

Orthopaedic Trauma in COVID-19 Pandemic: (A Study in a Tertiary Center, South of Iran)

Abstract

Background: The novel COVID-19 disease was presented at first in Wuhan, China, in December 2019. During COVID-19 pandemic, elective surgeries were postponed, and health care facilities and resources were reorganized to provide efficient service for the large number of infected patients with COVID-19. Therefore, approaching trauma patients, who could have had COVID-19, was a challenging issue requiring special considerations and healthcare set up.

Methods: This retrospective cohort study was conducted at Rajaei hospital, the main trauma center of the south of Iran, between March 2020 and August 2020 from the beginning of the COVID-19 pandemic. The COVID-19 infection was considered positive by either positive lung CT scan or PCR test. Trauma-related data such as the mechanism and pattern of trauma and injury, and surgical intervention procedures on the suspicious patients were recorded. Baseline characteristics including age, sex, cigarette smoking, and comorbidities were also collected. Need for ICU admission and mortality rates for the Covid and non-Covid cases were investigated and compared together as outcome variables.

Results: During a six-month period of the pandemic Covid-19, 9248 patients referred to our trauma center. While 222 patients were suspected to have Corona infection, Sixty-four cases were confirmed to be positive that had mean age of 44 years. Among the 64 COVID-19 -positive patients, 33 cases with mean age of 36.4 had orthopaedic injuries. 23 patients underwent surgical treatment due to the orthopaedic injuries. 24 patients were victims of motor vehicle accidents which included 7 cases of pelvic and acetabulum fractures.

The mortality rate of COVID-19 -positive cases were 15.6 % (10 patients out of the 64 cases and COVID-19 negative ones was 10.1 % (16 patients out of 158). The difference was not statistically significant (p.value:0.25). Multivariate analysis of the effect of the baseline and trauma related factors on mortality rate, showed that older age (p. value: 0.001), COVID-19 infection (p. value: 0.033), and surgical procedure (p.value:0.038) were the poor prognostic factors associated with mortality rate.

Conclusion: The mortality rate of trauma patients with COVID-19 positive infection was 15.6 % (10 patients). Older age, COVID-19 infection, and surgical procedure were associated with higher mortality rate.

Keywords: Trauma, Orthopaedics, COVID-19, Pandemic, Epidemiology

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Introduction

The novel coronavirus, called SARS-COV-2, the cause of COVID-19 disease, was presented at first in Wuhan, China, in December 2019⁽¹⁾. Soon after that, it spread out through more than 190 countries with devastating morbidities and mortalities with over 450,000 infected cases and 20,000 deaths. This led the World Health Organization (WHO) to call this outbreak as pandemic and public health emergency by March 2020^(2, 3, 4).

The governors and authorities of the affected countries tried their best to legislate every possible action to reduce caseloads, such as lockdown measures, strict traffic laws, city blockade, social distancing, and self-isolation at homes to mitigate viral transmission in major cities⁽²⁾.

COVID-19 cases could be suspected through medical history, exposure to the suspicious or infected cases and observing clinical symptoms including fever, cough and dyspnea^(5, 6). Confirmation of the diagnosis is recommended via performing PCR (polymerase chain reaction) or lung CT (computed tomography) scan, which have approximately 83.3 % and 97.2 % sensitivity, respectively⁽⁷⁾.

During the COVID-19 pandemic, elective orthopaedic surgeries were cancelled or postponed and healthcare potential capacities and resources were reallocated and reorganized to support the large-scale number of infected patients with COVID-19. Only urgent and emergent orthopaedic situations like trauma, acute musculoskeletal infections, and rapidly progressing malignant tumours were the only orthopaedic cases that would receive treatment, and every other facility, hospital and ICU beds would be assigned to COVID-19 patients^(8,9,10).

Iran has a high number of mortality rates due to motor vehicle accidents, accounting for approximately 20,590 deaths, annually. Despite lockdown measures and quarantine rule in the COVID-19 pandemic, a significant number of trauma patients were still referred to orthopaedic centers⁽¹¹⁾. Dealing with orthopaedic trauma patients, some of whom could have COVID-19, is a challenging issue that requires special consideration and healthcare setting.

Our study aims to portray the characteristics of orthopaedic trauma patients with COVID-19 and eliciting different aspects of management issues in these cases in our single referral trauma center.

Methods

Study design

This retrospective cohort study was performed during six months from the beginning of the COVID-19 pandemic - March to August of 2020. Data were collected from the medical records of the main trauma center hospital of southern Iran, in Shiraz. Since the report of the novel COVID-19 infection in Iran on early March 2020, all the

musculoskeletal trauma patients requiring hospitalization or needing six hours or longer observation in the trauma rooms were considered "probable Covid" victims.

Stable trauma patients were examined, and precise history was taken for any signs and symptoms of COVID-19 infection or recent exposure to a suspicious case of COVID-19. In accordance with the hospital's and city's protocols, all the patients were screened by chest radiography, complete blood cell count, Erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP), in addition to detailed history taking and thorough physical examination. If there was any doubt or they had any findings in favour of COVID-19 infection, they were transferred to special gray zone ward dedicated to probable COVID-19 infected patients and PCR and lung High-resolution computed tomography (HRCT) scan were requested and screened for any possible signs of COVID-19 infection. All unstable patients were considered probable and transferred to a particular intensive care unit (ICU) and were evaluated for COVID-19 by further confirmatory tests such as PCR or lung HRCT.

Data collection

Data of the probable COVID-19 trauma patients were collected from their medical records. Baseline characteristics (including age, sex, and comorbidities, history of opium or cigarette smoking) and COVID-19 related data (signs, symptoms and history of exposure to positive or suspicious individuals) were obtained from center of control and prevention of COVID-19 registry in Fars province, a southern province in Iran. The trauma-related data including traumatic injuries, need for ICU admission, duration of hospitalization, and outcome were then synced with the information collected from their medical records.

Laboratory and radiologic confirmation of COVID-19

Nasopharyngeal and oropharyngeal samples were obtained and checked for SARS-CoV-2 using Real-time reverse transcriptase-polymerase chain reaction (RT-PCR). HRCT was obtained if the chest X-ray was suspicious. HRCTs were reviewed by a trained radiologist. The patients who had a diagnostic

pattern of COVID-19 in HRCT or those with positive PCR test were considered as confirmed cases of COVID-19.

Statistical analysis

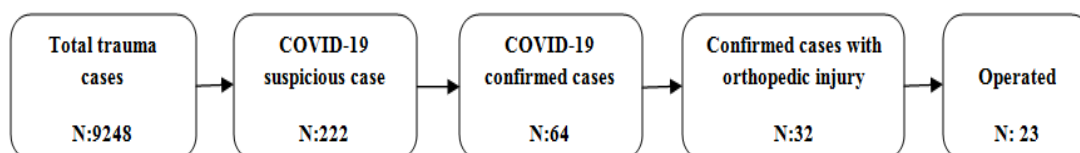
Data was analyzed by Statistical Package for the Social Sciences version 15.0 (SPSS Inc., Chicago, IL). Descriptive results are presented as mean \pm standard for quantitative data and number and percentile for qualitative data. The Chi-square test and T-test were applied to compare different parameters between probable trauma patients with positive and negative paraclinical test results. They were used to determine the association of different risk factors, such as age, trauma mechanism of, smoking, opium addiction, other comorbidities, and COVID-19 infection, with the final outcome factors i.e. need for ICU admission and mortality were analyzed with univariate and multivariate analysis studies.

Results

During six months from the emerging COVID-19 pandemic, 9248 patients were visited in our referral trauma center. From 222 patients who were suspicious of COVID-19 infection, 64 trauma patients were confirmed by either a HRCT scan or PCR test. From 222 patients, with mean age of 42.52, 183 (82.4%) patients were male and 39 (17.6 %) ones were female. Thirty-three patients of the confirmed cases had an orthopaedic injury and 23 needed surgical treatments Figure-1.

Baseline characteristics of the trauma patients with suspicious COVID-19 infection, categorized into COVID-19 negative or positive groups based on their confirmatory tests, are shown in Table.1. The age and sex distribution were similar between the two groups. The most prevalent comorbidities were hypertension, cardiovascular disease, and diabetes mellitus in both groups. The baseline characteristics were similar between positive and negative cases.

Figure 1: Diagram of orthopaedic trauma patients during six months from COVID-19 pandemic in our referral trauma center



N= number

Table 1. Baseline characteristics of all trauma patients with suspicious COVID-19 disease			
Baseline characteristics	Test result		P value
	Negative N=158	Positive N=64	
Age, Mean \pm SD	42.93 \pm 20.8	43.97 \pm 20.55	0.508
Sex: number (%)			
Male	132 (83.5)	51 (79.7)	0.494
Female	26 (16.5)	13 (20.3)	
Cigarette smoking: number (%)	26 (16.5)	6 (9.4)	0.174
Opium consumption: number (%)	17 (10.8)	3 (4.7)	0.152
Co-morbidities: number (%)			
Hypertension	12 (7.6)	7 (10.9)	0.433
Cardiovascular disease	8 (5.1)	8 (12.5)	0.081
Diabetes mellitus	7 (4.4)	3 (4.7)	1.0

n=number, SD: standard deviation

Clinical and outcome characteristics of the two groups were presented in Table.2. Only the history of exposure to suspicious COVID-19 infectious case was significantly higher among the positive cases compared to the negative ones: 8 (12.5 %) versus 5 (3.2 %). p .

$=0.012$. The most prevalent signs and symptoms among the patients in both groups were fever, cough, and weakness. One hundred eleven (48.1%) patients had been admitted to ICU and 26 (11.3%) were deceased.

Table 2. Clinical data and outcome characteristics of all trauma patients with suspicious COVID-19 disease

Characteristics	Test result, n (%)		P value
	Negative N=158	Positive N=64	
Sign and symptom, n (%)			
Fever	60 (38.0)	24 (37.5)	0.947
Cough	18 (11.4)	12 (18.8)	0.186
Weakness	24 (15.2)	6 (9.4)	0.287
Anorexia	9 (5.7)	1 (1.6)	0.288
Chest pain	4 (2.5)	4 (6.3)	0.232
Body pain	3 (1.9)	3 (4.7)	0.358
Headache	3 (1.9)	1 (1.6)	1.0
Vertigo	1 (0.6)	0 (0)	1.0
seizure	0 (0)	1 (0.4)	0.288
History of exposure to a positive or suspicious case	5 (3.2)	8 (12.5)	0.012
Destiny after admission			0.899
ward	24 (15.2)	9 (14.1)	0.286
Isolated room	54 (34.2)	24 (37.5)	
ICU	80 (50.6)	31 (48.4)	
Duration of hospitalization (day)	8 (1.2)	6 (1.3)	0.347
outcome			0.248
Discharged	138 (87.3)	51 (79.9)	
Deceased	16 (10.1)	10 (15.6)	
Remained	4 (2.5)	3 (4.7)	

n:number

ICU: Intensive care unit

Univariate analysis of the association of the baseline and prognostic factors, including, age, sex, mechanism of trauma, cigarette smoking, opium consumption, COVID-19 infection, and comorbidities with ICU admission was performed which revealed cigarette smoking was the only statistically significant factor associated with more ICU admission of the patients. After adjusting for the effect of all the mentioned variables,

multivariate analysis showed no significant association of any of the parameters with ICU admission. (Table 3)

Table 3. Analysis of the associations of baseline and demographic characteristics with ICU admission in patients presented with trauma and suspicious COVID-19 infection

Characteristics	Location of admission			
	ICU	Ward	p-value ¹	p-value ²
Age(mean)	40.9	44.1	0.12	0.76
Mechanism of Injury: High/low	76/24(76/24 %)	68/32(68/32 %)	0.21	0.24
Sex Male/female	91/20 (82.9/17.1 %)	92/19 (82/18 %)	0.86	0.56
Cigarette smoking	22 (19.8 %)	10 (9 %)	0.02	0.097
Opium consumption	14 (12.6 %)	6 (5.4 %)	0.06	0.93
COVID-19	31 (27.9 %)	33 (29.7 %)	0.77	0.95
Comorbidities				
HTN	8 (7.2 %)	11 (9.9 %)	0.47	0.39
CVD	10 (9 %)	6 (5.4 %)	0.30	0.21
DM	6 (5.4 %)	4 (3.6 %)	0.52	0.59
Asthma	2 (1.8 %)	1 (0.9 %)	0.56	0.52

ICU: Intensive care unit, HTN: hypertension, CVD: cardiovascular disease DM: diabetes mellitus

1. P-value related to the univariate analysis of the characteristics with mortality rate (mann-whitney and chi square)

2. P-value related to the multivariate analysis of the characteristics with mortality rate (binary logistic regression)

In an effort to investigate the association of the baseline and prognostic factors, which were mentioned in table 3, as well as surgical procedure with mortality rate, it was revealed that older age and asthma as the only statistically significant factors associated with more mortality rate of the trauma patients.

After adjusting for the effect of all the aforementioned variables, multivariate analysis showed a significant association of older age (p.value: 0.001), COVID-19 positive (0.03), and surgical procedure (0.03) with more mortality rate. (Table. 4)

Table 4. Analysis of the associations of baseline and demographic characteristics with hospital associated mortality rate in patients presented with trauma and suspicious COVID-19

Characteristics	Mortality			
	expired	alive	p-value ¹	p-value ²
Age(mean)	55.4	40.8	0.001	0.001
Mechanism of Injury High/low	16/6 (72.7/27.3 %)	128/50 (71.9/28.1 %)	0.96	0.18
Sex Male/female	20/6 (76.9/23.1 %)	163/33 (83.2/16.8 %)	0.43	0.40
Cigarette smoking	6 (23.1 %)	26 (13.3 %)	0.18	0.27
Opium consumption	5 (19.2 %)	15 (7.7 %)	0.05	0.09
Surgical procedure	16 (61.5 %)	100 (51 %)	0.06	0.033
COVID-19	10 (38.5 %)	54 (27.6 %)	0.25	0.038
Comorbidities				
HTN	4 (15.4 %)	15 (7.7 %)	0.19	0.76
CVD	5 (19.2 %)	11 (5.6 %)	0.012	0.20
DM	2 (7.7 %)	8 (4.1 %)	0.40	0.41
Asthma	2 (7.7 %)	1 (0.5 %)	0.003	0.09

HTN: hypertension, CVD: cardiovascular disease, DM: diabetes mellitus

1. P-value related to the univariate analysis of the characteristics with mortality rate (mann-whitney and chi square)

2. P-value related to the multivariate analysis of the characteristics with mortality rate (binary logistic regression)

Table.5 illustrates the characteristics of the trauma patients who needed orthopaedic intervention.

Twenty-four (72.7%) cases had traffic accidents while the remaining 9 (27.3%) sustained their orthopaedic injuries following falls. The most prevalent sites of injury were

pelvic and acetabulum (10 cases), femur (11 cases), and clavicle (7 cases). Twenty-three patients were treated surgically with a mean admission to surgery duration of 8.2 ± 6.8 days. The mean operation duration time was 3.1 ± 2.0 hours.

Table 5: The characteristics of the orthopaedic trauma patients with confirmed COVID-19 disease.

Characteristics	Value
Mechanism, n (%)	
Traffic accident	24 (72.7)
Falling down	9 (27.3)
Orthopaedic injury, n (%)	
Falling down	
Pertrochanteric fx	3 (0.09)
Pelvic fx	3 (0.09)
Spinal fx	2 (0.06)
Femoral shaft fx	1 (0.03)
Distal radius fx	1 (0.03)
Tibia shaft fx	1 (0.03)
Shoulder dx	1 (0.03)
Elbow dx	1 (0.03)
Accident	
Pelvic & acetabulum fx	7 (0.21)
Clavicle fx	7 (0.21)
Femoral shaft fx	4 (0.12)
Pertrochanteric fx	3 (0.09)
Spinal fx	3 (0.09)
Tibia shaft fx	3 (0.09)
Humerus fx	3 (0.09)
Bimalleolar fx	2 (0.06)
Distal radius fx	1 (0.03)
Both bone fx of forearm	1 (0.03)
Bennet fx	1 (0.03)
Calcaneous fx	1 (0.03)
Cuboid fx	1 (0.03)
Patella fx	1 (0.03)
ACL avulsion fx	1 (0.03)
Scapula fx	1 (0.03)
Surgical treatment of orthopaedic injury, n (%)	23 (0.70)
Admission to surgery time interval, mean days (SD)	8.2 (6.8)
Surgery duration, mean hours (SD)	3.1 (2.0)

n= number, SD: standard deviation, Fx: fracture, ACL: anterior cruciate ligament
Dx: dislocation

Discussion

Characteristics of COVID-19 and trauma patients

Among all of 9248 trauma patients, 222 cases were suspicious of having COVID-19 infection. Similar to previous reports, fever, cough and fatigue were the most common symptoms in

our study (39 %, 13 %, 13%, respectively) ^(10, 12, 13, 14).

Sixty-four confirmed cases showed a history of exposure to suspicious and symptomatic people at a higher rate compared to the 158 COVID-19-negative cases, which was statistically significant. (12.5 % to 3.2 %. p.Value=0.012). This could lead us to be more cautious about approaching a patient with a

history of exposure by not only providing more personal protective equipment for medical staff, but also taking immediate actions toward the isolation of these patients from other unsuspecting ones.

The most prevalent comorbidities among our studied patients were hypertension, diabetes mellitus and cardiovascular disease, similar to the previous reports^(13, 15, 16).

We observed different age and injury patterns compared to the other studies in COVID-19 pandemic reporting the mean age of 67 years or older^(10,15,16), and demonstrating low energy trauma as the most common mechanism of trauma^(12,17,18). Mean age of the patients in our study was 42.5 and 80 % of them were men, most were the victims of motor vehicle accidents (MVA) (72.7%). Besides, One study from Iran showed the mean age of the studied patients was 38.6, and high energy trauma was the main cause (8 patients out of 13)⁽¹¹⁾. Noteworthy, it could be concluded that despite government legislation of lockdown measures, strict traffic laws, and self-isolation at home, the MVA still has a devastating impact and the utmost role, giving rise to traumatic injury to the patients in this region during the COVID-19 pandemic.

Among 64 confirmed cases, 33 showed orthopaedic injuries, mostly comprised of the pelvis and acetabulum, clavicle, and peritrochanteric fractures (10, 7, and 6 patients, respectively). Among the patients with orthopaedic injuries, 24 (72.7%) ones were the victim of MVA and 9 patients were injured due to falling down. The most common orthopaedic injury in MVA and falling down subgroups were pelvic fractures and peritrochanteric fractures respectively. One systematic review on 44 COVID-19 positive cases with concomitant fractures, showed 29 patients with proximal femoral fractures, eight patients with spine fractures, and seven patients with limb bone fractures⁽¹⁶⁾. The 23 (69 %) out of 33 COVID-19 positive cases of the present paper that underwent orthopaedic surgery is in line with the results of Jain et. al. where 68 % of their 44 Covid patients required surgery⁽¹⁶⁾.

In terms of ICU admission for Covid_19 cases and the mortality and morbidity associated

with that, we observed no significant association with any baseline and prognostic factors with more ICU admission.

The outcome of COVID-19 and Trauma patients: ICU admission and hospital associated mortality

In our study, 111 patients (50%) were admitted to the intensive care unit (ICU). This proportion remained constant among both COVID-19 negative and positive groups. One study of 82 COVID-19 positive versus 340 COVID-19 negative patients with concomitant hip fracture showed 9.8 % (8 patients) ICU admission in COVID-19 positive cases compared to 0.9 % (3 patients) in COVID-19 negative ones, suggesting that ICU admission was not a poor prognostic factor⁽¹⁰⁾. While, a study of 34 COVID-19 patients, who had been operated, with an ICU admission proportion similar to our study (44%), stated that patients with comorbidities such as HTN and CVD, older age and the more complicated surgery had increased risk for ICU admission⁽¹³⁾. Of note, the ICU admission rate among COVID-19 patients without surgery is documented at 26 % in the literature⁽¹⁹⁾. One reason could be that any surgical procedure would bring about immune system compromise, jeopardizing multi-organ functions resulting in the need for more ICU care. It should be taken into account that our surgical procedures were performed after ICU admission of the trauma patients. One explanation for the observed no significant effect of associated comorbidities on the rate of ICU admission among our patients, may be rooted in the younger age of their age compared with the aforementioned studies.

11.7 % (26 patients) of 222 patients expired during hospitalization. The hospital-associated mortality rate of the COVID-19 positive cases with concomitant orthopaedic trauma was 15.6 % (10 patients) which was in contrast to previous reports by Jain (36.3 %), Kayani (30.5 %), and Maniscalco (43 %) ^(10, 16, 20). The most logical explanation could be the younger population of our study (mean age: 42) comparing to the mentioned studies. One study on 34 COVID-19 patients who underwent surgery with closer age distribution (median age: 55) to ours, showed

a 20.5 % mortality rate ⁽¹³⁾. Meanwhile, it should be mentioned that case fatality rate of COVID-19 patients without trauma is 2.3 % ⁽²¹⁾. After a multivariate analysis of risk factors association with the mortality rate in the suspicious COVID-19 patients with trauma, it was determined that older age, COVID-19 infection, and surgical procedure are poor prognostic factors. However, Kayani et al. showed cigarette smoking and multiple comorbidities, and Lei et al. proposed more complicated surgeries and medical comorbidities as detrimental factors associated with more mortality rate in their study population ^(10, 13). One of the most important findings of our study was that the presence of COVID-19 showed significant association with more mortality rate among trauma patients, which was similar to Kayani's report ⁽¹⁰⁾.

Strengths and limitations

We conducted a retrospective cohort study with a medium-sized sample of suspicious COVID-19 and trauma patients in a center with a high volume of incoming trauma patients from south of Iran, which evaluated 9248 trauma cases in a six months pandemic period. This large-scale referred patient to our hospital is an efficient representative of the Iranian people's profile regarding COVID-19 status during the pandemic. The other strength of our study could be using two confirming tests (HRCT and PCR) to increase more diagnostic accuracy and sensitivity.

One of the limitations was that asymptomatic carriers of COVID-19 disease were not investigated due to the lack of enough available PCR kits. Meanwhile, the incubation period of COVID-19 infection is stated to be 14 days, and trauma patients need to be managed urgently and any delay in surgical treatment may accelerate or exacerbate their current condition and leading to the poor functional outcomes ⁽¹⁴⁻²²⁾. The other limitation was that any developing signs and symptoms in suspicious cases after their hospital course were not assessed.

During the COVID-19 pandemic, medical health care and hospital resources should be utilized wisely and optimally to reduce devastating morbidities and mortalities. The vast majority of trauma patients in Iran are

victims of motor vehicle accidents and are in need of urgent medical and surgical interventions. Providing resourceful information about the epidemiological and clinical characteristics of trauma patients with COVID-19 would contribute to the well-organized decisions and systematic approach to the issues in pandemic condition.

Conclusion

Pelvic and Acetabular fractures were the most common injury patterns from MVA seen in our 64 cases with positive Covid-19, and 48 % of the COVID-19 positive patients were admitted to the ICU. The mortality rate of these cases was 15.6 % (10 patients). Older age, COVID-19 infection and major trauma were the possible reasons for the higher mortality rate observed in our study of orthopaedic trauma related mortality.

Abbreviations

WHO: World health organization; PCR: Polymerase chain reaction; CT: Computed tomography; HRCT: High resolution computed tomography; ICU: intensive care unit; HTN: Hypertension; CVD: Cardiovascular disease; DM: Diabetes mellitus; SD: Standard deviation; Fx: Fracture, ACL: Anterior cruciate ligament; Dx: Dislocation; MVA: Motor vehicle accidents

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