

Recommendations for SARS-CoV-2 testing and organ procurement from deceased donors in the Republic of Korea

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We present a summary of the evidence on testing for severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) and organ procurement from deceased donors and provide recommendations based on current clinical data and the guidelines from major transplant organizations. Because of the limited historical experience with coronavirus disease 2019 (COVID-19), certain recommendations in this document are based on theoretical rationales rather than clinical data. The recommendations in this manuscript may be subject to revision as subsequent clinical studies provide definitive evidence regarding COVID-19 in organ procurement.

Keywords: COVID-19; SARS-CoV-2; Tissue and organ procurement; Organ transplantation; Tissue donors

HIGHLIGHTS

- The coronavirus disease 2019 (COVID-19) pandemic resulted in significant changes in organ donation and transplantation.
- These recommendations summarize the evidence regarding COVID-19 and organ procurement.
- These recommendations can be revised as new data become available.

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic caused significant changes in organ donation and the transplantation environment worldwide, including a decrease in the number of donors and the availability of intensive care units [1]. With a lack of research on the transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) via organs in the early stages of the pandemic, it was recommended that transplantation of organs from deceased donors who tested positive for SARS-CoV-2 be avoided [2]. Subsequently, short-term observations showed the transmission of SARS-CoV-2 via organ transplantation in lung transplants only, accompanied by increasingly many reports of favorable outcomes in extrapulmonary organ transplantation from SARS-CoV-2-infected deceased donors [3-5]. Based on the guidelines of major transplant organizations, this study summarizes the available data for evaluating deceased donors for SARS-CoV-2 and the

considerations for organ procurement from deceased donors with a history of COVID-19. Our recommendations can be revised as new data become available. A summary of the study recommendations is presented in Supplementary Material 1.

EVALUATION OF DECEASED DONORS FOR SARS-COV-2

Personal Protective Equipment for the Organ Procurement Team

The personal protective equipment (PPE) requirements for COVID-19 such as masks (N95 equivalent), face shields, gloves, and gowns should follow the guidelines of the institution where the organ is recovered.

Verification of the Medical History of the Deceased Donor

The donor's COVID-19 history and history of close contact with COVID-19 patients should be obtained.

SARS-CoV-2 Testing for the Deceased Donor

The major national guidelines recommend testing respiratory specimens for SARS-CoV-2 using a polymerase chain reaction (PCR) test and obtaining specimens as close as possible to the time of organ procurement (Table 1). The Organ Procurement and Transplant Network (OPTN) [6] in the United States recommends obtaining a respiratory specimen for SARS-CoV-2 PCR testing within 72 hours of planned organ procurement. For lung procurement, a PCR test for SARS-CoV-2 on both upper

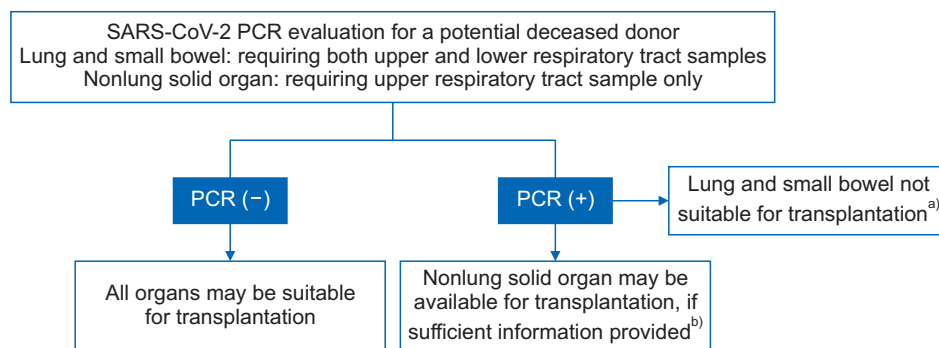


Fig. 1. Schematic flowchart for the assessment of SARS-CoV-2 testing and organ procurement from a deceased donor. SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; PCR, polymerase chain reaction. ^{a)}If patients had a history of coronavirus disease 2019 (COVID-19) within 21-90 days before transplantation, PCR positivity did not suggest virus viability. In this situation, lung and small bowel transplantation could be considered; ^{b)}Some guidelines suggest that all solid organ transplantation from a deceased donor with severe COVID-19 is contraindicated.

Table 1. Guidelines from the main international transplantation societies for SARS-CoV-2 testing and organ procurement from deceased donors

Guideline	OPTN (United States)	TSANZ (Australia & New Zealand)	NHSBT (United Kingdom)	CNT (Italy)	CST (Canada)
LRT SARS-CoV-2 PCR test for nonlung donation	No	No	Yes	Yes	Yes
Negative SARS-CoV-2 by PCR required	No	No	Yes	No	Yes
Donor SARS-CoV-2 PCR Ct value	No	No	No	No	No
Routine screening of donor for SARS-CoV-2 antibody	No	No	No	No	No
Analysis of donor organ quality	Yes	Yes	Yes	No	No
Specific recipient informed consent	Yes	Yes	Yes	Yes	Yes

SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; OPTN, Organ Procurement and Transplantation Network; TSANZ, The Transplantation Society of Australia and New Zealand; NHSBT, National Health Service Blood and Transplant; CNT, Centro Nazionale Trapianti (Italian Transplantation Society); CST, Canadian Society of Transplantation; LRT, lower respiratory tract; PCR, polymerase chain reaction; Ct, cycle threshold.

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and lower respiratory tract specimens is advised. There is insufficient evidence to support a recommendation for the PCR testing of nonpulmonary organs, tissues, or body fluids [6].

The Transplantation Society of Australia and New Zealand (TSANZ) [8] recommends PCR testing for SARS-CoV-2 on nasopharyngeal specimens obtained within 24 hours (up to 48 hours) of planned organ procurement for all deceased donors. Testing for SARS-CoV-2 in the lower respiratory tract is strongly recommended for lung procurement and is also encouraged for organ donation outside of the lungs. While tracheal aspiration for specimen collection is permitted, TSANZ recommends obtaining specimens through bronchoscopy in deceased donors with a previous history of COVID-19 infection.

The National Health Service (NHS) [9] guidelines in the UK recommend PCR testing for SARS-CoV-2 on nasal, nasopharyngeal, and tracheal aspirate specimens obtained within 24 hours (up to 48 hours) of planned organ procurement for all deceased donors. Among the 2,469 organ recoveries (including 75 lung recoveries) performed in the UK as of January 2021, 987 deceased donors had negative PCR tests for SARS-CoV-2 in both upper and lower airway specimens, and there was no evidence of COVID-19 transmission by solid organ transplantation [6].

The Canadian Society of Transplantation [10] recommends PCR testing for SARS-CoV-2 on upper and lower respiratory tract specimens obtained within 24 hours of planned organ procurement for all deceased donors. The Centro Nazionale Trapianti (Italian Transplantation Society; CNT) [7] in Italy recommends PCR testing for SARS-

CoV-2 in nasopharyngeal or lower respiratory tract specimens (bronchoalveolar lavage) obtained 24–48 hours prior to organ procurement in deceased donors. The Italian guidelines also suggest tissue testing for SARS-CoV-2 and histopathological evaluation for the liver and kidney, as well as PCR testing for SARS-CoV-2 in organ preservation fluid.

Utilization of Cycle Threshold Values for SARS-CoV-2 PCR Testing in Deceased Donors

Higher cycle threshold (Ct) values are frequently associated with lower viral loads and negative culture results, but there may be variations in results between individuals and different respiratory specimens [11]. Therefore, Ct values can be used as an adjunct tool to determine the potential for SARS-CoV-2 transmission, but are not recommended as an absolute criterion.

Utilization of SARS-CoV-2 Antibody Results in Deceased Donors

Due to a lack of research data, SARS-CoV-2 antibody testing is not recommended for assessing the safety or potential transmission risk to recipients.

Utilization of Chest Computed Tomography for COVID-19

Although chest computed tomography in COVID-19 patients can be helpful for early diagnosis and stratification of disease severity, its routine use for clinical decision-making regarding organ suitability or the characterization of organ donors is not recommended due to the limited sensitivity and specificity of this method [12,13].

ORGAN PROCUREMENT FROM A DECEASED DONOR WITH A POSITIVE PCR TEST FOR SARS-COV-2

Organ Procurement and Transplantation of the Lungs and Small Bowel

Procuring the lungs and small bowel from deceased patients with COVID-19 and a presumed risk of respiratory transmission is not recommended due to concerns for potential SARS-CoV-2 transmission and the limited experience with transplantation cases. In lung and intestinal transplantation, there is a possibility of COVID-19 transmission for 20 days after the onset of symptoms in the infected donor. Therefore, the procurement of lungs and small bowel from patients with COVID-19 is recommended only after this period of potential transmission risk (Fig. 1).

Cases were reported during the early phase of the pandemic in which COVID-19 was transmitted via lung transplantation from deceased donors who tested positive for SARS-CoV-2. The Disease Transmission Advisory Committee in the United States plays a role in evaluating and classifying the potential for transmission of infectious diseases during organ transplantation. Between March 2020 and March 2021, a total of 27 cases of COVID-19 were reported among recipients, and nine cases were reported among donors. Three of these cases involved COVID-19 transmission via lung transplantation from donors with COVID-19. In all three cases, the upper respiratory COVID-19 PCR test conducted prior to transplantation was negative, but the lower respiratory COVID-19 PCR test performed immediately after transplantation was positive [14,15]. As a result, the OPTN issued an urgent recommendation that starting May 27, 2021, all deceased donors with the potential for lung procurement must undergo testing of lower respiratory tract specimens for SARS-CoV-2 before proceeding with organ procurement [16]. Most countries, including the United States, currently do not recommend recovering lungs from COVID-19 patients with a presumed risk of respiratory transmission [6,8-10,17]. After this urgent recommendation, the OPTN reported that from May 27, 2021, to January 31, 2022, a total of 22 lung recoveries and transplantations had been performed from patients who tested positive for SARS-CoV-2 by PCR. In the 11 reported cases with available follow-up data, no deaths or transplant failures were observed within 30 days [5]. In 10 of the 11 cases, the upper respiratory tract tested positive for SARS-CoV-2 while the lower respiratory tract tested negative (Table 2). There-

fore, if only the upper respiratory tract PCR test is positive, lung transplantation could be considered for critically ill patients with high priority, if sufficient explanation is provided and consent is obtained from the patient and their guardians.

The potential risk of COVID-19 transmission may be higher in the small bowel than in other organs due to its abundant distribution of lymphoid tissue and the requirement for intense immunosuppression after transplantation [18]. In the OPTN data mentioned earlier, there were only two cases of small bowel procurement and transplantation within 21 days of a positive PCR result for SARS-CoV-2, and no information regarding the outcomes of these cases was provided [5]. Due to the lack of sufficient evidence to ensure safety, the guidelines from most countries did not recommend procurement of intestines from COVID-19 patients [6,8-10,17].

The respiratory transmission period for COVID-19 may vary according to the severity of the infection. For mild COVID-19, this period lasts approximately 10–14 days from the onset of symptoms, whereas for severe COVID-19, it can last approximately 20 days [19]. In a study conducted during the Omicron variant phase of the pandemic, the positivity rate for the viral cultures of respiratory specimens from patients with mild COVID-19 was reported as 17% between days 6–10 after symptom onset [20]. Another study reported that the positivity rates for the cultures of respiratory specimens were 13.5% on day 10 and 8% on day 14 after symptom onset [21]. In addition, a positive PCR result for SARS-CoV-2 90 days or more after the initial infection was more likely to reflect a new infection caused by a different virus rather than a repeat detection of the previous infection [22]. These data are currently being used in transplantation guidelines to manage the timing of transplantation and the potential for virus transmission. In the OPTN guidelines in the United States, even if a donor with a history of COVID-19 shows a positive PCR result for SARS-CoV-2 within 21–90 days from the diagnosis, it is considered a repeat detection of the previously resolved virus, and organ procurement and transplantation, including lungs, are recommended. In other guidelines, if it has been more than 90 days since the initial diagnosis, the likelihood of reinfection is high, and lung procurement and transplantation are not recommended [6]. In Spain, the guidelines recommend considering standard-risk donors for transplantation procedures if 21 days have elapsed since the onset of symptoms for lung and small bowel transplants and 14 days or more

Table 2. The graft outcomes and SARS-CoV-2 transmission data from deceased donors positive for SARS-CoV-2 in nationwide studies

Study	Country	Study design	Study period	Donor definition and the number of donors	Number of recipients	Clinical outcome	Note
Goldman et al. (2023) [5]	United States	Retrospective cohort study from OPTN database	May 27, 2021–Jan 31, 2022	617 SARS-CoV-2 positive deceased donors (positive result within 21 days from the date of organ procurement)	1,241 Recipients: 281 Kidney 106 Liver 36 Heart 11 Lung ^{a)} 14 Kidney-pancreas 5 Simultaneous liver-kidney 5 Simultaneous heart-kidney	<ul style="list-style-type: none"> Kidney: 30-day GF 0.8% (6/776), 30-day M 1.6% (2/776) Liver: 30-day GF 3.8% (12/316), 30-day M 2.3% (10/316) Heart: 30-day GF 3.8% (4/106), 30-day M 2.8% (3/106) Lung: 30-day GF 0% (0/11), 30-day M 0% (0/11) Other: 30-day GF 3.1% (1/32), 30-day M 3.1% (1/32) 	<ul style="list-style-type: none"> No significant difference in 30-day graft/patient survival was observed between the graft outcomes from SARS-CoV-2-positive and -negative deceased donors. No proven/probable DDTE case was reported. Only 1 possible case was reported (confirmed by DTAC). DCD rate was higher in SARS-CoV-2-positive deceased donors.
Dhand et al. (2023) [23]	United States	Retrospective cohort study from OPTN database	Mar 2020–Dec 2021	193 SARS-CoV-2-positive deceased donors (positive result within 14 days from the date of organ procurement)	414 Recipients (age ≥18 yr): 281 Kidney 106 Liver 36 Heart 1 Lung 14 Kidney-pancreas 5 Simultaneous liver-kidney 5 Simultaneous heart-kidney	<ul style="list-style-type: none"> Kidney: delayed graft function 21.8% (61/281), 30-day GF 0.7% (2/281), 30-day M 1.8% (5/281) Liver: 30-day GF 4.7% (5/106), 30-day M 3.8% (4/106) Heart: 30-day GF 0% (0/36) Kidney-pancreas: delayed graft function 14.3% (2/36), 30-day GF 7.1% (1/36), 30-day M 0% (0/36) 	<ul style="list-style-type: none"> No significant difference in 30-day graft/patient survival was observed between graft outcomes from SARS-CoV-2-positive and -negative deceased donors. No COVID-19-related death was observed in the SARS-CoV-2-positive group. The DCD rate was higher in SARS-CoV-2-positive deceased donors. None of the extrapulmonary organ recipients had evidence of DDTE.
Free et al. (2022) [14]	United States	Retrospective cohort study from DTAC database	Mar 2020–Mar 2021	9 SARS-CoV-2-positive donors (positive result within 72 hours from the date of organ procurement, 6 living and 3 deceased donors)	21 Organs and 19 recipients: 12 Kidney 4 Liver 3 Bilateral lung(b) 1 Pancreas 1 Heart	<ul style="list-style-type: none"> 3 lung recipients (100%, 3/3) were confirmed DDTE, and 1 patient (33.3%, 1/3) died. 	
Montiel Villalonga et al. (2023) [3]	Spain	Prospective case series study	Dec 15, 2020–May 31, 2022	32 SARS-CoV-2-positive deceased donors: 20, 10, and 2 SARS-CoV-2 positive, 0–14, 15–90, and >90 days after COVID-19 diagnosis	69 Recipients: 41 Kidney 18 Liver 8 Heart 2 Simultaneous liver-kidney	<ul style="list-style-type: none"> 30-Day GF 5.8% (4/69, all failure from kidney recipients) 30-Day M 2.9% (2/69, 1 from heart and 1 from liver-kidney recipient) 	<ul style="list-style-type: none"> 4 Patients were posttransplant SARS-CoV-2-positive, but all patients had a history of close contact with confirmed COVID-19 patients. No COVID-19-related death was observed.
Ushiro-Lumb et al. (2022) [4]	United Kingdom	Retrospective case series study	Mar 1, 2020–Mar 23, 2022	24 SARS-CoV-2-positive deceased donors (13 had a result profile suggesting previously resolved infection, 9 had indeterminate results, and 2 had results compatible with current asymptomatic infection)	66 Organs and 64 recipients: 35 Kidney 19 Liver 3 Heart 3 Bilateral lung 4 Simultaneous pancreas-kidney	NA	<ul style="list-style-type: none"> Only 1 recipient (bilateral lung) was positive for SARS-CoV-2 by PCR 5 days after transplantation, but the evidence does not support the donor-derived transmission.
Romagnoli et al. (2021) [24]	Italy	Retrospective case series study	Nov 20, 2020–Feb 8, 2021	10 SARS-CoV-2-positive deceased donors (time between the first detection of SARS-CoV-2 positivity and organ procurement: 0–10 days)	10 Liver recipients	<ul style="list-style-type: none"> 1 Patient died 75 days after transplantation. 	<ul style="list-style-type: none"> No definitive COVID-19 transmission was observed.

OPTN, Organ Procurement and Transplantation Network; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; GF, graft failure; M, mortality; DDTE, donor-derived transmission events; DTAC, Disease Transmission Advisory Committee; DCD, donation after cardiac death; COVID-19, coronavirus disease 2019; NA, not available; PCR, polymerase chain reaction.

^{a)}Ten of 11 lung donors showed results of positive upper respiratory tract (URT) and negative lower respiratory tract (LRT) testing; ^{b)}All three lung donors showed results of negative URT and positive LRT testing.

for other organs [17]. However, guidelines from the NHS in the UK, as well as the TSANZ guidelines in Australia and New Zealand, do not recommend the procurement of lungs or intestines from deceased donors in all PCR-positive cases of SARS-CoV-2, regardless of the timing of infection [8,9].

Although the data were limited, there were reported cases of lung procurement and transplantation in Korea from two adult deceased donors who tested positive for SARS-CoV-2. The time elapsed after each donors' COVID-19 diagnosis was 24 days and 56 days. The outcomes of the recipients were not reported (Table 3).

Organ Procurement and Transplantation of Nonlung Solid Organs

If sufficient explanation is provided and consent is obtained, nonlung and non-small bowel solid organ procurement can be considered from deceased donors with COVID-19. The risk of COVID-19 transmission through nonlung and non-small bowel solid organs is very low. For organs other than the lungs and small bowels, if 14–90 days have passed since the onset of COVID-19 symptoms, they can be considered to have the same risk level as donors who are PCR-negative for COVID-19, even if the PCR test for SARS-CoV-2 is positive at the time of transplantation (considered reinfection if positive after 90 days) (Fig. 1).

The procurement of nonlung and non-small intestine solid organs from patients diagnosed with COVID-19 has been consistently performed even if they had active SARS-CoV-2 infection or were diagnosed during the pretransplantation evaluation process. Italy, one of the countries that experienced the COVID-19 pandemic earliest, allowed the acquisition and transplantation of organs from COVID-19 deceased donors for patients in need of emergency transplantation as authorized by the CNT from November 2020. In the following 3 months, a total of 10 liver transplantations from patients with COVID-19 were performed at five institutions. Among the 10 donors, three were diagnosed with COVID-19 at the time of organ acquisition, while the remaining seven were diagnosed within 10 days before transplantation. Tissue examinations were conducted on the livers obtained from nine patients, and no SARS-CoV-2 was detected in the tissue samples. As for the recipients, there were no suspected cases of COVID-19 transmission through transplantation, and (except for one patient who died due to sepsis) all recipients survived for more than 5 months [24]. A study

evaluating SARS-CoV-2 in the plasma and renal tissue of 24 kidney transplant recipients with COVID-19 reported that the virus was not detected in either the donors' plasma or renal tissue [18]. Based on this evidence, the organ procurement and transplantation of nonlung and non-small bowel organs from COVID-19 patients has increased worldwide. Data from the OPTN in the United States, from May 2021 to January 2022, show that 617 organs were recovered from donors who were positive for COVID-19 (within 21 days of initial diagnosis), and 1,241 organ recipients were identified. Among these recipients, which included 776 kidney, 316 liver, and 106 heart transplant cases, the 30-day graft failure and mortality rates were like those of recipients who received organs from donors who were negative for COVID-19. Furthermore, there were no confirmed or probable cases of COVID-19 transmission through transplanted organs, except for one possible case [5]. Another study using OPTN data, limited to COVID-19-positive donors within 14 days of the initial diagnosis, found that the outcomes of transplant recipients were like those of recipients who received organs from COVID-19-negative donors [23]. Although the reported cases were limited in number, both the UK and Spain reported organ transplantations from donors who were positive for COVID-19 with no transmission to the recipients. Furthermore, the outcomes of the recipients were favorable [3,4] (Table 2). Thus, although patients with COVID-19 are generally considered to be a risk for transmission through the respiratory route, it can be inferred that: (1) SARS-CoV-2 is not detected in nonlung organs, (2) transplantation of organs from donors who are positive for COVID does not result in the transmission of COVID-19, and (3) the short-term posttransplant outcomes for recipients appear not to be affected. According to the OPTN guidelines, procurement of nonlung organs can proceed from donors who are 10–21 days past a mild COVID-19 infection, since the risk of transmitting COVID-19 to the recipient is considered very low. Even if the donor is diagnosed with COVID-19 for the first time during the evaluation process for organ procurement, the transplantation of nonlung organs can be considered [6]. According to the NHS and TSANZ guidelines, if a sufficient explanation is provided and consent is obtained, the procurement and transplantation of nonlung organs from COVID-19-positive donors can be considered. These guidelines do not differentiate recommendations based on the specific timing of the COVID-19 diagnosis. However, it is explicitly stated that COVID-19 should not be

Table 3. Characteristics of deceased donors PCR-positive for SARS-CoV-2 in respiratory samples taken within 72 hours of organ procurement and solid organ transplantation in the Republic of Korea

Donors with SARS-CoV-2 RNA detected in respiratory samples							Recipients			
Donor	Age (yr)	Sex	Cause of brain death	SARS-CoV-2 by PCR, Ct value	The interval between COVID-19 diagnosis and organ procurement (day)	Recipient	Organs transplanted	Age (yr)	Sex	Adverse outcome
A	46	F	CNS tumor	Positive, NR	13	A-1	Liver	53	M	NR
						A-2	Kidney	47	M	NR
						A-3	Kidney	52	F	NR
B	6	M	NR	Positive, NR	21	B-1	Heart	3	F	NR
						B-2	Liver	40	F	NR
						B-3	Kidney	8	F	NR
						B-4	Kidney	5	M	NR
C	65	M	Hypoxia	Positive, NR	32	C-1	Liver	53	M	Graft loss & death
						C-2	Kidney	63	M	NR
						C-3	Kidney	50	M	NR
D	26	M	Hypoxia	Positive, 29.36 (NP swab)	24	D-1	Heart	69	F	NR
						D-2	Lung	58	M	NR
						D-3	Liver	43	M	NR
						D-4	Kidney	52	M	NR
						D-5	Kidney	43	M	NR
E	68	M	Head trauma	Positive, 28.51	10	E-1	Kidney	67	M	NR
						E-2	Kidney	57	F	NR
F	22	M	Hypoxia	Positive, 24 (NP swab)	3	F-1	Heart	52	M	NR
						F-2	Liver	45	M	NR
						F-3	Kidney	31	M	NR
						F-4	Kidney	59	M	NR
G	21	M	Hypoxia	Positive, NR	56	G-1	Heart	73	M	NR
						G-2	Lung	70	M	NR
						G-3	Liver	51	M	NR
						G-4	Kidney	43	F	NR
						G-5	Kidney	67	M	NR
						G-6	Pancreas	29	F	NR

PCR, polymerase chain reaction; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; Ct, cycle threshold; COVID-19, coronavirus disease 2019; CNS, central nervous system; NR, not reported; NP, nasopharyngeal.

the cause of death in the case of deceased donors [8,9]. In Spain, even if the donor is diagnosed with COVID-19 at the time of organ recovery or within 14 days of diagnosis, the donor can be evaluated as a nonstandard-risk donor and considered for transplantation in cases where emergency transplantation is necessary for the recipient. This can be done with patient consent after sufficient explanation that they have not been evaluated as being at the standard level of risk [17]. According to the guidelines in Spain, if COVID-19 is the cause of death, transplantation is contraindicated. However, cases have been reported in the United States of organ procurement and transplantation from donors who died from COVID-19, but there are no reports of COVID-19 transmission or transplant failure associated with the organs transplanted from such donors [23]. Therefore, there is insufficient evidence to universally prohibit organ procurement and transplantation based solely on donor death from COVID-19. More studies are needed to further evaluate this issue.

According to data from the Korean Network for Organ Sharing, a total of 14 kidney, 6 liver, 4 heart, and 1 pancreas transplant cases were reported from seven deceased donors who were positive for SARS-CoV-2. Among the cases, one deceased donor was a pediatric patient. The time interval between organ procurement and COVID-19 diagnosis ranged from 3 to 56 days. One liver transplant recipient experienced graft loss and death, while the outcomes of the remaining patients were not reported (Table 3).

ORGAN PROCUREMENT FROM DECEASED DONORS WITH A HISTORY OF COVID-19 BUT A NEGATIVE PCR TEST FOR SARS-COV-2

If the upper and lower respiratory tract samples from deceased donors with a history of COVID-19 yield negative SARS-CoV-2 test results, the likelihood of SARS-CoV-2 transmission via the transplanted organs is expected to be significantly low.

As previously mentioned, according to the NHS, in cases in which both upper and lower respiratory tract samples yield confirmed negative PCR results for SARS-CoV-2, there has been no evidence of COVID-19 transmission through organ procurement and transplantation [6]. However, in lung transplantation, there have been reported cases of COVID-19 transmission via the lungs of donors with negative upper respiratory tract samples but

positive lower respiratory tract samples. Therefore, it is necessary to confirm negative SARS-CoV-2 test results in lower respiratory tract samples before lung transplantation [6,8,9,14,16]. When deciding on organ transplantation from a deceased donor with a history of COVID-19, if the respiratory tract samples show a negative PCR test for SARS-CoV-2, the possibility of transmission through the transplanted organs is expected to be very low. However, it is important to obtain informed consent from the recipient after sufficient explanation of the theoretical possibility of transmission [8].

Based on previous research on the long-term outcomes of COVID-19 infection, it cannot be completely ruled out that deceased donors with a history of COVID-19 may experience end-organ dysfunction associated with COVID-19. Therefore, a thorough evaluation of the organs should be conducted prior to transplantation to assess for the possibility of such complications [25-28]. There is a lack of research on the long-term outcomes for the recipients of organs from deceased donors with a history of COVID-19. Therefore, when deciding on organ transplantation, it is important to consider the potential risks of delaying transplantation and thereby aggravating underlying diseases and complications in the recipient versus the possibility of late complications due to the functional deterioration of the transplanted organ related to the donor's past COVID-19 infection [6].

ORGAN PROCUREMENT FROM DECEASED DONORS WHO TESTED NEGATIVE FOR SARS-COV-2 BUT HAD CLOSE CONTACT WITH COVID-19 PATIENTS

It remains unclear whether there is a possibility of SARS-CoV-2 transmission via organs transplanted from deceased donors with a history of close contact with COVID-19 patients (within 7 or 10 days) but who tested negative for SARS-CoV-2. From the current reports, there have been no documented cases of COVID-19 transmission through organ transplantation from deceased donors who had close contact with COVID-19 patients but tested negative for SARS-CoV-2 [6,8,9,29].

If test results are negative during the evaluation process for organ procurement, there is a possibility that the deceased donor who had close contact with a COVID-19 patient might have been tested during the eclipse peri-

od (time between infection and test positivity), but it is difficult to clearly distinguish such situations in clinical practice. Previous studies have shown the eclipse period of the SARS-CoV-2 virus to be 7–8 hours or 12–36 hours [30]. While the theoretical possibility is low, the transmission of SARS-CoV-2 to the recipient through lung transplantation cannot be completely ruled out. A case-by-case evaluation and plan are necessary for lung transplantation. However, in nonpulmonary organ transplantation, the transmission risk is considered to be very low or nonexistent [8].

ARTICLE INFORMATION

Conflict of Interest

Jong Man Kim is an editorial board member of the journal but was not involved in the peer reviewer selection, evaluation, or decision process of this article. No other potential conflict of interest relevant to this article was reported.

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