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Research Article

Surgical Management of Extremity Fractures in COVID-19 Patients

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Abstract

Background: COVID-19 is spreading rapidly and potentially affects every person, including fracture patients. This study was conducted with the aim to evaluate our primary months' experience of surgical treatment of fractures in COVID-19 infected patients in order to assist in better decision-making in the next waves of the infection.
Methods: In this cross-sectional study, 15 patients with orthopedic trauma and COVID-19 infection were included from 2 trauma centers during February and March 2020.
Results: Most of the patients were younger than 40 year of age. The most common COVID-19 related symptom at presentation was malaise, and a hypoxia rate of 85.7% was detected among the patients. Two-thirds of the fractures were in the lower extremities. One patient expired, but all others were discharged with no follow-up complications.
Conclusion: Surgical management of fractures in COVID-19 patients is inevitable. To achieve this, sensitive screening techniques and standard protection measures are essential.

Keywords: Bone; COVID-19; Fractures; Orthopedics; Personal Protective Equipment

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Background

The latest threat to global health is the new respiratory disease outbreak, named Coronavirus Disease 2019 (COVID-19). It was characterized as a pandemic on March 11, 2020, in a World Health Organization (WHO) report (1).

Increasing patient volume led to a lack of critical care resources and protective equipment for medical staff (2). This condition influenced the practice of orthopedic surgery, and many countries, including Iran, as a country with a high reported infection rate, recommended the cancellation or postponement of elective procedures (3, 4). However, urgent and emergent orthopedic cases such as fractures need to be managed with the consideration of the patients' safety and the staff and the necessity to conserve healthcare resources, including hospital beds and ventilators (5, 6).

The clinical manifestations of this disease may be a combination of different respiratory or non-respiratory symptoms such as fever, cough, myalgia, fatigue, and dyspnea. However, many patients are asymptomatic or experience mild symptoms. Therefore, accurate screening of the patients at the emergency room is an important issue (7).

A few previous studies on orthopedic surgeries in patients with COVID-19 have recommended surgical and medical treatment; however they vary among different centers and are not universal (8-10).

Assuming that recurrence will not occur after the first wave of the disease subsides was a misconception (11). Now, we can see that new waves have started in some territories, and health systems are predicting higher peaks of the disease (12-15).

We conceived this study to investigate the A to Z of the surgical treatment of fractures in COVID-19 infected patients. We hypothesized that surgery is challenging; however, it might reduce the length of stay (LOS) and facilitate patient rehabilitation. Moreover, it may increase the patient's self-care ability, which is essential for these patients for self-isolation so that the experience can be used in similar situations in the coming waves.

Methods

The study population of this cross-sectional study included all consecutive trauma patients who had been diagnosed with COVID-19 infection and had undergone orthopedic surgery in February and March 2020 in the 2 large trauma centers in Tehran (Imam Hossein and Shohada Tajrish trauma hospitals, Tehran, Iran).

Data on the demographic characteristics, past medical history, signs and symptoms at presentation in the emergency room (ER), fracture sites and their treatment, data of hospital course, and personal protection protocols were compiled from patients' files based on a questionnaire (Appendix 1).

COVID-19 was diagnosed in all patients based on standardized spiral chest high-resolution CT (HRCT) findings (Appendix 2), except 1 who was diagnosed based on reverse

transcription-polymerase chain reaction (RT-PCR). To document the radiological findings in detail, a senior radiologist reviewed all patients' HRCTs. Patients received online or phone call follow-ups after they were discharged from the hospital. Radiological review findings and follow-up data were documented based on appendix 1. The number of infected health personnel of orthopedic and anesthesiology wards was obtained from Shohada Tajrish Hospital.

The statistical analysis was performed using SPSS software (version 21.0, IBM Corp., Armonk, NY, USA). Continuous variables were displayed as mean ± standard deviation, and categorical variables were reported as counts and percentages.

The ethics committee of the vice-chancellor in research affairs, Shahid Beheshti University of Medical Sciences, Iran, approved this study (IRCT code: IR.SBMU.RETECH.REC.1399.027).

Results

The number of patients included in this study was 15; 10 patients were admitted to Shohada Tajrish Hospital (out of the 130 ER trauma patients during the study), and 5 to Imam Hossein Hospital (out of the 150 patients). The patients' age and sex is presented in table 1. About 90% of patients were younger than 61 years of age, and the mean body mass index (BMI) was 24.0 ± 1.8 kg/m². Most of the patients were workers or self-employed and 1 patient was a specialist physician in the frontline of the COVID-19 battle. Moreover, 4 cases had an underlying disease (Table 1).

Pre-Operation Evaluation

Mechanism of Injury, Fracture Types: Of the 15 cases, 12 were brought in by emergency medical services (EMS), and 3 came to the ER on their own. The most common mechanism of injury was motor vehicle accident (MVA) in 10 cases (66.6%) followed by falling (33.3%) that included 1 high-energy trauma. Of the 15 patients, 2 (13%) patients had a traumatic brain injury leading to epidural hematoma with non-surgical management, and 2 patients had spinal injuries.

More than two-thirds of the extremity fracture sites were located in the lower extremity, and the rest were in the upper extremity. The distribution of the extremity fracture sites among the patients is illustrated in figure 1. Furthermore, 60% of fractures were closed. The fracture sites are presented in table 1.

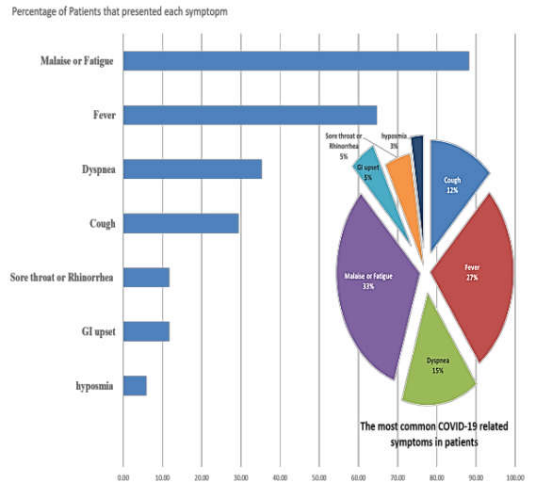

Figure 1. The distribution of extremity fracture sites among the patients

Diagnosis and the Considered Treatments for COVID-19: One patient was diagnosed with COVID-19 with a positive RT-PCR 3 weeks before coming to the hospital. The first case of this study was diagnosed with COVID-19 after the surgery was performed. This issue led to a change in the COVID-19 screening protocol in our center; all trauma patients who were considered to be admitted were screened via HRCT on the 1st day of hospital admission, and COVID-19 was confirmed for them. Excluding the 1 individual diagnosed with COVID-19 3 weeks earlier, in 50% of patients there was no suspicion of COVID-19 on admission and no notable symptom. The most primary COVID-19 related symptoms of these 14 patients are summarized in figure 2.

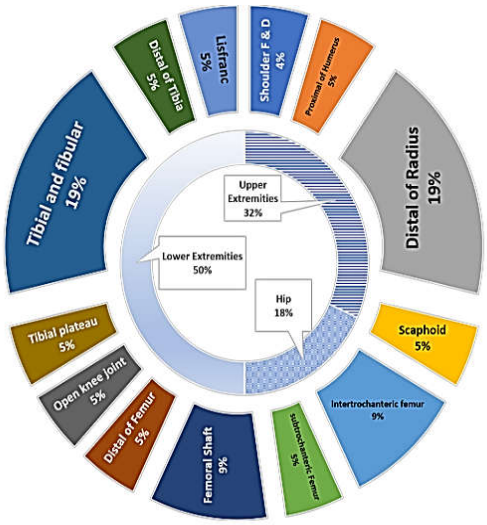

Figure 2. COVID-19 related symptoms in patients

The patients' available laboratory results compared with the normal ranges are shown in table 2; 4 patients were febrile pre-operatively, while the others were not.

All the patients' HRCTs were reviewed (Table 3). HRCT pattern shows the patient's lung involvement at different stages of the disease.

All patients received hydroxychloroquine as a medication for COVID-19, which was in combination with Oseltamivir (Tamiflu) in 7 patients. All the patients were treated for 14 days, except those who died due to multiple trauma complications.

The pre-operation and post-operation bed types of each patient, the type of supportive therapy, medications, and isolation precaution considerations are presented in table 1.

The Operation: Orthopedic and Anesthesia Team, and Safety Considerations: The operation details, including the approach, the device used for fixation, and the need for blood transfusion, are summarized in table 1. Senior orthopedic surgeons in each center performed the operation.

Anesthesia and surgical teams used personal protective equipment (PPE) based on the WHO protocol. The anesthesia methods used are presented in table 1. Ventilator connector tube exchange was performed and antibacterial-antiviral filters were used for all patients. However, the operating room (OR) was not evacuated at the time of intubation in any operations.

Post-Operation Evaluation: Hospital Course and Short-term Follow-up: We followed our routine antibiotic prophylaxis for operated patients.

Table 1. Patients' characteristics, diagnosis, treatment, and follow-up

Number	Sex and age	Revised trauma score	Past medical and drug history	Fracture site	Pre-operative bed– isolation precautions Supportive care	Anesthesia method	Device	Surgical approach	Post-operative bed	Antibiotics Duration (day)	Length of Stay	Discharge status Follow-up duration (days)
1	39 ♂	7.84	-	Tibia and fibula	Non COV. Ward O_2	GA	Nail	MIS	Non COV. Ward (was not diagnosed with COVID-19 yet)	Keflin – Cipro (14)	10	Discharged (55)
2	24 ♂	7.84	-	Open knee joint	Non COV. Ward O_2	GA	I&D Repair	MIS	ICU	Keflin – Cipro (14)	11	Discharged (61)
3	25 ♂	7.84	-	Femoral Shaft Scaphoid Syndesmosis rupture	COV. Ward ✕ O_2	GA	Nail (femur) Plate & screw (Syn) Casting (Scaphoid)	ORIF	COV. Ward	Keflin - Cipro (13)	15	Discharged (25)
4	23 ♂	7.84	-	Distal of femur	Non COV. Ward NIPPV - O_2	GA	Plate	ORIF	Non COV. Ward	Meropenem -Colistin (14)	43*	Discharged (11)
5	94 ♀	7.84	DM,IHD Insulin, ASA	Femoral shaft	Non COV. Ward O_2	GA	Nail	MIS	ICU	Keflin – Cipro (14)	8	Discharged (44)
6	28 ♂	7.84	-	Subtrochanteric hip Lisfranc	COV. Ward ✕ O_2	R	Nail (Femur) Plate and screw (Lisfranc)	MIS	COV. Ward	Keflin – Cipro (14)	9	Discharged (46)
7	61 ♂	7.84	-	Distal of radius	COV. Ward ✕	R	PCP	MIS	COV. Ward	Keflin (7)	2	Discharged (41)
8	48 ♂	7.84	Opium addict	Tibial plateau	COV. Ward ✕	R	Plate	MIS	COV. Ward	Keflin – Cipro (14)	6	Discharged (48)
9	27 ♂	5.97	-	Tibia and fibula proximal of humerus C_4 fracture	COV. Ward ✕ NIPPV - O_2 - Intubated (ICU was not available)	GA	Nail (Tibia) Sling (PH) PSF (C_4)	MethICU –	ICU – intubated	KEFLIN+ Cipro (till was alive)	14	Expired. (Due to multiple trauma and brain edema)
10	43 ♂	7.84	B Hepatitis Opium addict	Tibia and fibula distal of tibia	Non COV. Ward ✕	R	Nail + Plate	ORIF	COV. Ward	Keflin - Cipro (14)	16	Discharged (53)
11	29 ♂	7.84	-	Fracture and dislocation of shoulder intertrochanteric femur C2 odontoid fracture	COV. Ward ✕ NIPPV - O_2	GA	Nail (Femur) Non-op (GT) PSF (C_2)	ORIF	COV. Ward	Azithromycin (5)	5	Discharged (31)
12	81 ♂	7.84	IHD ASA	Intertrochanteric femur	COV. Ward ✕ O_2	R	Nail	MIS	COV. Ward	Keflin - Cipro (10)	4	Discharged. (36)
13	61 ♂	7.84	-	Distal of radius	COV. Ward ✕ O_2	R	PCP	MIS	COV. Ward	Keflin (7)	3	Discharged. (37)
14	17 ♂	7.84	-	Tibia and fibula	Non COV. Ward ✕	R	Nail	MIS	COV. Ward	Keflin - Cipro (14)	12	Discharged. (60)
15	36 ♂	7.84	COVID-19 was diagnosed three weeks ago	Bilateral distal of radius	Non COV. Ward	R	PCP	MIS	Non COV. Ward	Keflin (7)	1	Discharged. (46)

NIPPV: Non-invasive positive-pressure ventilation; O_2: Oxygen supplementation therapy 3-5 lit/min; ✕: Isolation precautions were considered.
GA: Rapid sequence induced general anesthesia; MIS: Minimally invasive Surgery; R: Regional; ORIF: Open reduction and internal fixation; IHD: Ischemic heart disease; DM: Diabetes mellitus; Keflin: Cephalothin;
Cipro: Ciprofloxacin; COV. Ward: COVID-19 dedicated wards
*: Long length of stay due to wound drainage

Table 2. Laboratory and Vital sign results of the patients

Parameters	Mean Patients' laboratory result	Normal ranges
Hemoglobin – pre-operative	11.6 ± 2.8	14–18 g/dl
Hemoglobin – post-operative	10.0 ± 2.0	14–18 g/dl
	Cut-off consideration	**Frequency of patients**
Leukopenia	< 4 * 109/l	6.6%
Lymphopenia	Lymphocyte count < 4 * 109	86.6%
Hypoxemia pre-operative	O_2 saturation < 93%	85.7%
Hypoxemia post-operative	O_2 saturation < 93%	78.5%
C-reactive protein (CRP)	10 mg/l <	100%

For venous thromboembolism (VTE) prophylaxis, 11 patients received enoxaparin sodium 4,000 IU (40 mg) once daily through subcutaneous injection. The daily dressing protocol was suspended and dressing changes were limited to those who needed it, based on the attending opinion.

No one presented with post-operative infection, and there was no case of readmission. None of the patients reported any complications relating to a probable VTE during the follow-up. About half of the patients experienced cough and minor weakness after discharge, and a patient presented with hyposmia. The follow-up duration of each patient is presented in table 1. The mean follow-up duration was 42.4 ± 13.8 days, with a median of 45 days.

The LOS and discharge status of the patients are presented in table 1. The mean LOS was 10.6 days, with a median of 9 days.

Table 4 shows the distribution of COVID-19 infected medical staff of orthopedic and anesthesiology wards of Shohada Tajrish Hospital.

Discussion

This study was conducted with the aim to evaluate the performance of orthopedic trauma surgeries in patients with COVID-19 infection. The evaluation included radiologic findings, injuries, and treatments, and following the principles of personal protection. It was considered that the findings would help orthopedic surgeons worldwide to gain a better notion of what they are going to confront and how to manage them in their similar experiences. The literature review showed that there is minimal real reported experience on orthopedic trauma surgeries on patients with COVID-19, and the few recommendations available are based on hypotheses and personal points of view (5, 8, 10).

Pre-Operative Evaluation

Screening and its Considerations: The gender distribution of patients was consistent with previous studies, indicating that the prevalence of traumatic orthopedic injuries in Iran is higher in men than in women (16). It is postulated that younger patients develop a milder form of COVID-19 infection and usually are not suspected of having COVID-19 infection, while older patients are more symptomatic and more easily recognized (7). The majority of patients in our cohort study were younger than 40 years of age. This indicated that younger patients with milder symptoms do not observe isolation rules and continue to socialize, making them prone to trauma.

Our first asymptomatic case, diagnosed with COVID-19 post-operatively, may be a nosocomial infection case. However, we found that almost all of our patients acquired COVID-19 infection in the community. This finding is in contrast to that of the study by Mi et al. in which 7 out of 10 reported cases were nosocomial (8). This difference could be related to the diverse strategies of countries and centers to control epidemics. Interestingly, most of our patients were from the lower socioeconomic class. A possible explanation might be that this population does not obey self-isolation recommendations due to their economic challenges. Governments should consider special arrangements for the economic support of vulnerable people to prevent disease spread. Meanwhile, the orthopedic surgeons should be vigilant during epidemics and be aware that trauma patients might be COVID-19 infected and an institutional protocol is needed for patient screening.

Diagnosis of COVID-19: The reported COVID-19 related symptoms in our patients are consistent with those of previous studies. However, the most commonly reported symptom was malaise and fatigue, which is not consistent with previous research (7). The majority of patients were afebrile, so fever may not be an excellent tool for the screening of COVID-19 in trauma patients. Only 53.3% of our patients complained of respiratory symptoms, including cough, rhinorrhea, and dyspnea. An implication of this finding is that the absence of respiratory symptoms in fracture patients would not rule out COVID-19 infection. In contrast, 85.7% of patients showed pre-operative hypoxemia (SpO2 equal to or less than 93%) as a presentation. Though the low oxygen saturation may be due to multiple trauma itself, we believe that every patient with a fracture and low O_2 saturation should be scrutinized for COVID-19 infection (17).

The rate of leucopenia and lymphopenia in our patients was 6.6% and 86.6%, respectively. Previous studies reported an incidence of 25% for leucopenia and 65% for lymphopenia in COVID-19 patients (18). Therefore, lymphopenia may be a sign of COVID-19 infection in trauma patients, while white blood cell count may not be a reliable marker. However, increased CRP level could be the initial marker of an infective process such as COVID-19 in these patients.

Table 3. Lung involvement Characteristics

Lung zonal involvement						
Lung Zone	RUZ	RMZ	RLZ	LUZ	LMZ	LLZ
Number of Patients	5 (35.7%)	9 (64.3%)	11 (78.6%)	6 (42.9%)	6 (42.9%)	8 (57.1%)
Involvement	32.5%	43.75%	25.0%	29.1%	25.0%	33.9%
Lung involvement distribution						
Craniocaudal Direction	**Number (%)**		**Axial Direction**		**Number (%)**	
Upper predominance	3 (21.4)		Peripheral		12 (90.9)	
Middle predominance	3 (21.4)		Central		0 (0)	
Lower predominance	7 (50.0)		Mixed		2 (9.1)	
Diffuse distribution	1 (7.1)					
Prominent Pattern						
	Reticular pattern		Mixed pattern		Ground-glass opacities	
	2 (14.3%)		2 (14.3%)		10 (71.4%)	

RUZ: Right upper zone; RMZ: Right middle zone; RLZ: Right lower zone; LUZ: Left upper zone; LMZ: Left middle zone; LLZ: Left lower zone; Involvement: Mean amount of zone involvement among the patients who have involvement in that zone

Table 4. The distribution of COVID-19 infected medical staff of orthopedic and anesthesiology wards in Shohada Tajrish Hospital

Orthopedic Service	Frequency	Anesthesiology Service	Frequency
Orthopedic attending physicians	0.4	Anesthesiology attending physicians	5.7
Orthopedic residents	1.9	Anesthesiology residents	2.10
Orthopedic nurses	4.15	ICU nurses	3.47
Orthopedic caregivers	1.3	ICU caregivers	2.11
Orthopedic service force	1.3	ICU service force	0.6

RT-PCR is considered a standard method for diagnosing COVID-19 (19). However, it has several inherent limitations. First, the test's sensitivity ranges between 50% and 70%; therefore, some infected cases may not be identified and cause the spread of the infection (20, 21). Second, the test is time-consuming, and it may take from 8 to 48 hours to get the results based on availability. Third, in the early stages of this outbreak, RT-PCR is not available. Therefore, recent studies have focused on alternative tests for COVID-19 (21-24). Ai et al. found that with RT-PCR as a reference, the chest CT sensitivity for COVID-19 is 97% (25). Fang et al. reported a sensitivity of 98% for CT compared to 71% for RT-PCR, which was significant (22). Li and Xia reported a prevalence of only 3.9% for missed CT diagnosis , and announced that it might be a standard method for COVID-19 diagnosis (23).

Standard CT features of COVID-19 are ground-glass opacities (GGOs) and consolidation with or without vascular enlargement, air bronchogram sign, and interlobular septal thickening. Pulmonary nodules with a halo sign and the "reversed halo" sign are uncommon CT features, as were presented in our study (23, 25-27). Recently, the Iranian Society of Radiology COVID-19 Consultant Group (ISRCC) designed a low-dose thoracic CT scan protocol to screen and/or diagnose patients suspected of COVID-19, and the Iranian national guideline considered chest CT as a diagnostic method (28, 29).

The Operation: Orthopedic and Anesthesia Team, and Safety Considerations

There have been few studies or recommendations on surgical orthopedic management in the COVID-19 pandemic (5, 8, 10). While the few previous studies available emphasized non-operative treatment when possible, our study demonstrated that patients requiring surgical intervention in the trauma setting would have an acceptable outcome (8). We believe that early surgical intervention and fracture fixation would be a better option as it would reduce the LOS and lead to earlier ambulation. The latter is essential for COVID-19 infected patients who need to follow a self-isolation protocol at home. We think that, regarding the reviewed literature, the minimally invasive surgery (MIS) procedure and presence of senior orthopedic surgeons in the OR may reduce the correlated complications in COVID-19 trauma patients (30, 31).

Both general and regional anesthesia have their own advantages and disadvantages in pandemic situation (32). However, performing regional anesthesia whenever feasible may be preferable to the non-aerosol-producing procedure.

Nosocomial infection is a notable concern in this pandemic, and the literature review showed concerning data regarding the infection of health workers. Recently, in Italy, it was announced that 10% of physicians and nurses have positive tests for viruses and cannot continue patient care (32). In China, 70% of fractured patients acquired COVID-19 infection in the hospital (8). Our experience showed that 1 case was diagnosed with COVID-19 after the surgery, which might be a case of nosocomial infection. We believe that timely primary screening to find the unrecognized COVID-19 patients, as we did with HRCT, and the implementation of standard PPE protocols for protecting both patients and healthcare workers are essential and helpful in preventing nosocomial infection. Our experience showed that 5 of 7 anesthesiologists were infected with COVID-19 infection at 1 trauma center. This finding reiterates that the anesthesia team has more potential exposure to patients' aerosols and is at risk, so attention to their safety through the use of standard PPE may be vital. We believe that the implementation of standard PPE protocols for protecting both patients and healthcare workers is essential and helpful. There is no specific guideline for ventilator connector tube exchange or antibacterial-antiviral filter insertion, but it was performed for all the patients in our study.

Post-Operative Care and Follow-up: Post-operative care was performed regularly. Patients need to be transferred to COVID-19 dedicated wards or COVID-19 ICUs. All principles of personal protection should apply to post-operative wards. We modified the regular daily wound dressing for patients to decrease staff exposure. Shorter LOS and early discharge to home or quarantine facility are important as they reduce staff exposure. They also conserve resources for new patients. We performed some follow-up steps virtually; this facility is notable in this pandemic, as well as other roles of virtual networks in diagnostic to treatment processes in clinical experiences (33).

It is noticeable that short-term follow-up showed no complications, and the only mortality case was the consequence of brain injury due to multiple traumas.

To the best of our knowledge, this is 1 of the few original studies on orthopedic surgery in COVID-19 patients that have evaluated the different aspects of management from diagnosis to post-operative care.

One of the limitations of this study is that the patients have not been followed for a long time when reporting this survey, and the sample size could be larger. However, the emergence of the outbreak, lack of real surgical experiences in the reviewed literature, and the calls for preparation for the following peaks of the disease were the most important reasons for sharing this experience. Further investigations are needed to illuminate the different aspects of the surgical management of fractures in COVID-19 patients.

Conclusion

In conclusion, we believe that this study illustrates that urgent orthopedic surgeries for fractures in COVID-19 patients are viable options provided that the patient's general condition allows. However, these operations need to be performed under a standard institutional protocol covering on-time, available, and reliable screening methods, PPE preparation, and an equipped OR. This study's conclusions may assist in preparing a better setting for fracture management in the next waves of the disease.

Conflict of Interest

The authors declare no conflict of interest in this study.

Acknowledgements

None.

Appendix 1. Questionnaire for collection of data from patients' files, and HRCT review of COVID 19 patients with orthopedic trauma

Patient ID	**Age**	**Name**
Admission date	Discharge date	Admission diagnosis: Orthopaedic trauma COVID
Job: Level of Education:	Residence:	Tel. number:
Symptoms: Cough □ Fever □	Time until diagnosis of COVID following admission	Height:
Dyspnea □ Malaise □	(days)	Weight:
Intestinal sign □ Night sweats □		
Sore throat or rhinorrhea □		BMI:
Loss of smell or taste □		
Others □		
Type of injury	Suspicion of corona at admission	Arriving at the emergency department
Motor vehicle accident □	Yes □	
Sport injury □	No □	Personally □
Occupational injury □		
High-energy fall □		With ambulance □
Low-energy fall □		
Other □		
Medication History	Smoking	PMH:
O_2 Sat Pre-op:	Temperature Pre-op:	Drug abuse
Post-op:	Postop:	Yes □ No □
		Type:
ESR:	PLT:	WBC count:
		PMN count:
CRP:		Lymph count:
Lymphopenia: Yes ○ No ○	Hemoglobin	COVID diagnosis Method:
Count:	Pre-op: Post-op:	PCR ○ HR-CT ○
COVID PCR:	Chest CT review for COVID	Other traumas:
Positive ○ Negative ○	Positive ○ Negative ○	Head □ Spine □ chest □ abdomen □
Fracture location:	Type of fracture: Close □ open □	Fixation Device:
Need for ICU admission following surgery	Need for ICU admission before surgery	Diagnosis of COVID-19 at the time of surgery
Yes ○ No ○	Yes ○ No ○	
Covi-19 ○	Covid-19 ○	Yes ○
Orthopedic surgery ○	Orthopedic trauma ○	
Other ○	Other ○	No ○
Days:	Days:	
Other complications during admission:	NIPPV mask	Intubation during surgery
	Yes ○ No ○	Yes ○ NO ○
	Days:	Days:
Admission ward after surgery	Admission ward before surgery	Preoperative cares:
Emergency ward ○	Emergency ward ○	Oxygen ○
COVID ward ○	COVID ward ○	Isolation ○
Clean ward ○	Clean ward ○	Other supportive cares ○
ICU	ICU	
Intubation ○ LMA ○	Rapid sequence induction (GA)	Anesthesia:
	Yes ○ No ○	GA ○ Regional ○
PPE for Surgical team	PPE for Anesthesia team	Intubation method:
Face shield ○ N95 Mask ○	Face shield ○ N95 Mask ○	Video laryngoscope ○
Shoe Cover ○	Shoe Cover ○	Laryngoscope ○
Protective clothing ○	Protective clothing ○	Fiber optic ○
Ventilator cleaning method:	Antibacterial-antiviral filter	Connector tube exchange for each patient
	Yes ○ NO ○	Yes ○ NO ○
Surgery duration (Minutes)	Surgeon's level of skill	Evacuation of OR at the time of intubation
	Senior orthopedic surgeon ○	
	Junior orthopedic surgeon ○	Yes ○ NO ○
	Resident ○	
Antibiotic following surgery:	MIPO ○ ORIF ○	Time from diagnosis of COVID to surgery (days)
Dressing intervals (hour)	COVID treatment:	Anticoagulant following surgery
Alive ○ Dead ○	Days remained in hospital	Post-op infection
If dead (reason) :		Yes ○ NO ○
		Superficial ○ Deep ○
Blood transfusion	Location of the patient after discharge:	Readmission
Yes ○ No ○	COVID rehab center ○	Yes ○ No ○
Reason:	Home isolation ○	
Number of pack cells:	Days	Reason:

HRCT review findings

Lung Zonal Involvement					
0-none; 1(1-25%); 2(26-50%); 3(51-75%); 4(76-100%)					
RUZ	**RMZ**	**RLZ**	**LUZ**	**LMZ**	**LLZ**

Predominant Pattern			
CHOOSE ONE ONLY (1; yes)			
GGO	**CONS**	**Reticular**	**Mixed**

Distribution	
Axial	**Craniocaudal**
(peripheral, cental)	(upper, mid, lower, diffuse)

Effusion	
1-small; 2-mod; 3-large	
Pleural	**Pericardial**

Background lung disease			
Emphysema	**Fibrosis**	**Bronchiectasis**	**Bronchial wall thickening**
0-no; 1-mild; 2-mod;3-sev	0-no; 1-yes	0-no; 1-yes	0-no; 1-yes

Miscellaneous		
crazy paving 0-no; 1-yes	reversed halo 0-no; 1-yes	round opacities 0-no; 1-yes
linear opacities 0-no; 1-yes	Lymphadenopathy 0-no; 1-yes	

Follow-up Questionnaire for patients with orthopaedic trauma

Duration of follow-up: **Any complication:**	**COVID-19 related symptoms post-discharge:**	**Medication duration** **COVID:** **Abx:**

Appendix 2. High-resolution CT (HRCT) protocol for COVID-19 diagnosis in educational hospitals of Shahid Beheshti University of Medical Sciences, Iran

Patient's position: Supine, arms above head with a single breath hold
Tube voltage = 100-120 kV
Automatic tube current modulation = 50-100 mAs
Pitch = 0.8–1.5 mm
Slice thickness = 1-3 mm
No reconstruction is needed.

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