

RESEARCH ARTICLE

Management of Spine Trauma in COVID-19 Pandemic: A Preliminary Report

Mohammadreza Chehrassan, MD¹; Adel Ebrahimpour, MD¹; Hasan Ghandhari, MD²; Morteza Sanei Taheri, MD³; Bahador Athari, MD⁴; Mehrdad Sadighi, MD¹; Meisam Jafari KafiAbadi, MD¹; Amin Karami, MD¹; Alireza Zali, MD⁵

*Research performed at Shahid Beheshti University of Medical Sciences, Tehran, Iran
The paper was accepted without peer review process*

Received: 14 April 2020

Accepted: 14 April 2020

Abstract

Background: COVID-19 was first identified in Iran in February 2020 and since then it spread rapidly through all over the country and soon after that it was reported as a pandemic. The current study presents a preliminary report of spine trauma management during COVID-19 pandemic.

Methods: A cross sectional study was designed to evaluate patients admitted for vertebral fractures with diagnosis of COVID-19 infection on February and March 2020. Analysis was made based on clinical and laboratory data along with the imaging findings from chest HRCT.

Results: Seven patients with spine trauma including five males and two females ranging from 14 to 59 years were diagnosed for COVID-19 infection through CT-scan findings. Except one, all other patients were asymptomatic for COVID-19 at the time of admission. In three cases the COVID diagnosis was made the day after arrival and in others after 10, 14 and 35 days. Five patients were treated surgically among whom four were admitted to ICU soon after the surgery. The mean ICU stay for operated patients were eight days and the mean hospital stay was 22.6 days.

Conclusion: Proper diagnosis of COVID-19 is the keystone to protect both patients and health care providers. During the pandemic all admitted patients should be screened for COVID-19 infection. Unnecessary procedures for spine trauma patients should be avoided in order to reduce complications related to surgery and to preserve ICU beds.

Level of evidence: IV

Keywords: Coronavirus, COVID-19, Pandemic, Spine trauma, Spine surgery, Vertebral fracture

Introduction

In December 2019 an epidemic of viral pneumonia in Wuhan, China started and then spread rapidly in so many countries until WHO declared pandemic on 30 January 2020 (1, 2). The etiology of this pandemic is a new coronavirus which is named by WHO 2019-nCoV and the disease caused by 2019-nCoV is called coronavirus disease 2019 (COVID-19). Common symptoms are fever, fatigue, and dry cough and it can be fatal (3).

COVID-19 was first identified in Iran in February 2020 in the city of Qom (4) and since then it spread rapidly through all over the country. Due to the highly

contagious nature of 2019-nCoV virus and in order to decrease nosocomial infection and preserve more beds for COVID-19 infections, all elective procedures including spinal surgeries were canceled (5). However, emergency situations such as progressive or ongoing neurological deficit or instability of the spine following fractures, infections, or tumors could not be postponed.

While different considerations should have been taken before performing regular spine surgeries, unknown aspects of COVID-19 infection made the latter more complicated. Moreover, surgery in these patients

Corresponding Author: Adel Ebrahimpour, Department of Orthopedic Surgery, Shohadaye Tajrish Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran
Email: a.ebrahimpour@sbmu.ac.ir



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made the health care providers and medical staff more vulnerable due to higher risk of exposure and put them at the risk of transmission. To the best of our knowledge there is no study about spinal surgeries in COVID-19 patients in literature. We conceived this study to report the early results of vertebral fracture management in COVID-19 patients. The second aim was to report the clinical and laboratory findings of these patients at the time of presentation.

Materials and Methods

A cross sectional study was designed to evaluate patients admitted for vertebral fractures with diagnosis of COVID-19 infection between February and March 2020, during the early stage of Covid-19 epidemic in Iran. The patients were admitted to our trauma centers which are also referral for COVID-19 infections.

A self-administered questionnaire with clear instructions and questions was prepared and data were collected according to records from patients' files including demographic and clinical records, nursing records, and laboratory findings. Any clinical record related to COVID-19 infection and spine problems were evaluated precisely and added to questionnaire. Due to the low available number of reverse transcriptase polymerase chain reaction (RT-PCR) test at the early stage of epidemic in Iran, high resolution CT-Scan (HRCT) was considered as the modality for the diagnosis of COVID-19 infection. Radiological records were reviewed separately by a senior consultant (according to Iranian Society of Radiology COVID-19 Consultant Group) (6).

A separate questionnaire dedicated to HRCT characteristics of COVID-19 infection was prepared and applied. The predominant pattern and the degree of lung zonal involvement, distribution pattern and any background lung disease were checked and recorded for each patient.

The admission details and the data regarding the

surgery and type of anesthesia were also recorded. The availability of Personal Protection Equipment (PPE) for surgery and anesthetist staff was checked for each procedure.

Ethical approval for this study was provided by the ethics committee of Shahid Beheshti University of Medical Sciences in accordance with the ethical standards of the national research committee and the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Results

All vertebral fractures with confirmed COVID-19 infection were approached for eligibility. Nine patients with the diagnosis of COVID-19 infection and vertebral fractures including seven males and two females were identified and evaluated. Diagnosis was made with low dose high resolution HRCT for all patients. During the review of imaging records by our senior radiologist consultant, the characteristic findings on CT scan of two patients, who were diagnosed first for COVID infection, were not compatible with the diagnosis of COVID-19 and consequently they were excluded from the study. However the review of imaging records was made after the discharge of these patients and they remained in COVID ward and one transferred later to ICU during their hospital stay. Finally seven cases including five males and two females ranging from 14 to 59 years (Mean: 33.7) were enrolled in this study [Table 1]. In three cases the diagnosis of COVID-19 was made the day after arrival to the hospital; in one case during the following three days; and in three cases in 10, 14 and 35 days after the admission.

The diagnosis of COVID-19 infection was made with HRCT in all patients [Figure 1]. Radiological findings on HRCT were summarized in Table 2. Higher grade of involvement in lung zones was observed among relatively older patients with history of Major Depression Disorder

Table 1. Clinical and laboratory characteristics of patients with vertebral fractures

Number	1	2	3	4	5	6	7
Age and Sex	29 ♂	27 ♂	14 ♀	38 ♀	37 ♂	32 ♂	59 ♂
Admission date	April 1, 2020	Mar 4, 2020	Mar 1, 2020	Jan 26, 2020	Mar 2, 2020	Mar 25, 2020	Mar 10, 2020
Discharge date	April 10, 2020	Died (Mar 18, 2020)	Mar 19, 2020	Died (Mar 18, 2020)	Mar 21, 2020	Mar 27, 2020	Mar 30, 2020
Hospital stay (Days)	10	14	18	52	19 (9 + 10)	2	20
PMH & Medications	None	None	None	MDD / Trifluopromazine and Clonazepam	None	None	None
Smoking / Drug abuse	NO	NO	NO	NO	No	NO	Yes
COVID Symptoms After diagnosis	None	None	Cough / Fever / Hyposmia	Dyspnea	Dyspnea	None	Cough/ Fever / Dyspnea
COVID diagnosis after admission (days)	1	1	10	35	3	1	14
Time from diagnosis to surgery (days)	4 days	6 days	Diagnosis after surgery	Diagnosis after surgery	Diagnosis after surgery	-	Diagnosis after surgery (Splenuctomy)

Table 1. Continued							
Vertebral Fracture	C2 odontoid	C4	L1	T3, T5, T12 Sacrum	T12. L1	T10	T8, T9, T10
Mechanism of injury	MVA	MVA	HEF	HEF	MVA	MVA	MVA
Frankel Score	E	A	E	A	D	E	E
Other traumas	Limbs (Intertochaneric Humerus)	Head / Limbs (Proximal tibia Humerus)	Abdomen	Head / Abdomen / Chest/ Pelvis	Head	Abdomen	Abdomen
Corticosteroid for spine or head trauma	Yes	No	No	No	Yes	No	No
O ₂ sat % Pre / Post op	88 / 90	91 / 88	96 / 92	98 / 95	98/ 80	93 / -	92 / -
Temperature Pre / Post op	37.1 / 37.1	36.5 / 36.5	36.7 / 37.9	37.1 / 37.5	37 / 36.8	36.2 /	38.9 / -
CRP	71	126	77	25	2 +	3 +	2 +
ESR	5	80	12	11	-	14	36
PLT	133000	299000	322000	155000	261000	198000	110000
WBC count	17500	11200	27600	1700	10500	14900	13200
PMN count	78%	80%	88%	90%	84%	84%	82%
Lymph count	19% (3325)	15% (1680)	5% (1380)	7% (119)	0.8% (85)	16% (2384)	17% (2244)
Hg Pre / Post-op	9.7 / 9.6	12.2 / 8.5	10.5 / 9.2	11.3 / 10.3	14.1 / 10	17.5	12 / -
Chest CT During admission	Positive	Positive	Positive	Positive	Positive	Positive	Positive
Chest CT following Review	Positive	Positive	Positive	Positive	Positive	Positive	Positive
ICU admission	None	Pre and post-operative	Pre and post-operative	Pre and post-operative	Post-operative	None	Post-operative
ICU admission after COVID Diagnosis	-	14	5	14	7		
COVID diagnosis at the time of surgery	Yes	Yes	No	No	NO	None	No
PPE	ALL	All	Only Face Shield	None	Only protective clothing	-	-
Spine Surgery duration	450 (Min)	330 (Min)	160 (Min)	120	120 (Min)	-	
Other Surgeries	Limb fracture fixation	Limb fracture fixation	None	Chest Tube / Laparotomy / Colostomy	None	-	Splenectomy
COVID treatment	Hydroxychloroquine	Hydroxychloroquine / Oseltamivir / Azithromycin	Hydroxychloroquine / Azithromycin	Oseltamivir	Hydroxychloroquine / Oseltamivir	Hydroxychloroquine	Hydroxychloroquine / Oseltamivir
RBC pack cell transfusion	None	2	2	3	2	None	4
Location of patient after discharge	Home isolation	-	Home isolation	-	Home isolation	Home isolation	Home isolation

PMH (past medical history) / CRP (C Reactive Protein) / ESR (Erythrocyte Sedimentation Rate) / PPE (Personal Protection Equipment) / MDD (major depression disorder)

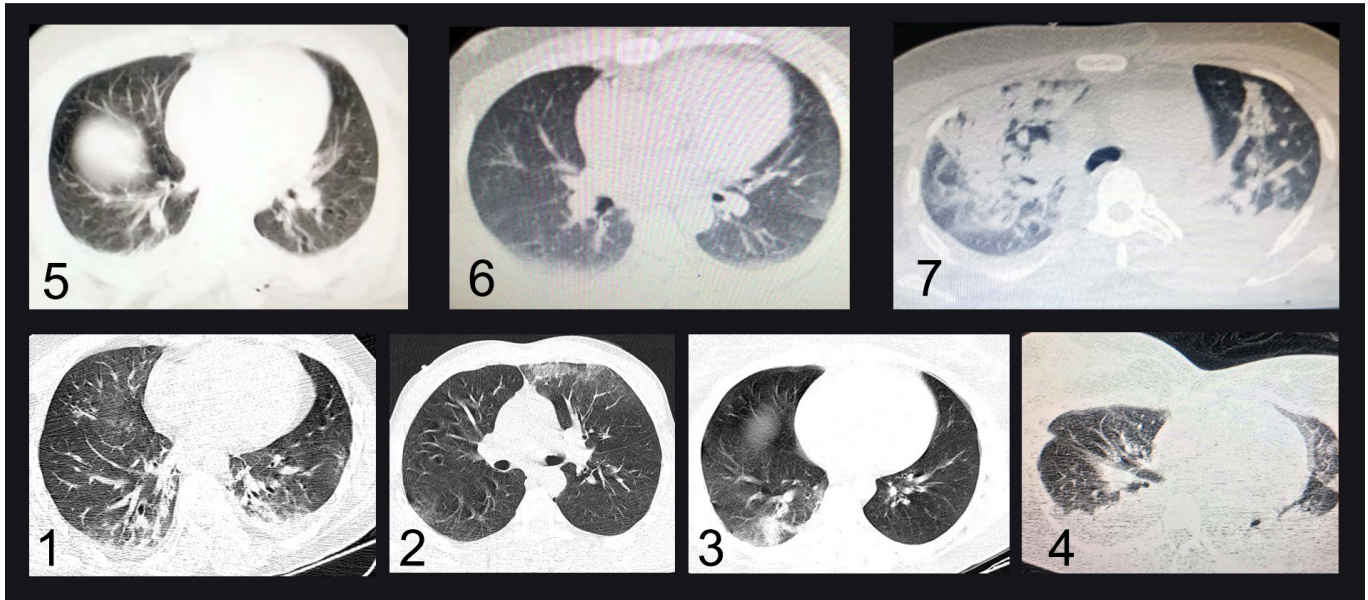


Figure 1. Chest CT scans related to all 7 patients. The number appear on each image match the case number on tables 2

Table 2. HRCT review findings

Number		1	2	3	4	5	6	7
Lung Zone Involvement	RUZ	1-25%	1-25%	1-25%	1-25%	1-25%	1-25%	76-100%
	RMZ	1-25%	1-25%	1-25%	51-75%	1-25%	1-25%	76-100%
	RLZ	26-50%	1-25%	26-50%	51-75%	1-25%	1-25%	76-100%
	LUZ	1-25%	26-50%	26-50%	1-25%	0	1-25%	51-75%
	LMZ	1-25%	26-50%	0	51-75%	0	1-25%	76-100%
Predominant Pattern	LLZ	26-50%	1-25%	1-25%	51-75%	1-25%	1-25%	76-100%
		GGO	GGO	Mixed	CONS	CONS	GGO	GGO
Distribution Pattern	Axial	Peripheral	Peripheral	Peripheral	Mixed	Peripheral	Peripheral	Mixed
	Cranial	Lower	Upper	Lower	Diffuse	Lower	Lower	Diffuse
Effusion	Pleural	No	No	No	Mild	Mild	Mild	Mild
	Pericardial	No	No	No	No	No	No	No
Background Lung Disease		Fibrosis	None	Fibrosis	Fibrosis	None	None	Fibrosis
Miscellaneous Findings		LO	RH	RO / LO	RO / LO	LO	LO	CP / RO / LO

Miscellaneous Findings: Crazy Paving (CP) / Reversed Halo (RH) / Round Opacities (RO) / Linear Opacities (LO) / Lymphadenopathy (LA)

Lung Zone Involvement: Right Upper Zone (RUZ) / Right Middle Zone (RMZ) / Right Lower Zone (RLZ) / Left Upper Zone (LUZ) / Left Middle Zone (LMZ) / Left Lower Zone (LLZ)

Predominant Pattern: Ground-glass opacities (GGOs) and Consolidation (CONS)

(MDD) and Smoking (Case 5 and 7). Predominant pattern was ground-glass opacities (GGO) (57.2%) followed by consolidation (CONS) (28.5%) and mixed (14.3%) and most frequently the peripheral area on axial cuts was involved.

One patient suffered from MDD and one had history of cigarette smoking for many years. Except one patient

(Case 3) who had cough and hyposmia, all patients were asymptomatic for COVID-19 at the time of admission. Three cases were remained asymptomatic for the rest of admission, while three others showed some symptoms including cough, fever and dyspnea.

Two patients had fracture of the cervical spine (one C2 odontoid fracture and one C4 vertebral body fracture)

while five cases had sustained thoracic or thoracolumbar junction fractures. Multiple vertebral fractures were observed in three cases, one of which was associated with sacral fractures and spinopelvic dissociation. In five patients the mechanism of injury was motor vehicle accident (MVA) while high energy fall (HEF) was the reason of trauma in two other cases. Two patients arrived to the hospital with complete cord injury (Frankel A); one with incomplete cord injury (Frankel D); and four without neurological deficit. All patients were poly-trauma cases with other injuries to head, chest, abdomen and limbs. Two patients (Case 1 and 5) received corticosteroid following admission due to confusion, head trauma or neurological compromise.

All patients had leukocytosis ($<10,000$ per μl) with neutrophil granulocytosis. Lymphopenia (<1500 per μl) was observed in three cases but was severe in two patients (Case 4 and 5). C-reactive protein (CRP) level was elevated in all cases and above 70 mg/L in 3 cases (case 1, 2 and 3) [Table 1].

Five patients underwent surgery for spine fusion and two cases (Case 6 and 7) were treated conservatively for vertebral fractures in whom one had splenectomy. All surgeries were performed through open reduction and posterior spinal fusion and minimally invasive spine surgery was not applied. In two patients the surgery was postponed to 4 and 6 days after the diagnosis of COVID-19 and in three cases the diagnosis was made following the surgery. All procedures were performed through posterior approach in prone position. PPE was available for all confirmed cases of COVID-19 patients at the time of surgery procedures. Among five patients with spine surgery four needed ICU admission postoperatively and one patient remained in COVID dedicated ward. The mean ICU bed occupation was 8 days and the mean total hospital stay was 22.6 days (Range: 10-52) for five patients who underwent spine surgery. Mild O₂ sat drop ($<94\%$) was observed in all patients postoperatively which required oxygen mask support. Two patients (case 2 and 4) died due to trauma severity and cardiopulmonary complications associated with COVID infection.

All patients received Hydroxychloroquine as the therapeutic regimen for COVID-19. In two cases Oseltamivir and in one case Azithromycin were added to Hydroxychloroquine while in one case a combination of Hydroxychloroquine, Oseltamivir, and Azithromycin was prescribed.

Discussion

The current study was performed on 7 cases with concomitant COVID-19 infection and vertebral fractures to improve the understanding about the effects of this viral pneumonia on patients who may need long hospital stay or surgical procedures.

Early diagnosis of COVID -19 infection can be made through RT-PCR test or based on HRCT findings, however the sensitivity of HRCT is higher in comparison to RT-PCR (98% and 71%, respectively) and may detect the infection in earlier stages (7). Diagnosis of COVID-19 is important from different aspects; while false positive diagnosis put a non-infected patient at unnecessary risk of exposure by

admitting him in an infected ward, false negative diagnosis puts the health care providers at risk due unprotected contact with a positive COVID infection patient. To avoid the latter, particularly in case of diagnosis based on chest HRCT and clinical findings, more expert radiologist and infectious disease consultants should be involved in the process of diagnosis. Moreover it seems necessary to consider RT-PCR test for all suspected patients or when HRCT findings are not reliable for the diagnosis (7). In our study two cases who were excluded from the study later, were first admitted in a ward dedicated for COVID-19 infected patients with the diagnosis of COVID-19. One patient remained asymptomatic and discharged while the other was transferred to ICU due to aspiration pneumonia.

Home isolation in many countries were planned in order to decrease social contacts (8) and expected to influence urban and extra urban trips. In Iran MVA is the main cause of trauma followed by falling (9). Our study showed that despite social distancing and reduction in the number of trips, MVA was the main reason of vertebral fracture in our series that should be considered more seriously by the authorities.

Silent infection and asymptomatic patients consist the major part of COVID-19 infection (10). Common presentations of COVID-19 infection included fever (87%), dry cough (58%), dyspnea (38%), myalgia, fatigue, and intestinal upset (3). Fever(87%) was the most common symptom followed by cough (58%) and dyspnea (38%) (10, 11). It should be considered that asymptomatic patients at the time of surgery may be in their incubation period and having symptoms following the surgery does not indicate nosocomial infection necessarily (12). In our study, the majority of our cases (five cases) were asymptomatic for COVID infection at the time of admission and two remained asymptomatic until the discharge. There is an assumption about the nosocomial infection of three cases who were diagnosed days after surgery; however, due to the lack of negative RT-PCR test at the admission time we have no data to support this hypothesis.

Great controversy exists on the efficacy of corticosteroid usage in case of spinal cord injury (13-16). However in the COVID-19 pandemic this issue may be more critical due to the decreased cell mediated immunity which is vital for viral diseases. Russell et. al recommended to avoid corticosteroid use in case of COVID-19 infection (17). Our results showed that patients who died had no history of corticosteroid use during their hospital stay.

One important finding in our study was that all patients had viral pneumonia at the time of surgery. In a study by Bohl et al. pneumonia was related to an increase in mortality rate upto 20% following posterior lumbar fusion procedures (18). All patients in our study were poly-trauma cases who had higher risk of pneumonia complications related to trauma. In addition, prone position during the spine surgery may decrease respiratory compliance to 30% and increase the peak airway pressure (19). Prone positioning can also decrease cardiac output and venous return and may affect the patient with already compromised pulmonary function

(20). All patients in our study required supportive oxygen therapy due to relatively low O₂ saturation following the surgery.

The severity of the trauma in vertebral fractures including spinal cord injury and other concomitant traumas to other organs, increases the risk of complications and mortality (21). Our results showed that patients with more severe trauma including complete cord injury (Frankel A) may have higher risk of mortality. Also, the degree of lung zone involvement and the intensity of pneumonia showed to be more severe in patients with history of smoking or other comorbidities. Majority of patients in our study who underwent spine surgery needed ICU bed for a relatively long period (Mean 8 days).

This study presents a preliminary report of spine trauma management and is not free of limitations. Low number of cases and limited follow-up to the time of discharge from the hospital are inconvenient factors of the study. Moreover, our data had many short comes and in case of poly trauma and spine injury with COVID infection, a more comprehensive investigation should be made.

There is no consensus regarding the management of patients with vertebral fractures and spinal cord injury among spine surgical community. This issue may be even more critical in case of COVID-19 infection. According to our results only some strategies can be proposed in order to improve better approach by spine surgeons when confronting spine trauma during COVID-19 pandemic. Proper diagnosis is the keystone to avoid disease transmission to uninfected patients or any unprotected exposure of healthcare providers. During the pandemic all patients who are planned for a surgical procedure should be screened for COVID-19 infection. We believe HRCT might be a better option for screening as it is a sensitive diagnostic tool and would inform the surgeon about the pulmonary involvement. The latter may affect the decision making for surgical intervention. Unnecessary procedures for these patients should be avoided in order to reduce surgery-related complications and preserving ICU beds.

Conflict of interests: The authors declare that they have

no conflict of interest.

Funding: There is no funding source.

Acknowledgements

We would like to thank our colleagues for their collaboration and sharing their clinical cases with us including: Afsoun Seddighi and Reza Jalili Khoshnood from Functional Neurosurgery Research Center, Shahid Beheshti University of Medical Sciences; Omid Momen from Department of orthopedic surgery, Golestan University of medical sciences; Majid Rezvani from Department of Neuroscience research center, Isfahan University of Medical Sciences; Khalil Komlakh from Department of Neurosurgery, Imam Hossein Hospital, Shahid Beheshti University of Medical Sciences.

Mohammadreza Chehrassan MD¹

Adel Ebrahimpour MD¹

Hasan Ghandhari MD²

Morteza Sanei Taheri MD³

Bahador Athari MD⁴

Mehrdad Sadighi MD¹

Meisam Jafari KafiAbadi MD¹

Amin Karami MD¹

Alireza Zali MD⁵

1 Department of Orthopedic Surgery, Shohadaye Tajrish Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran

2 Bone and Joint Reconstruction Research Center, Shafa Orthopedic Hospital, Iran University of Medical Sciences, Tehran, Iran

3 Department of Radiology, Shohadaye Tajrish Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran

4 Department of Orthopedic Surgery, Imam Hossein Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran

5 Functional Neurosurgery Research Center, Shohadaye Tajrish Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran

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