.94%)	3 (17.65%)			
	Solumedrol	4 (30.77%)	4 (30.77%)	5 (38.46%)			
	Dexamethasone	0 (0%)	2 (50%)	2 (50%)			
Anticoagulant post-COVID-19 infection	None	2 (100%)	0 (0%)	0 (0%)		0.086[d]	NS
	Prophylaxis	8 (38.1%)	10 (47.62%)	3 (14.29%)			
	Therapeutic	3 (15%)	10 (50%)	7 (35%)			
Type of anticoagulation post	None	2 (100%)	0 (0%)	0 (0%)		0.16[d]	NS
	LMWH	8 (36.36%)	10 (45.45%)	4 (18.18%)			
	DOACs	3 (15.79%)	10 (52.63%)	6 (31.58%)			

[a]One way ANOVA test of significance (f=one way ANOVA test value).
[b]*Post-hoc* LSD test was significant between:
[c]mild group vs. (moderate and severe and critical groups).
[d]Fisher's exact test of significance.
[e]Chi-square test.
LMWH, low molecular weight heparin; DOACS, direct acting oral anticoagulation; IS, immunosuppression; CNI, calcineurin inhibitors; MMF, mycophenolate mofetil; BMI, body mass index.

did not match with our study; as only 6 (14%) and 4 (9.3%) of the cases were severe and critical, respectively.

We compare the course of the disease in recipients already on multiple IS drugs and on steroid before Covid-19 infection and we found that recipients on multiple IS and those on steroids had milder disease (although not statistically significant) although the correlation between disease severity and immunosuppressive status is generally poorly understood and controversial yet these data are supported by similar results from Verma *et al.*[24] in UK and Choudhury *et al.*[25] in India.

With reference to the mortality rates, results from European Liver and Intestine Transplantation Association and European Liver Transplant Covid-19 registry illustrated that recipients with older ages had higher mortality than younger ages and the disease could be more severe.[26] Our experience showed two (4.7%) deaths among all cases with no significance to age ($P = 0.297$), this is in agreement with Jadaun *et al.*[27] who reported that despite older age and higher proportion of comorbidities deaths in the studied group was not higher than general population. One of the major discovered problems in recipients with

Table 6. Relation between lab investigations and severity of the disease

	Group			Kruskal–Wallis test	
	Mild Median (IQR)	Moderate Median (IQR)	Severe and critical Median (IQR)	*P*-value	Sig.
WBC Count (thousands/cm)	4 (2.8–6.5)	4 (2.85–6.2)	4.3 (2.9–9.5)	0.837	NS
Absolute lymphocyte count (10^9/l)	1.1 (0.7–1.6)	0.95 (0.75–1.25)	0.7 (0.6–1.3)	0.387	NS
Absolute neutrophil count (10^9/l)	2.2 (2.0–5.5)	2.3 (1.4–4.11)	2.4 (1.5–7.5)	0.717	NS
CRP	9.9 (2.7–35)	16 (7.5–29)	35.5 (13.2–96)	0.126	NS
Ferritin	249 (195–550)	291.5 (232.5–646.5)	568 (285–670)	0.193	NS
D-dimer	0.55 (0.4–0.9)	0.7 (0.47–1.15)	1.1 (0.8–1.8)	0.076	NS

Table 7. Relation between the use of multiple IS and steroid before catching Covid-19 infection and disease outcome

		Outcome		Fisher's exact test	
		Recovery *N* (%)	Death *N* (%)	*P*-value	Sig.
Multiple IS	Single	17 (41.46)	0 (0)	0.511	NS
	Multiple	24 (58.54)	2 (100)		
Steroids	No	39 (95.12)	0 (0)	0.007	S
	Yes	2 (4.88)	2 (100)		

IS, immunosuppression.

Covid-19 infection is the lack of consistency between the suggestive symptoms of Covid-19 and the positive results of RT-PCR, leading to a longer window of infection.[28] In our center, we established specific safe patient circuit for suspected clinical cases in order to minimize the community acquired transmission. We encouraged telemedicine communication between the patients and the transplant physicians, patient and family education about frequent infection control procedures and social distancing policies and raising the awareness among our recipients toward potential Covid-19 symptoms.

Conclusions

In the setting of LDLT, the risk of being chronically immunosuppressed increases the possibility of catching Covid-19 infection but the outcomes in term of morbidity and the needs for hospital admission or intensive care is generally matched to population.

Limitation of this study is the small sample size, the pandemic is extra exceptional event and we hope these data to add benefit to better understanding the course of Covid-19 in such special group of patients who underwent LDLT.

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Ethical approval

The study was approved by the Research and Ethical Committee of faculty of medicine, Ain Shams University, Cairo, Egypt in accordance with local research governance requirements.

Conflict of interest. None declared.

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