



Original research

Incidence of Symptomatic COVID-19 in Unvaccinated Patients Within One Month After Elective Total Joint Arthroplasty: A Multicenter Study

Erfan Sheikhabaehi, MD ^a, Seyed Peyman Mirghaderi ^{b, c}, Alireza Moharrami, MD ^b, Danial Habibi, PhD ^d, Mehdi Motififard, MD ^{e, **}, Seyed Mohammad Javad Mortazavi, MD ^{b, *}^a Student Research Committee, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran^b Joint Reconstruction Research Center (JRRC), Tehran University of Medical Sciences, Tehran, Iran^c Students' Scientific Research Center (SSRC), Tehran University of Medical Sciences, Tehran, Iran^d Department of Biostatistics and Epidemiology, Faculty of Health, Isfahan University of Medical Sciences, Isfahan, Iran^e Department of Orthopedic Surgery, Kashani University Hospital, School of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran

ARTICLE INFO

Article history:

Received 8 October 2021

Received in revised form

6 January 2022

Accepted 15 January 2022

Available online 24 January 2022

Keywords:

Arthroplasty

COVID-19

Safety

SARS-CoV-2

ABSTRACT

Background: The safety of continuing total joint arthroplasty (TJA), as an elective procedure, during the pandemic is controversial. The present study aimed to investigate the incidence of symptomatic coronavirus disease 2019 (COVID-19) and its related risk factors in unvaccinated patients after TJA within 1 month after discharge in 2 large cities of our country.

Material and methods: The present prospective study included all the patients admitted to 3 hospitals, located in Tehran and Isfahan, 2 highly populated cities of Iran, from April 1, 2020, to April 1, 2021, for elective TJA. Urgent TJA (traumatic fractures) were excluded. The primary outcome was symptomatic COVID-19 within 1 month after discharge that was diagnosed using the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) reverse transcription polymerase chain reaction test. Afterward, the incidence of COVID-19 in the study population was compared with that in the general population to estimate the safety of elective TJA during the pandemic.

Results: From the 1007 patients undergoing TJA, 755 patients met the inclusion criteria. None of the patients was vaccinated against COVID-19. Among them, 18 patients (2.4%) developed symptomatic COVID-19 within 1 month after discharge. In the same time interval, the incidence of COVID-19 was 2.2% in the general population of these 2 cities, which was similar to the incidence reported in the study population. Of the patients who were positive for COVID-19, 4 patients were hospitalized, and 3 of them were admitted to an intensive care unit; however, no mortality was reported.

Conclusion: The TJA will be a safe elective procedure for the patients during the pandemic if the preventive protocols are followed strictly.

© 2022 The Authors. Published by Elsevier Inc. on behalf of The American Association of Hip and Knee Surgeons. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has adversely influenced global health care, rendering hospitals unsafe

for the patients [1–4]. Generally, governments have taken several measures to prevent the disease spread, including quarantines, social distancing, and lockdowns. Owing to the risk of COVID-19 contact during hospitalization and surgery, hospital admission for many elective surgical procedures, such as arthroplasty, has been reduced or completely suspended for a while [5]. Considering the shortage of health-care-related resources at the beginning of the pandemic and the preventive protocols announced by the health-care authorities, many surgeons postponed their elective surgeries, such as arthroplasties [5,6].

However, the continuation of this situation made both hospitals and patients face a dilemma. On the one hand, hospitals developed

* Corresponding author. Hip and Knee arthroplasty, Joint Reconstruction Research Center, Imam Khomeini hospital, Tehran University of Medical Sciences, End of Keshavarz Blvd, 1419733141 Tehran, Iran. Tel.: +98 2161192767.

** Corresponding author. Department of Orthopedic Surgery, Kashani University Hospital, School of Medicine, Isfahan University of Medical Sciences, Azadi sq., Hezar Jarib Blvd, Isfahan 6719675344, Isfahan Province, Iran. Tel.: +98 9188400108.

E-mail addresses: Motifi298@yahoo.com, smjmort@yahoo.com

financial problems because of increased costs and decreased income [7]. On the other hand, patients had to tolerate their prolonged articular pain and dysfunction. Therefore, elective surgeries, such as the total joint arthroplasty for the hip and knee, need to be continued [8,9] and should not be deferred to an unknown time. However, there was no protocol for resuming elective surgeries during the pandemic. Every health-care facility had its own protocol based on the related management policy and available resources, such as beds [10].

During the past 2 years, the prevalence and incidence of COVID-19 had several fluctuations and led to different challenges in each country. However, the introduction and implementation of vaccination against COVID-19 were highly effective, remarkably reducing the global incidence, prevalence, and mortality. Therefore, people are gradually getting back to a new routine life [11,12]. However, the slow expansion of vaccination coverage in some countries, rapid reopening, and the emergence of the new mutated variants of SARS-CoV-2 (such as delta and omicron variants) led to many new outbreaks with a more extensive spread of the disease, especially in the developing countries [13–17]. Therefore, restarting the mass elective practice by the orthopedic surgeons, especially arthroplasty surgeries, is still being debated, and the related protocols have been changed several times [18–21]. Moreover, limited studies have investigated the possibility of COVID-19 contraction and related risks due to hospitalization for the TJA.

The present study aimed to investigate the incidence of symptomatic COVID-19 within 1 month after elective TJA and its related risk factors in unvaccinated patients in 3 hospitals of 2 populated cities in our country.

Material and methods

Data collection and participants

The present study was a prospective study including the data from all the patients admitted to 3 hospitals, including university-affiliated (Imam Khomeini Hospital in Tehran city) and private (Atieh hospital in Tehran and Saadi Hospital in Isfahan city) hospitals, located in Iran from April 1, 2020, to April 1, 2021, for the elective TJA. The university-affiliated hospitals investigated in the present study had a COVID-19 ward, while the private centers did not admit COVID-19 patients. All the procedures included in the present study followed the ethical standards of the institutional and national research committees. Before the study began, the participants were explained the study steps and objectives and gave informed written consent for participation.

The required data were extracted from their medical records. We prepared our checklists, which were filled using the following data of the participants: age, gender, weight, height, type of surgery (total hip or total knee arthroplasty), surgery being primary or secondary, TJA indication, surgery cancellation and delay due to the pandemic, any contact with a COVID-19-positive patient before the surgery and its exact time, vaccination for COVID-19, and the patients' comorbidities, including type 2 diabetes mellitus, hypertension, pulmonary problems, chronic kidney disease, end stage renal disease needing dialysis, cerebrovascular accidents/stroke, past or present cardiovascular diseases (coronary artery disease, history of coronary artery bypass grafting surgery or percutaneous coronary angioplasty), immune system disorders (autoimmune diseases, taking immunosuppressive medications, immunocompromised patients such as those having transplantations), and being under cancer chemotherapy or radiotherapy. Moreover, the patients indicated for TJA due to traumatic fractures were excluded from the study because they are not elective.

Preoperative COVID-19 protocols

The preoperative TJA protocol included 2 parts. The first part was a comprehensive routine assessment of complete history taking (any recent symptoms suggestive of COVID-19 or any contact with COVID-19 patients within the last months), body temperature measurement using a digital thermometer, and oxygen saturation measurement using pulse oximetry. These routine assessments were performed for all the patients in all 3 hospitals before the TJA surgery. The second part included laboratory and imaging investigations that were different between the hospitals. The patients hospitalized in Isfahan were tested for COVID-19 using the reverse transcription polymerase chain reaction (RT-PCR) twice: 48–72 hours before operation and on the day of the surgery. However, the patients in both hospitals of Tehran were not tested for COVID-19 by RT-PCR, and they underwent a chest X-ray for screening. Then, those suspicious for COVID-19 (ie, any related symptoms or with airspace opacities in radiography) were referred to the COVID-19 clinic for further investigations. If COVID-19 was ruled out by the infectious disease service, the patient was listed for the surgery.

Postoperative outcomes

All the patients were followed up for 1 month after surgery. They received weekly phone calls and were asked about recent COVID-19 symptoms, such as fever, fatigue, sore throat, dyspnea, cough, or diarrhea. The patients experiencing any suspicious symptoms were tested via RT-PCR for SARS-CoV-2 using nasopharyngeal and oropharyngeal swabs. Those positive for COVID-19 were visited by the infectious disease specialist, and the data regarding their disease, such as the interval between discharge and the onset of COVID-19 symptoms, hospital stay, intensive care unit (ICU) admission, the need for intubation/mechanical ventilation, and mortality due to COVID-19, were recorded.

The monthly number of TJA procedures performed in the hospitals before the pandemic was extracted from the Hospital Information Systems and compared with the number of TJA procedures performed during the pandemic. Moreover, we received the daily number of new COVID-19 cases in these 2 cities and the whole country in the study duration from the Deputy for Health, Research, and Education of the Ministry of Health and Medical Education of our country to compare the incidence of COVID-19 between the study population and the general population.

Statistical analysis

The data analysis was performed using the IBM SPSS software (version 24). Numerical variables were described as mean and standard deviation, while nominal variables were described as percentage. The intergroup comparisons of the qualitative variables (between the participants contracting COVID-19 and those who were not infected) were performed using the chi-squared and Fisher's exact tests. Independent sample T-test was used for intergroup comparisons of the quantitative variables. We investigated the potential risk factors predicting the possibility of COVID-19 between the study variables using the logistic regression test. The significance level was considered <0.05 (2-sided).

Results

A total of 1007 patients underwent TJA procedures in the mentioned hospitals during the study period, of which 857 completed the follow-up, while 14.9% were lost to follow-up. One hundred and one patients who underwent emergent TJA due to traumatic fractures were excluded. Of the remaining 755 patients,

240 (31.8%) underwent total hip arthroplasty, while 515 (68.2%) underwent total knee arthroplasty. None of the patients were vaccinated for COVID-19. The participants' mean age was 61.58 ± 12.49 years, and 74.2% ($n = 561$) were female. Ninety-eight patients (13%) reported delayed surgery, with a mean delay time of 3.68 ± 2.96 months. Eighteen patients (2.4%) had symptomatic COVID-19 within 1 month after surgery, while 68 patients (9%) had been diagnosed with COVID-19 before the surgery, of which only one participant developed a reinfection. The patients' demographics, clinical information, and comorbidities are presented in Table 1. At the same time, COVID-19 incidence was 2.2% in the general population of the 2 cities, which was similar to the incidence reported in the study population ($P = .76$).

The monthly number of TJA procedures during the study, compared with that before the pandemic, and the number of patients diagnosed with symptomatic COVID-19 within 30 days after discharge are presented in Figure 1a. According to our results, the number of TJA procedures had a mean $57 \pm 12\%$ decrease in comparison to the same period before the pandemic. The total number of daily new cases of COVID-19 in our country is presented in Figure 1b.

According to the logistic regression results, older patients were more likely to contract COVID-19 after being discharged;

however, the difference was not significant (odds ratio = 1.011 with 95% confidence interval = 0.966–1.058, $P = .632$). There was no significant intergroup difference in gender and body mass index. Also, none of the comorbidities could increase the risk of COVID-19 after discharge except for the pulmonary disease, which increased the risk of postoperative COVID-19 significantly (odds ratio = 3.93 with 95% confidence interval = 1.23–12.55, $P = .008$).

Of the patients undergoing TJA in the university-affiliated hospitals (which had COVID-19 wards), 1.56% had symptomatic COVID, while 2.66% of those admitted to the private hospitals were diagnosed with COVID-19 ($P = .38$). In spite of the different preventive protocols followed in Isfahan city vs Tehran city, 2.48% of the patients being operated in Isfahan contracted COVID-19, while the rate was 2.21% for the patients admitted to Tehran hospitals ($P = .81$).

Of the patients who were positive for COVID-19, 4 patients (22%) were hospitalized, and 3 (17%) of these were admitted to an ICU; however, no mortality was reported. The detailed clinical information of the COVID-positive patients is presented in Table 2. The patients with COVID-19 developed symptoms at a mean time of 10 days after discharge (range = 4–22 days). The data regarding the duration between the hospital discharge and onset of symptoms are presented in Figure 2.

Table 1
The demographics, clinical information, and comorbidities of the patients.

Variables	Postarthroplasty COVID-19		P value
	Positive (N = 18)	Negative (n = 737)	
Demographics			
Age (y)	63.94 ± 6.66	61.52 ± 12.60	0.15
Female gender, n (%)	15 (83.3%)	546 (74.1%)	0.37
BMI (kg/m ²)	30.38 ± 6.24	28.58 ± 5.10	0.14
Comorbidities			
Diabetes, n (%)	7 (38.9%)	163 (22.1%)	0.09
Hypertension, n (%)	9 (50.0%)	347 (47.1%)	0.81
Pulmonary problem, n (%)	4 (22.2%)	47 (6.4%)	0.008
			OR (95% CI) = 3.93 (1.23–12.55)
Renal disease, n (%)	0	39 (5.3%)	0.31
Cardiovascular disease, n (%)	4 (22.2%)	122 (16.6%)	0.79
Immune system disease, n (%)	2 (11.1%)	68 (9.2%)	0.78
Cancer, n (%)	1 (5.6%)	18 (2.4%)	0.41
Clinical variables			
Delayed surgery, n (%)	1 (5.6%)	97 (13.2%)	0.343
Delay duration (month)	6.00	3.66 ± 2.96	0.43
COVID-19 before surgery, n (%)	1 (5.6%)	67 (9.1%)	0.98
COVID-19 before surgery (months)	2.00	4.67 ± 2.63	0.31
Hospital, n (%)			
Academic (N = 192, 25.4%)	3 (16.7%)	189 (25.6%)	0.38
Private (N = 563, 74.6%)	15 (83.3%)	548 (74.4%)	
City, n (%)			
Isfahan (N = 483, 64%)	12 (66.7%)	471 (63.9%)	0.81
Tehran (N = 272, 36%)	6 (33.3%)	266 (36.1%)	
Joint; n (%)			
Hip	1 (5.6%)	239 (32.4%)	0.016
Knee	17 (94.4%)	498 (67.6%)	
Surgery, n (%)			
Primary	18 (100%)	674 (91.5%)	0.19
Revision	0	63 (8.5%)	
Primary causes, n (%)			
OA	18 (100%)	581 (78.8%)	0.41
DDH	0	23 (3.1%)	
AVN	0	63 (8.5%)	
RA	0	7 (1.0%)	
Revision causes, n (%)			
Infection	0	24 (3.3%)	-
Dislocation	0	13 (1.8%)	
Periprosthetic fracture	0	12 (1.6%)	
Aseptic loosening	0	14 (1.9%)	
Hospital stay for arthroplasty	2.83 ± 0.99	3.56 ± 1.62	0.06

BMI, body mass index; CI, confidence interval; OR, odds ratio; OA, osteoarthritis; DDH, developmental dysplasia of the hip; AVN, avascular necrosis; RA, rheumatoid arthritis.

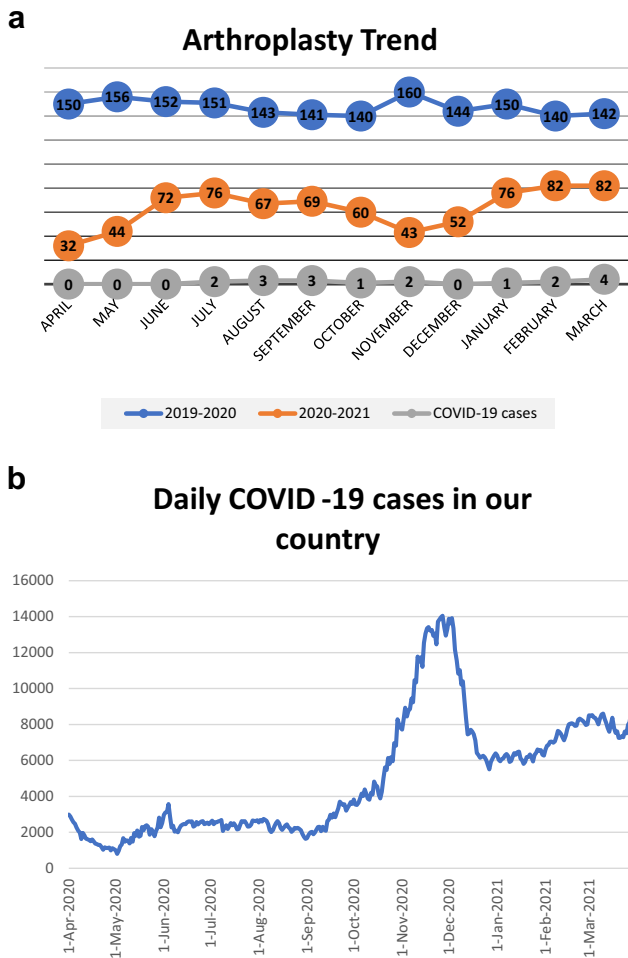


Figure 1. (a) The number of TJA procedures performed in the study duration (April 2020–April 2021, blue line) and comparison with that before the pandemic (orange line); the COVID-19 cases are represented in gray line. (b) COVID-19 daily new cases in our country.

Data from the Worldometers: <https://www.worldometers.info/> [21].

Discussion

The present study investigated the incidence of symptomatic COVID-19 in unvaccinated patients undergoing elective TJA within 1 month after being discharged in 3 arthroplasty centers of 2 highly populated cities of our country. According to our results, of the 755 unvaccinated patients meeting the eligibility criteria, 18 patients (2.4%) developed COVID-19 within 1 month. In the same time interval, the incidence of COVID-19 was 2.2% in the general population of these 2 cities, which was similar to the incidence reported in this study population. Moreover, pulmonary disease was the only risk factor for postoperative COVID-19. Twenty-two percent of patients developed a severe COVID-19 and were hospitalized. However, no mortality due to the postoperative COVID-19 was reported.

Previous studies have investigated the safety of other elective surgeries, such as bariatric surgery, during the COVID-19 pandemic [22,23]. This international cohort study followed up 7704 patients undergoing bariatric surgery for a month and reported that 43 patients (0.56%) developed symptomatic COVID-19 [22]. According to them, preoperative testing for COVID-19, preoperative self-isolation, and operating in those hospitals with no COVID-19 ward could not decrease the risk of contracting COVID-19. Eventually, the authors concluded that elective bariatric surgery was

safe during the pandemic and could be resumed while following safety protocols [22]. We can also conclude similarly, however, we reported a higher rate of postoperative COVID-19 than the mentioned study (2.4% vs 0.56%), which can be due to higher cases of COVID-19 in our country, smaller sample size, and a different study population.

A prospective study by Balieiro et al. investigated 300 patients undergoing bariatric surgery who were all negative for COVID-19 before operation and reported no case of postoperative COVID-19 and related mortality [23]. Therefore, the authors suggested that a preoperative screening protocol including a questionnaire evaluating the related symptoms and an RT-PCR test were sufficient for the patients undergoing elective surgery during the pandemic.

Clement et al. investigated 547 patients undergoing elective orthopedic surgeries, reporting 2 cases (0.4%) of postoperative COVID-19 contraction [24]. In this condition, the rate of postoperative COVID-19 in urgently operated patients was significantly higher (60 out of 1016, 5.9%). According to this study, old age, lower American Society of Anesthesiologists grades, and specific types of surgery (hip or periprosthetic fracture) could significantly increase the risk of postoperative COVID-19 [24]. Moreover, another study by Hernigou et al. on 104 patients undergoing an elective orthopedic surgery reported that all patients were negative for COVID-19 after the surgery [25].

We assumed that all the cases showing COVID-19 symptoms after operation had been contracting the disease due to hospitalization. However, finding the exact source of infection is not possible. In order to reduce the risk of postoperative COVID-19, surgeons should recommend to their patients to avoid public places after discharge. In addition, screening the family and friends visiting the patients can be helpful.

Mortazavi et al. followed up 165 patients undergoing arthroplasty for 2 weeks, reporting only one case (0.006%) of postoperative COVID-19 who developed the symptoms 1 week after the discharge [26]. Therefore, they suggested that their preventive protocol, including history taking and physical examination, was effective for preoperative screening of the patients undergoing arthroplasty in a hospital that was a referral center for COVID-19. Eventually, the study recommended resuming the elective orthopedic surgeries while following the disease prevention protocols [26,27]. However, our study reported a higher rate of postoperative COVID-19, which can be because the study by Mortazavi et al. was performed from February to August 2020, when the national incidence of COVID-19 was remarkably lower, presented in Figure 1b [26].

According to our results, there was no difference in the rate of postoperative COVID-19 cases between the hospitals of Tehran city (2.2%), where the screening was performed using clinical and imaging investigations, and those located in Isfahan city (2.5%), which used the RT-PCR ($P = .81$). Therefore, we can determine that both preventive protocols were effective. However, considering the low number of postoperative COVID-19 cases in our study, this conclusion lacks robust evidence. Given the shortage of resources needed for routine RT-PCR testing in some hospitals and the low sensitivity of this test leading to a high rate of false-negative cases (up to 54%) [28], the screening protocol including the clinical and radiologic investigations is probably sufficient.

A study by Gehrke et al. approved the preoperative screening protocol using a questionnaire by Parvizi et al., including the mentioned questionnaire in the guidelines of the International Consensus Group [18,19]. The mentioned questionnaire evaluated the symptoms suggestive of COVID-19 and any contact with the infected patients. According to Gehrke et al., none of the patients classified at low risk by the mentioned questionnaire were positive for COVID-19 [18]. Therefore, it seems that strict screening protocols do not benefit the patients.

Table 2
Clinical information of the patients contracting COVID-19 within 1 month after discharge.

Patients	Age	Gender	Type of surgery	City	Indication	Previous COVID-19 history	Comorbidity	BMI	Duration between the hospital discharge and onset of symptoms	Hospital stay for COVID-19	ICU stay	Need for intubation	Pulmonary involvement in CT scan (%)
Patient #1	65	Female	THA	Isfahan	OA/primary arthroplasty	No	DM, HTN, CVD,	22.04	7.00	No	No	No	20
Patient #2	60	Male	TKA	Isfahan	OA/primary arthroplasty	No	DM,	40.82	10.00	No	No	No	15
Patient #3	76	Male	TKA	Isfahan	OA/primary arthroplasty	No	DM, HTN	40.82	14.00	No	No	No	0
Patient #4	70	Female	TKA	Isfahan	OA/primary arthroplasty	No	DM, HTN	28.72	9.00	No	No	No	10
Patient #5	75	Female	TKA	Isfahan	OA/primary arthroplasty	No	DM, HTN	29.30	10.00	10	5	Yes	30
Patient #6	59	Female	TKA	Isfahan	OA/primary arthroplasty	No	HTN	20.20	6.00	No	No	No	20
Patient #7	55	Female	TKA	Isfahan	OA/primary arthroplasty	No	Immune system disease	25.39	4.00	5	2	No	40
Patient #8	58	Female	TKA	Isfahan	OA/primary arthroplasty	No	DM, HTN, Immune system disease	31.11	8.00	No	No	No	20
Patient #9	61	Female	TKA	Isfahan	OA/primary arthroplasty	No	HTN	31.22	9.00	No	No	No	0
Patient #10	67	Female	TKA	Isfahan	OA/primary arthroplasty	No	CVD, cancer	29.30	12.00	No	No	No	15
Patient #11	66	Female	TKA	Isfahan	OA/primary arthroplasty	No		25.59	15.00	No	No	No	0
Patient #12	70	Male	TKA	Isfahan	OA/primary arthroplasty	No	CVD	32.27	22.00	No	No	No	0
Patient #13	56	Female	TKA	Tehran	OA/primary arthroplasty	No	HTN,	37.78	14.00	10	7	Yes	30
Patient #14	64	Female	TKA	Tehran	OA/primary arthroplasty	No	DM	37.89	8.00	No	No	No	25
Patient #15	67	Female	TKA	Tehran	OA/primary arthroplasty	No	DM, CVD	20.70	9.00	No	No	No	20
Patient #16	62	Female	TKA	Tehran	OA/primary arthroplasty	Yes (3 mo before the surgery)		29.59	6.00	7	No	No	20
Patient #17	68	Female	TKA	Tehran	OA/primary arthroplasty	No	HTN	31.25	7.00	No	No	No	15
Patient #18	52	Female	TKA	Tehran	OA/primary arthroplasty	No		32.88	10.00	No	No	No	25

BMI, body mass index; CT, computed tomography; THA, total hip arthroplasty; TKA, total knee arthroplasty; OA, osteoarthritis; DM, diabetes mellitus; HTN, hypertension; CVD, cardiovascular disease.

According to our results, preoperative pulmonary diseases were a significant risk factor for postoperative COVID-19. Therefore, we recommend establishing strict preventive protocols for patients with an underlying pulmonary disease. According to a meta-analysis by Shi et al., the underlying pulmonary disease can make the affected patients susceptible to a more severe disease with a higher chance of mortality [29]. However, there are also studies not considering underlying pulmonary diseases, such as asthma, as a risk factor for severe COVID-19 [30–32], while the evidence for approving chronic obstructive pulmonary disease as a risk factor for severe COVID-19 is sufficient [30,33]. The higher possibility of contracting COVID-19 in patients with pulmonary diseases can be because these patients are less likely to tolerate facemasks than the general population. Therefore, they are at increased risk of being infected with the respiratory aerosols suspended in the air within the health-care facilities. However, further studies are needed to confirm this hypothesis.

The present study had some limitations as well. Considering the extensive lockdowns and cancellation of numerous elective surgeries, we had a small sample of patients undergoing TJA, which was insufficient to investigate the risk factors of contracting COVID-19 and related complications, such as ICU admission. Furthermore, our participants were from different hospitals and cities. The hospitals had different preventive protocols, and the cities had different daily incidence rates of COVID-19. In addition, it was impossible to determine the infection source for the patients contracting COVID-19 after discharge. Another possible limitation is that patients followed up only by their symptoms and asymptomatic COVID-19 cases or patients with a mild course of disease were missed in the results. Therefore, further studies tracking systems and laboratory screening tests for the asymptomatic patients are needed. In this study, about 14% of patients were lost to

follow-up completely, and this is a serious limitation highlighting the important role of complete pursuit of patients.

Conclusion

It is very likely that the COVID-19 pandemic continues even with extensive vaccination. Therefore, we have no choice but to stick

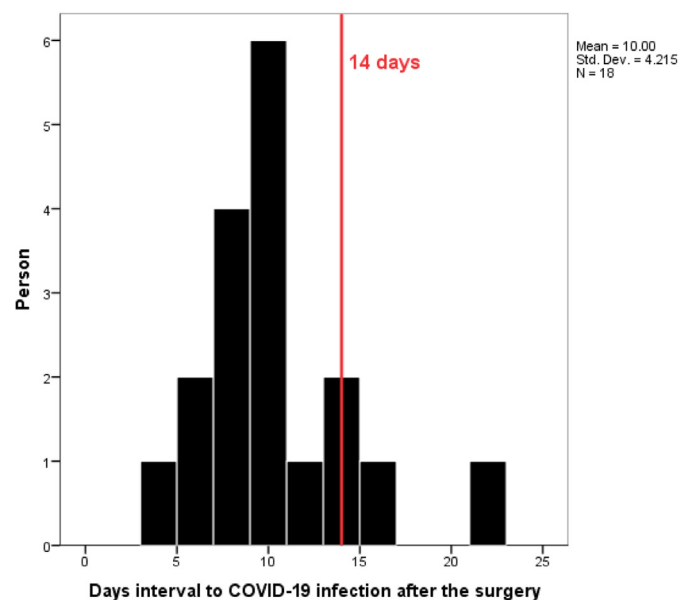


Figure 2. The duration between the hospital discharge and onset of symptoms for patients contracting COVID-19 after operation.

with the safety protocols, including social distancing, using face-mask, and minimizing unnecessary close contact with other people and outdoor activities. However, if perioperative safety protocols are followed strictly, the TJA surgery has an approximate 2% risk of contracting COVID-19 after discharge during the pandemic. Resuming elective procedures is not free of risks, which should be noted by both surgeons and the patients. Finally, surgeons should evaluate the risk of COVID-19 and subsequent complications for each patient separately.

Conflicts of interest

The authors declare that there are no conflicts of interest.

References

- [1] Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* 2020;395(10223):497.
- [2] SeyedAlinaghi S, Karimi A, MohsseniPour M, et al. The clinical outcomes of COVID-19 in HIV-positive patients: a systematic review of current evidence. *Immun Inflamm Dis* 2021;9(4):1160.
- [3] Mehraeen E, Olliaei S, SeyedAlinaghi S, et al. COVID-19 in pediatrics: the current knowledge and practice. *Infect Disord Drug Targets* 2021;21.e290921196908.
- [4] Non-emergent, elective medical services, and treatment recommendations: center for medicare & medicaid services (CMS). <https://www.cms.gov/files/document/cms-non-emergent-elective-medical-recommendations.pdf>; 2020 [accessed 07.10.21].
- [5] Zeegen EN, Yates AJ, Jevsevar DS. After the COVID-19 pandemic: returning to normalcy or returning to a new normal? *J Arthroplasty* 2020;35(7s):S37.
- [6] AAOS guidelines for elective surgery during the COVID-19 pandemic. <https://www.aaos.org/about/covid-19-information-for-our-members/aaos-guidelines-for-elective-surgery/> [accessed 11.07.21].
- [7] Grimm CA. Hospital experiences responding to the COVID-19 pandemic: results of a national pulse survey March 23–27, 2020. US Department of Health and Human Services Office of Inspector General. 2020;41. <https://justthenews.com/sites/default/files/2020-04/HHS2020ReportPandemicHospitals.pdf>; 2020 [accessed 06.10.21].
- [8] Canovas F, Dagneaux L. Quality of life after total knee arthroplasty. *Orthop Traumatol Surg Res* 2018;104(1s):S41.
- [9] Ethgen O, Bruyère O, Richey F, Dardennes C, Reginster JY. Health-related quality of life in total hip and total knee arthroplasty. A qualitative and systematic review of the literature. *J Bone Joint Surg Am* 2004;86(5):963.
- [10] Oussedik S, Zagra L, Shin GY, D'Apolito R, Haddad FS. Reinstating elective orthopaedic surgery in the age of COVID-19. *Bone Joint J* 2020;102-B(7):807.
- [11] Chang WH. A review of vaccine effects on women in light of the COVID-19 pandemic. *Taiwan J Obstet Gynecol* 2020;59(6):812.
- [12] Schaefer GO, Tam CC, Savulescu J, Voo TC. COVID-19 vaccine development: time to consider SARS-CoV-2 challenge studies? *Vaccine* 2020;38(33):5085.
- [13] Erhabor GE. The challenges of delta variant (COVID-19) and assisted reproductive therapy. *West Afr J Med* 2021;38(7):609.
- [14] Torjesen I. Covid-19: delta variant is now UK's most dominant strain and spreading through schools. *BMJ* 2021;373:n1445.
- [15] Cifuentes-Faura J. COVID-19 mortality rate and its incidence in Latin America: dependence on demographic and economic variables. *Int J Environ Res Public Health* 2021;18(13):6900.
- [16] Fonseca EMD, Shadlen KC, Bastos FI. The politics of COVID-19 vaccination in middle-income countries: lessons from Brazil. *Soc Sci Med* 2021;281:114093.
- [17] Olliaei S, SeyedAlinaghi S, Mehrtak M, et al. The effects of hyperbaric oxygen therapy (HBOT) on coronavirus disease-2019 (COVID-19): a systematic review. *Eur J Med Res* 2021;26(1):96.
- [18] Gehrke T, Linke P, Sandiford A, Lausmann C, Citak M. Results of the first 1,000 procedures after resumption of elective orthopedic services following COVID-19 pandemic: experiences of a high-volume arthroplasty center. *Jt Dis Relat Surg* 2021;32(1):3.
- [19] Parvizi J, Gehrke T, Krueger CA, et al. Resuming elective orthopaedic surgery during the COVID-19 pandemic: guidelines developed by the International Consensus Group (ICM). *J Bone Joint Surg Am* 2020;102(14):1205.
- [20] Iyengar K, Jain V, Vaish A, Vaishya R, Maini L, Lal H. Post COVID-19: planning strategies to resume orthopaedic surgery –challenges and considerations. *J Clin Orthop Trauma* 2020;11(Suppl 3):S291.
- [21] North T, Bullock M, Danoff J, et al. Arthroplasty during the COVID-19 pandemic. *Arthroplasty Today* 2020;6(3):427.
- [22] Singhal R, Ludwig C, Rudge G, et al. 30-Day morbidity and mortality of bariatric surgery during the COVID-19 pandemic: a multinational cohort study of 7704 patients from 42 countries. *Obes Surg* 2021;31(10):4272.
- [23] Balieiro MPM, da Silva MM, Coelho ACJ, et al. Restarting elective bariatric and metabolic surgery under a security protocol during the COVID-19 pandemic—a prospective observational cohort study. *Obes Surg* 2021;31(7):3083.
- [24] Clement ND, Hall AJ, Makaram NS, et al. IMPACT-Restart: the influence of COVID-19 on postoperative mortality and risk factors associated with SARS-CoV-2 infection after orthopaedic and trauma surgery. *Bone Joint J* 2020;102-B(12):1774.
- [25] Hernigou J, Valcarenghi J, Safar A, et al. Post-COVID-19 return to elective orthopaedic surgery—is rescheduling just a reboot process? Which timing for tests? Is chest CT scan still useful? Safety of the first hundred elective cases? How to explain the “new normality health organization” to patients? *Int Orthop* 2020;44(10):1905.
- [26] Mortazavi SMJ, Kalantar SH, Moharrami A, Zarei M, Zare NH. Total joint arthroplasty during coronavirus disease-2019 COVID-19 pandemic. *J Orthop Spine Trauma* 2020;6(2):28–9.
- [27] Seyed Hadi K, Mortazavi SMJ, Mohammadreza R, Alirza M, Nima B, Mohammad Z. Unlocking of the orthopedic department in the largest tertiary referral hospital of Iran: our experience during coronavirus disease 2019 pandemic. *J Orthop Spine Trauma* 2021;6(2):33–8.
- [28] Arevalo-Rodriguez I, Buitrago-Garcia D, Simancas-Racines D, et al. False-negative results of initial RT-PCR assays for COVID-19: a systematic review. *PLoS One* 2020;15(12):e0242958.
- [29] Shi C, Wang L, Ye J, et al. Predictors of mortality in patients with coronavirus disease 2019: a systematic review and meta-analysis. *BMC Infect Dis* 2021;21(1):663.
- [30] Gao YD, Ding M, Dong X, et al. Risk factors for severe and critically ill COVID-19 patients: a review. *Allergy* 2021;76(2):428.
- [31] Ou M, Zhu J, Ji P, et al. Risk factors of severe cases with COVID-19: a meta-analysis. *Epidemiol Infect* 2020;148:e175.
- [32] Li X, Xu S, Yu M, et al. Risk factors for severity and mortality in adult COVID-19 inpatients in Wuhan. *J Allergy Clin Immunol* 2020;146(1):110.
- [33] Attaway AA, Zein J, Hatipoğlu US. SARS-CoV-2 infection in the COPD population is associated with increased healthcare utilization: an analysis of Cleveland clinic's COVID-19 registry. *EClinicalMedicine* 2020;26:100515.