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Is Early COVID-19 in Kidney Transplant Recipients Concerning Enough to Halt Transplantation? A Multicenter Comparative Analysis from India

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ABSTRACT

Background. Limited data exist on the incidence and outcome of early coronavirus disease 2019 (COVID-19) in kidney transplantation recipients (KTR).

Methods. A retrospective multicenter research study was conducted across 12 centers in India. We explored the symptomatology, demographic, laboratory findings, and outcome of COVID-19 within 30 days of transplantation. The outcome was compared with the overall KTR and waitlisted patients acquiring COVID-19.

Results. The incidence of early COVID-19 was 2.6% (n = 22) for the cumulative 838 renal transplants performed since nationwide lockdown in March 2020 until May 2021. Overall, 1049 KTR were diagnosed with COVID-19 and 2% of those had early COVID-19. The median age of the early COVID-19 cohort was 43 (31-46) years. COVID-19 severity ranged from asymptomatic (18.2%), mild (59.1%), moderate (9.1%), and severe (13.6%). Among clinical symptoms, dyspnea and anosmia were frequent, and in laboratory parameters, neutrophil lymphocyte ratio, high-sensitivity C-reactive protein, and D-dimer were higher in patients requiring oxygen. The mortality in early COVID-19 was not higher than overall KTR (4.5% vs 8.5%; P = 1). COVID-19 severity (23.9% vs 15.7%; P = .0001) and mortality (15.5% vs 8.5%; P = .001) among waitlisted patients (n = 1703) were higher compared with overall KTR.

Conclusions. We report higher burden of COVID-19 in waitlisted patients compared with KTR and a favorable outcome in early COVID-19 in KTR. Our report will help the transplant physicians in dealing with the ongoing dilemma of halting or resuming transplantation in the COVID-19 era.

ORO navirus disease 2019 (COVID-19) ceased transplan-
tation activity in almost all parts of the world for a while, and resumption of transplantation became an altogether strenuous task, especially in densely populated nations like India with a high COVID-19 tally and unprecedented surges [1]. Many transplant centers resumed stepwise transplant activities...
outcomes [3-11]. However, there is a scarcity of data from
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plantation has been extensively reviewed in both developing 
coronavirus 2 (SARS-CoV-2) infection in solid organ trans-
safety of donors, recipients, and health care workers are jeopar-
during the COVID-19 era [2]. Because the 
safety of donors, recipients, and health care workers are jeopard-
dized, the logistics and ethics involved for transplantation in the 
COVID-19 era are intricate. Severe acute respiratory syndrome 
coronavirus 2 (SARS-CoV-2) infection in solid organ trans-
plantation has been extensively reviewed in both developing and 
newly emerging nations with wide diversity in clinical profile and 
outcomes [3-11]. However, there is a scarcity of data from 
developing nations about COVID-19 as an early infection when 
transplantation was restarted after a halt by the pandemic. Early 
COVID-19 in a transplant patient can possibly have a lethal out-
come. The three major research questions to contemplate in the 
context of resuming transplantation are:

1. Do kidney transplant recipients (KTR) acquiring early 
COVID-19 have a worse outcome compared with those who 
acquire COVID-19 later?
2. Is the outcome of early COVID-19 poor enough to the extent 
that it would hinder the transplant activity?
3. Is the severity of COVID-19 worse for transplant patients 
compared with waitlisted patients?

The aim of this report was to study the clinical profile and 
outcome of early COVID-19 in KTR and compare the outcomes 
of COVID-19 in KTR with waitlisted patients.

MATERIALS AND METHODS
Ethical Statement
The study was designed as a retrospective study and was approved by 
the institutional ethical committee (ECR/143/Inst/GJ/2013/RR-19). All 
transplant activities performed in the centers were in accordance with 
the regulations of the Declaration of Helsinki, Declaration of Istanbul, 
and Transplantation of Human Organs Act. The research strictly 
 adheres to the Strengthening The Reporting of Observational Studies in 
Epidemiology checklist for reporting the data.

Settings
Data were explored from the following 12 transplant centers in 
India: Institute of Kidney Diseases and Research Centre, Dr. H. L. 
Trivedi Institute of Transplantation Sciences, Ahmedabad, Gujarat; 
Rabindranath Tagore International Institute of Cardiac Sciences, 
Kolkata; Muljibhai Patel Urological Hospital, Nadiad, Gujarat; 
Osmania General Hospital, Hyderabad; Nizam’s Institute of Medi-
cal Sciences, Panjangutta, Hyderabad; Institute of Post-Graduate 
Medical Education & Research, Kolkata; Manipal Hospital, Banga-
lore; Kovai Medical Centre and Hospital, Coimbatore, Tamil Nadu; 
Jaslok Hospitals, Mumbai; Centre Yashoda Hospitals, Secundera-
bad; Indira Gandhi Institute of Medical Science, Patna; and Lake-
shore Hospital, Kochi, Kerala.

Study Population
All KTR with confirmed COVID-19 diagnosed through SARS-CoV-2 
real-time polymerase test from nasopharyngeal sample were included in 
the study period of May 2020 to January 2021 (n = 10). For two centers 
(Institute of Kidney Diseases and Research Centre and Rabindranath 
Tagore International Institute of Cardiac Sciences), the data were

adjudicated until May 2021. The waitlisted patients detected with COVID-
19 were also included in the study. KTR with early COVID-19 were 
described for symptoms, laboratory findings, and treatment alternatives. The COVID-19 severity was divided as per the World Health Organization (WHO) grading into asymptomatic, mild, moderate, and severe [12].

Transplantation Protocol Followed in the Centers in the 
COVID-19 Era
All the donor recipient pairs (DRP) were advised to practice COVID-19 
etiquette such as social distancing, face masks, and hand hygiene for 
14 days before surgery. All the DRP underwent routine pretransplant 
evaluation as per the Kidney Disease: Improving Global Outcomes 
guidelines [13,14]. Additionally, two consecutive negative SARS-CoV-
2 real-time polymerase test results with normal radiology and no symp-
toms were mandatory for proceeding for transplant in DRP. Dedicated 
separate health care worker staffs were assigned to minimize the chan-
ces of hospital-acquired transmission. All the doctors and health care 
workers involved underwent routine preliminary clinical and epidemi-
ologic daily checkups for COVID-19. In summary, all transplantation activity carried out in the COVID-19 era was conducted as per the national guidelines [15] for transplantation. The authors also have previously 
documented the protocol for donor-recipient management in 
COVID-19-recovered donors [16] and recipients [17] in the context of 
living-related transplantation. There was no modification in practice of 
induction or immunosuppressive drug regimen, and the decision was 
based on the patient’s immunologic profile. The duration of admission 
before transplant for DRP was restricted to 1 to 2 days. Additionally, 
the discharge from the hospital after surgery was done as early as possi-
ble to prevent hospital-acquired infection.

Management of Early COVID-19 in KTR
The ideal regimen for the management of early COVID-19 is unknown. 
As a mark of caution, antimetabolites were stopped in even asymptom-
atic and mild cases of early COVID-19, whereas in moderate to severe 
COVID-19, both calcineurin inhibitors and antimetabolites were 
reduced. Because of the uncertainty in the course of early COVID-19, 
most patients patients were hospitalized regardless of their clinical con-
dition and were strictly followed through telemedicine for any unfavor-
able outcome once discharged. Even in mild cases, some centers have 
used antiviral drugs like remdesivir. Systemic steroids were used in all 
of the moderate and severe cases.

Data Collection and Statistical Analysis
A national call was raised to the 21 transplant centers, of which data 
from 12 centers were collected. The detailed pro forma for the study was 
created by two authors (V.B.K. and H.S.M.) in a Microsoft Excel 
(Microsoft Corporation, Redmond, Wash, United States) spreadsheet and 
distributed to all the centers through email. The final data were assembled 
in a master Excel spreadsheet and analyzed in SPSS v 21 (IBM Corp., 
Armonk, NY) software. No specified sample size was planned in the 
study. Continuous data were expressed as median and interquartile range 
and categorical data as numbers and percentage. The characteristics 
of recent transplants were compared between modified WHO ordinal scale 
≤3 and ≥4. The modified WHO ordinal scale [18] used was as follows: 
1 = At home with no limitations of activities; 2 = At home with slight 
limitations; 3 = Hospitalized and on ambient air; 4 = Low-flow oxygen 
therapy; 5 = High-flow oxygen or non-rebreather mask; 6 = Bilevel posi-
tive pressure ventilation; 7 = Mechanical ventilation; and 8 = Death. The 
comparison between the two groups was made through χ² test with Yates
correction, Fisher exact test, and \( t \) test as appropriate. The data comparing the severity of COVID-19 and associated mortality in waitlisted, recent transplants and overall KTR were also analyzed. The limitation of the design was that the finer details comparing the differences in risk factors for mortality in the 3 groups were not investigated from all of the centers. A 2-tailed \( P \) value of \(< .05\) was considered statistically significant.

RESULTS

Since the imposition of a national lockdown in India in late March 2020, 838 renal transplants were performed across 12 centers until May 2021. Deceased donor transplantation contributed to only 9.6\% (\( n = 81 \)) of the total transplants. Further, 47 recovered recipients and 20 recovered donors were transplanted across these centers. Thus, the incidence of early COVID-19 calculated overall was 2.6\%. The incidence was higher in deceased transplants (6.1\% vs 2.37\%; \( P = .06 \)) compared with living-related transplants, although not statistically significant. In total, 1049 KTR were diagnosed with COVID-19 and 2\% (\( n = 22 \)) of those had early COVID-19. A total of 1703 waitlisted patients were reported in the study.

Demographic Characteristics

The median age of the early cohort was 40.5 (31-46) years with oxygen requirement more in the older age group, although statistically insignificant (38 [25-45] vs 46 [31-54.5]; \( P = .19 \)). A high proportion of cases occurred in living-related transplantation (\( n = 17, 77.3\% \)) compared with deceased donor (\( n = 5, 22.7\% \)). The induction used varied according to the immunologic profile and included thymoglobulin (\( n = 17, 77.3\% \)) no induction (\( n = 3, 13.6\% \)), and interleukin 2 (IL-2) blocker (\( n = 2, 9.1\% \)). There was no difference in severity of COVID-19 as per the native kidney disease as detailed in Table 1.

### Table 1. Demographic of the Cohort Compared as per the WHO Ordinal scale of COVID-19 Severity

| Characteristic | Total Cases (\( n = 22 \)) | WHO Ordinal scale \( \leq 3 \) (\( n = 17 \)) | WHO Ordinal Scale \( \geq 4 \) (\( n = 5 \)) | \( P \) Value |
|---------------|-----------------------------|-----------------------------|-----------------------------|-------------|
| Age (y)       | 40.5 (31-46)                | 38 (25-45)                  | 46 (31-54.5)                | .19         |
| Female sex    | 5 (22.7)                    | 4 (23.5)                    | 1 (20)                      | > .99       |
| Blood group distribution |                   |                             |                             |            |
| A             | 1 (4.5)                     | 1 (5.9)                     | 0 (0)                       | > .99       |
| B             | 7 (31.8)                    | 5 (29.5)                    | 2 (40)                      | > .99       |
| AB            | 4 (18.1)                    | 4 (23.5)                    | 0 (0)                       | .53         |
| O             | 10 (45.6)                   | 7 (41.1)                    | 3 (60)                      | .62         |
| Transplant type |                         |                             |                             |            |
| Deceased donor | 5 (22.7)                   | 4 (23.5)                    | 1 (20)                      | > .99       |
| Living-related compatible |    |                             |                             | > .99       |
| Native kidney disease |                 |                             |                             | > .99       |
| Diabetes      | 8 (36.5)                    | 6 (35.2)                    | 2 (40)                      | > .99       |
| Hypertension  | 5 (22.7)                    | 3 (17.6)                    | 2 (40)                      | .54         |
| Unknown etiology | 3 (13.6)                  | 2 (11.7)                    | 1 (20)                      | > .99       |
| Chronic glomerulonephritis | 3 (13.6)                | 3 (17.6)                    | 0 (0)                       | > .99       |
| Obstructive uropathy | 2 (9.1)                    | 2 (12.1)                    | 0 (0)                       | > .99       |
| Others        | 1 (4.5)                     | 1 (5.8)                     | 0 (0)                       | > .99       |
| Induction regimen |                         |                             |                             |            |
| Thymoglobulin | 17 (77.3)                   | 14 (82.4)                   | 3 (60)                      | .54         |
| Interleukin-2 blocker | 2 (9.1)                  | 1 (5.9)                     | 1 (20)                      | .41         |
| Graftalon      | 0 (0)                       | 0 (0)                       | 0 (0)                       | > .99       |
| No induction   | 3 (13.6)                    | 0 (0)                       | 1 (20)                      | .22         |
| Comorbidities, n (%) |                     |                             |                             |            |
| Hypertension   | 16 (72.7)                   | 12 (70.5)                   | 4 (80)                      | > .99       |
| Diabetes       | 6 (27.2)                    | 4 (23.5)                    | 2 (40)                      | .58         |
| Heart disease  | 1 (4.5)                     | 1 (5.9)                     | 0 (0)                       | > .99       |
| Obesity        | 5 (22.7)                    | 3 (17.6)                    | 2 (20)                      | .54         |
| None           | 3 (13.6)                    | 2 (11.7)                    | 1 (20)                      | > .99       |
| \( \geq 2 \) comorbidities | 4 (18.1)                | 2 (11.7)                    | 2 (40)                      | .2          |
| Days from transplantation to COVID-19 | 14 (10-25)               | 13 (9-22)                   | 14 (11-26)                  | .61         |
| Other characteristics |                           |                             |                             |            |
| ACEI/ARB use   | 15 (68.1)                   | 12 (70.5)                   | 3 (60)                      | > .99       |
| History of pneumococcal vaccine | 2 (9.1)                | 1 (5.9)                     | 1 (20)                      | .41         |
| History of desensitization therapy | 1 (4.5)                | 1 (5.9)                     | 0 (0)                       | > .99       |
| History of antirejection therapy given | 3 (13.6)              | 2 (11.7)                    | 1 (20)                      | > .99       |
| History of COVID-19 in pretransplant period | 1 (4.5)                | 1 (16.7)                    | 0 (0)                       | > .99       |
| Hospital-acquired COVID-19 | 4 (18.1)                | 3 (17.6)                    | 1 (20)                      | > .99       |

Data expressed as numbers (percentage) or median (interquartile range) as appropriate. Fisher exact test or \( \chi^2 \) test with Yates correction used for calculating \( P \) value. WHO ordinal scale \( \leq 3 \) = All patients at home or hospitalized on air. WHO ordinal scale \( \geq 4 \) = Any form of oxygen requirement.

ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; COVID-19, coronavirus disease 2019; WHO, World Health Organization.
Inflammatory Markers and Laboratory Profile

The laboratory parameters that were higher and statistically significant in cases with WHO ordinal scale ≥4 were as follows: Neutrophil lymphocyte ratio: (5 [1.8-6.5] vs 11.2 [16.3-6.1]; \( P = .005 \)), high-sensitivity C-reactive protein: (15 [7-37.2] vs 56 [12-76]; \( P = .002 \)), and D-dimer (960 [2760-560] vs 2500 [473-5240]; \( P = .04 \)). In contrast, there was no difference in baseline, peak, and discharge serum creatinine (1.16 [0.82-1.38] vs 1.4 [1.18-1.89]; \( P = .15 \)) among the ordinal scales. Similarly, interleukin-6 (14 [2-45] vs 28 [53-10]; \( P = .05 \)), serum ferritin (378 vs 200 [158-721]; \( P = .002 \)) were not higher with increasing ordinal scale ≥4.

Clinical Spectrum and Outcome

The cohort was classified as asymptomatic \( (n = 4, 18.1\% ) \), mild (13, 59.1\%), moderate \( (n = 2, 9.1\% ) \), and severe cases \( (n = 3, 13.6\% ) \) (Table 2). WHO ordinal scale of COVID-19 for the cohort included scales of 1 \( (n = 1, 4.5\% ) \), 2 \( (n = 1, 4.5\% ) \), 3 \( (n = 15, 68.3\% ) \), 4 \( (n = 2, 9.2\% ) \), 5 \( (n = 1, 4.5\% ) \), 6 \( (n = 1, 4.5\% ) \), 7 \( (n = 1, 4.5\% ) \), and 8 \( (n = 1, 4.5\% ) \). The most common symptoms reported were depression \( (n = 14, 63.6\% ) \), sleep disturbances \( (n = 13, 59\% ) \), cough \( (n = 13, 59\% ) \), fever \( (n = 13, 59\% ) \), fatigue \( (n = 9, 40.9\% ) \), and anxiety \( (n = 9, 40.9\% ) \). Radiologic involvement was reported in most of the cases \( (n = 13, 59\% ) \) but was higher with increasing ordinal scale \( (n = 8, 47% \) vs \( n = 5, 100\% ; P = .05 \))

Mycophenolate mofetil was stopped \( (n = 18, 81.8\% ) \) or tapered \( (n = 4, 18.1\% ) \) in most of the cases, and there was no difference between the 2 groups. Likewise, calcineurin inhibitors were stopped \( (n = 1, 4.5\% ) \) or tapered \( (n = 7, 31.8\% ) \) in a few cases. The common therapeutics used were remdesivir \( (n = 13, 59\% ) \), steroids \( (n = 9, 40.9\% ) \), and anticoagulation \( (n = 8, 36.4\% ) \). Acute kidney injury \( (n = 10, 45.4\% ) \) was reported in almost half of the cases.

Comparative Analysis

Table 3 shows the comparison of three groups of early COVID-19 \( (n = 22) \), overall COVID-19 \( (n = 1049) \), and waitlisted patients \( (n = 1703) \). In the analysis, early COVID-19 cases had relatively lesser mortality \( (n = 1, 4.5\% \) vs \( n = 87, 8.5\% ; P = 1) \) compared with COVID-19 in KTR beyond 1 month. The proportion of mild cases \( (n = 13, 59.1\% \) vs \( 398, 38.7\% ; P = .07) \) was higher in early COVID-19 and lower in moderate \( (n = 2, 9.1\% \) vs \( n = 279, 27.1\% ; P = .08) \) cases compared with COVID-19 in KTR beyond 1 month. There was a trend toward lesser severity and mortality in early COVID-19, but the difference was not statistically significant.

On comparison, the COVID-19 severity between overall KTR and waitlisted patients showed higher severity in the waitlisted groups. The proportion of asymptomatic cases \( (n = 193, 18.4\% \) vs \( 380, 22.3\% ; P = .01) \) was higher in waitlisted patients compared with KTR. Mild \( (n = 411, 39% \) vs \( 517, 30.4\% ; P = .0001) \) and moderate \( (281, 26.8\% \) vs \( 399, 23.4\% ; P = .05) \) cases were higher in KTR. Severe cases \( (n = 164, 15.7\% \) vs \( 407, 23.9\% ; P = .0001) \) were disproportionally higher in waitlisted patients. The 28-day case fatality \( (n = 88, 8.4\% \) vs \( n = 262, 15.4\% ; P = .001) \) reported in the waitlisted group was quite high compared with the overall KTR.

DISCUSSION

Early COVID-19 in organ transplantation has been reported scarcely with mixed results. Our study sheds light on this critical aspect of kidney transplantation in India where COVID-19 has exploded with global peaks in recent times. This retrospective cohort conducted amid the SARS-CoV-2 pandemic explored nationwide repositories of renal transplantation and waitlisted data. We explore a comprehensive analysis of the clinical profile and outcome of early COVID-19. The first case of COVID-19 in India was reported on January 27, 2020. The nation had complete lockdown in March 2020, with graded unlock periods to combat the spread of infection. During the months of lockdown, transplantation was at a complete halt. It was restored gradually, up until March 2021, when the second wave struck. Currently, in the second wave, all transplantation activities are ceased in many centers for the last 2 months. Overall, 838 renal transplantations (live = 757 and deceased = 81) were performed during the study period. The reported incidence of 2% early COVID-19 in our study was quite low. The exact source of infection is difficult to elucidate, but hospital-acquired infection occurred in only four cases. Moreover, all donors were tested thrice negative for COVID-19 before transplant and none of the donors had a history of recovery from COVID-19 before the nephrectomy, so the chance of donor-derived transmission was minimized.

Ideal Immunosuppression Protocol in the COVID-19 Era

The decision to tailor the immunosuppression protocol routinely during COVID-19 is tricky and controversial. There have been many reports of transplant centers reducing the immunosuppression protocol during the COVID-19 era [19,20]. The authors have previously reported no change in immunosuppression in their study of COVID-19-recovered donors or transplant candidates and found no COVID-19-related or unrelated complications in the follow-up. Recent US data showed a reduction in lymphocyte-depleting agent in the COVID-19 era and an increasing trend in IL-2 blockers [21]. Another study reported a 30% increase in IL-2 blocker use in the COVID-19 era [22]. In our report, there was no change in the induction or immunosuppression regimen routinely in the centers in the 838 transplants performed. In our report, we have precautionarily tailored the...
## Table 2. Detailed Comparison of the Clinical Symptoms, Laboratory Analysis, and Outcomes of the Cohort

| Variable                                      | Total Cases (n = 22) | WHO Ordinal Scale ≤3 (n =17) | WHO Ordinal Scale ≥4 (n = 5) | P Value |
|-----------------------------------------------|----------------------|-------------------------------|------------------------------|---------|
| **Cumulative COVID-19 symptoms**              |                      |                               |                              |         |
| Asymptomatic                                  | 4 (18.1)             | 4 (23.5)                      | 0 (0)                        | .53     |
| Subjective fever                              | 13 (59)              | 9 (52.9)                      | 4 (80)                       | .36     |
| Cough                                         | 13 (59)              | 10 (58.8)                     | 3 (60)                       | > .99   |
| Expectoration                                 | 4 (18.1)             | 3 (17.6)                      | 1 (20)                       | > .99   |
| Dyspnea                                       | 7 (31.8)             | 2 (11.7)                      | 5 (100)                      | .0008*  |
| Diarrhea                                      | 1 (4.5)              | 1 (5.9)                       | 0 (0)                        | > .99   |
| Myalgia                                       | 7 (31.8)             | 5 (29.4)                      | 2 (40)                       | > .99   |
| Fatigue                                       | 9 (40.9)             | 6 (35.2)                      | 3 (60)                       | .6      |
| Headache                                      | 2 (9.1)              | 2 (11.7)                      | 0 (0)                        | > .99   |
| Anosmia                                       | 3 (13.6)             | 3 (17.8)                      | 0 (0)                        | > .99   |
| Ageusia                                       | 6 (27.2)             | 3 (17.6)                      | 3 (60)                       | > .99   |
| Sleep disturbances                            | 13 (59)              | 8 (47)                        | 5 (100)                      | > .99   |
| Anxiety                                       | 9 (40.9)             | 6 (35.2)                      | 3 (60)                       | > .99   |
| Depression                                    | 14 (63.6)            | 10 (58.8)                     | 4 (80)                       | .61     |
| Alopecia                                      | 2 (9.1)              | 2 (11.7)                      | 0 (0)                        | > .99   |
| Others                                        | 3 (13.6)             | 3 (17.6)                      | 0 (0)                        | > .99   |
| Radiologic abnormalities detected             | 13 (59)              | 8 (47)                        | 5 (100)                      | .05*    |
| **Laboratory analysis of the cohort**          |                      |                               |                              |         |
| Hemoglobin, g/dL                              | 9.5 (9-11.5)         | 9.8 (9-11.9)                  | 9.2 (9.1-9.8)                | .45     |
| White blood cell count, per mm$^3$             | 6600 (5400-8800)     | 6600 (6200-8800)              | 6250 (3700-9470)             | .82     |
| Neutrophil lymphocyte ratio                   | 6 (2-9)              | 5 (1.8-6.5)                   | 11.2 (16.3-6.1)              | .005*   |
| Platelet count, × 10$^3$/mm$^3$                | 197 (155-268)        | 230 (183-281)                 | 90 (84-187)                  | .09     |
| IL-6, pg/mL                                   | 16.1 (5.8-45.7)      | 14 (2-45)                     | 28 (53-10)                   | .64     |
| hsCRP, mg/dL                                  | 15 (6-49.7)          | 15 (7-37.2)                   | 56 (12-76)                   | .002*   |
| D-dimer, ng/mL                                | 535 (1030-2765)      | 960 (2760-560)                | 2500 (473-5240)              | .04*    |
| Ferritin, ng/mL                               | 400 (145-920)        | 378 (859-145)                 | 600 (334-1381)               | .28     |
| LDH, IU/L                                     | 324 (215-376)        | 324 (231-351)                 | 200 (158-721)                | .2      |
| Serum creatinine, mg/dL                       |                       |                               |                              |         |
| Prior to COVID-19                              | 1.16 (0.82-1.38)     | 1.18 (0.8-1.55)               | 1.14 (0.9-1.28)              | .93     |
| Peak                                          | 1.4 (1.18-1.89)      | 1.23 (1.04-1.87)              | 1.8 (1.32-3)                 | .29     |
| Discharge                                      | 1.15 (0.93-1.45)     | 1.2 (0.87-1.49)               | 1.1 (0.9-1.5)                | .76     |
| **Immunosuppression modulation in COVID-19**   |                      |                               |                              |         |
| MMF tapered                                    | 4 (18.1)             | 3 (17.6)                      | 1 (20)                       | > .99   |
| MMF stopped                                    | 18 (81.8)            | 14 (82.3)                     | 4 (80)                       | > .99   |
| CNI tapered                                    | 7 (31.8)             | 4 (23.5)                      | 3 (60)                       | > .99   |
| CNI stopped                                    | 1 (4.5)              | 0 (0)                         | 1 (20)                       | > .99   |
| **Therapeutic regimen**                       |                      |                               |                              |         |
| Remdesivir                                     | 13 (59)              | 8 (47)                        | 5 (100)                      | .053    |
| Steroids                                       | 9 (40.9)             | 4 (23.5)                      | 5 (100)                      | .004*   |
| Anticoagulation                                | 8 (36.4)             | 3 (17.6)                      | 5 (100)                      | .002*   |
| Others                                        | 7 (31.8)             | 5 (29.4)                      | 2 (40)                       | > .99   |
| **Graft outcome**                              |                      |                               |                              |         |
| AKI                                           | 10 (45.4)            | 6 (35.2)                      | 4 (80)                       | .13     |
| AKI requiring HD                               | 1 (4.5)              | 0 (0)                         | 1 (20)                       | .22     |
| **WHO ordinal scale of oxygen requirement for COVID-19 ≤3** | 17 (77.3)             | 17 (100)                      | 0 (0)                        | .22     |
| **28-day mortality in COVID-19**               |                      |                               |                              |         |

Data expressed as numbers (percentage) or median (interquartile range) as appropriate. Fisher exact test or $\chi^2$ test with Yates correction used for calculating $P$ value. WHO ordinal scale for COVID-19 severity: 1 = at home with no limitations of activities; 2 = at home with slight limitations; 3 = hospitalized and on ambient air; 4 = low-flow oxygen therapy; 5 = high-flow oxygen or non-rebreather mask; 6 = Bi-level positive pressure ventilation; 7 = mechanical ventilation; 8 = Death. AKI, acute kidney injury defined by Kidney Disease: Improving Global Outcomes guidelines; CNI, calcineurin inhibitors; COVID-19, coronavirus disease 2019; HD, hemodialysis; hsCRP, high-sensitivity C-reactive protein; IL-6, interleukin-6; LDH, lactate dehydrogenase; MMF, mycophenolate; WHO, World Health Organization. * indicate a $P$-value value which is statistically significant.
Vaccination will play a prime role in combating COVID-19. And immunizing pretransplant patients before transplantation will be the new dictum in the COVID-19 era. Indian authorities have approved 3 vaccines (ChAdOx1 nCoV-19, BBV152, and Sputnik V) as of April 2021. As a staged approach for vaccination, individuals aged 45 years and older were included in April 2021, and people aged 18 years and over were included for inoculation in May 2021. Although vaccination is being
effectively implemented in many nations, India is battling its way out to inoculate such a bulk population. Currently, a vast majority of waitlisted patients and transplant candidates are unvaccinated in India. In our study where 831 transplant candidates underwent transplant, none received vaccination before surgery. The reports of adequate antibody response to COVID-19 vaccine in dialysis patients are encouraging [46]. Conversely, recent reports of low immunogenicity of the COVID-19 vaccine in organ transplants have raised the alarm bell for further research in the field of vaccine and transplantation [47-49].

Strength of the Study

The study describes the COVID-19 presentation and outcome in early transplant patients and is the largest cohort from the developing world reported to date. The large sample-sized data of KTR and waitlisted patients further adds to the study. The study involved a large number of patients, so applicability or universalization of the study is ensured. We found the incidence of early COVID-19 as low and with favorable outcomes. The telemedicine used for managing patients discharged after transplant proved to be an effective tool for preventing the spread of infection. Observations from the study can pioneer transplant centers to further boost their transplant activity while undertaking all preventive measures. More data are needed to better streamline the treatment protocol in the peritransplant period. Inflammatory phenotype was associated with high mortality in large meta-analysis both in general and in transplant patients [50].

Limitations

This retrospective analysis had a few inherent limitations. First, the results cannot be completely applied for other solid organ transplantation. However, the fact that the cohort had a high immunologic risk of receiving superadded immunosuppression negates this limitation. Secondly, COVID-19 has shown wide diversity in mortality and treatment modalities worldwide, so results should be interpolated accordingly. Third, a larger sample size of early COVID-19 cases could have enhanced the comparison performed.

CONCLUSIONS

We suggest the reason for cessation of transplantation should not be the fear of contracting COVID-19 in the early postrenal transplant period. The decision to halt should be primarily based on the resources available and the regional COVID-19 surge. The important message conveyed from our study is that with the available safety measures, it is clear that transplant centers should proceed with transplantation, checking the COVID-19 surge in their localities.

DATA AVAILABILITY

Data will be made available on request.

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