

Review Article

Management of orthopedic patients during COVID-19 outbreak

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Abstract: Coronavirus Disease 2019 (COVID-19) pandemic was declared on March 11, 2020, which led to the massive economic and social crisis in the world. Hospitals and healthcare systems faced the most changes during this time. As for any other medical departments, orthopedic departments were affected by this situation. Trauma and musculoskeletal injuries require emergency action or even operation which would not stop due to COVID-19 crisis. Special protocols and guidelines were used to minimize infection risks in Kashani educational trauma center. Here we explain the changes and protocols in the following sections: Outpatient-Clinic, emergency department, Operation room and Orthopedic Ward. These strategies included: reducing the number of admitted patients in clinics, changing the decoration of waiting rooms, screening the patients at the entrance and personal protection equipment for staff. We also dedicated special emergency rooms for patients suspicious to COVID-19 infection and also special operation rooms and corridor for patients with COVID-19 infection. Changes in discharging protocols and continuous consultations with infectious diseases specialists brought us the ability to manage these patients. Here in the present paper, we described different strategies of the management of patients in Kashani hospital during COVID-19 outbreak. We hope that our experience of patient's management could help other physicians and hospitals.

Keywords: COVID-19, trauma, musculoskeletal

Introduction

The novel coronavirus or commonly known as Coronavirus Disease 2019 (COVID-19) emerged in late December 2019 in Wuhan, China and is responsible for the largest pandemic of infectious diseases in the last century [1, 2]. On January 30, 2020, the outbreak of COVID-19 was declared by the World Health Organization (WHO) followed by the declaration of a pandemic on March 11, 2020 [1, 3, 4]. COVID-19 shortly caused the lock-down of half of the world rapidly spreading through countries. The person to person transmission of COVID-19 is mainly mediated by respiratory droplets and studies have also indicated that the infected patients could also be contagious even in their asymptomatic phase [5]. Social distancing, lockdowns and self-isolation are the main declared strategies by healthcare systems for

public health [6]. The main reported symptoms for COVID-19 are cough, dyspnea, fatigue and fever which are somehow similar to other upper-respiratory diseases [7, 8]. This virus causes fatal pneumonia and also some secondary bacterial infection such as ventilator-associated pneumonia, septic shock and acute kidney injuries [9]. The current therapeutic managements for COVID-19 are mainly supportive and conservative treatments but studies look forward for development of a vaccine or effective antiviral agents [10].

The managements of different patients in almost all of the medical departments have been influenced vastly by COVID-19 outbreak most importantly, orthopedic departments [11-13]. Due to the variable range of patients and diseases from congenital diseases to major and minor traumas, orthopedic departments

should have developed management protocols to minimize the risks of disease transmission between patients themselves and also healthcare providers and hospital employees. Orthopedic surgeons deal with vast varieties of patients and are also accounted as frontlines of the defense against COVID-19. Patients with severe trauma who require emergent surgical action, patients with minor traumas and also elective patients should be managed carefully during COVID-19 pandemic. Due to higher susceptibilities of surgeons to develop COVID-19, the British Association of Oral and Maxillofacial Surgeons (BOAMS) developed guidelines for management of patients. This guideline has 4 main principles and could be used in other departments as well. 1. PPE (personal protective equipment): using protective instruments including masks and gloves with variable recommendations ranging from evidence-based to availability based are principles of protection against COVID-19. 2. Avoid (avoid contact, avoid the transfer of patients, and avoid surgery): main recommended avoidance strategies could be simplifying treatments, reducing the number of visits and avoid elective surgeries. 3. Restrict (restrict number of visits, generation of aerosols, restrict visitors) and 4. Abbreviate (abbreviate waiting times, abbreviate treatment) are these four guidelines [14]. Abolghasemian and colleagues have also developed the Iranian Orthopedic Association (IOA) response guidance to COVID-19 Pandemic which could help us gain our best abilities during this time [15].

As the disease spread in the Middle East and affect Iran, the epidemic of COVID-19 was declared in Iran by the government on February 18th. With increased and growing of corona crisis in Iran, Isfahan city was recognized as one of the high risk areas and a center for COVID-19 epidemic and also with a red flag by Iranian health ministry. Here in the present study we explain different treatment and therapeutic strategies in orthopedic department of Kashani hospital during COVID-19 outbreak. We divide these strategies based on different divisions: outpatient/clinic, emergency, operation room and orthopedic ward.

Outpatient-clinic

During COVID-19 outbreak in Iran, all of the hospitals, clinics, medical staff and patients

were affected. Our orthopedic department and clinic are located in Kashani hospital in Isfahan city which is also the most important educational trauma referral center in central regions of Iran. Our hospital covers almost all of the orthopedic field subspecialties such as arthroplasty, tumor, spine, sports, shoulder, foot and ankle, and hand surgery. The fundamental principle of protection against COVID-19 in every medical department is personal protection. Personal protection is considered as the most useful strategy for reducing the diseases spreading in clinics and hospitals and is performed for health workers, employers, departments of health and patients. There is always a wide range of patients who refer to an orthopedic clinic or hospital demanding primary or secondary care.

In the time of COVID-19 epidemic and crisis in Iran, we decided to minimize the risk of disease spreading in our clinic via reducing the visits, changing the environment of the clinic and obligatory personal protection for both patients and physicians. Based on the suggestions, unnecessary touching and physical examinations were restricted. Radiological procedures were performed only in essential cases. Also, hand hygiene protocols were advised for all clinic and hospital staff including handwashing frequently for at least 20 seconds before and after touching every surface or patient's body. The seat decoration of waiting rooms was changed. Body temperature of all patients and co-patients referring to the clinic were measured by one of the clinic staff. If any fever was detected, the person was referred to emergency department to be visited by an emergency specialist. Otherwise, they entered the first waiting saloon. The distance between seats was at least 1-1.5 meter. They were then entered into the second waiting room one by one and then into the doctor's office. An effective air conditioner was also established for every visiting room and physicians were suggested to keep the windows open. Hand sanitizers with antibacterial and antiviral effects were provided in every room and section. Posters containing hygienic advice were installed in clinics and hospital corridors as well. These strategies helped to minimize the spreading COVID-19. Special rooms with specific staff were also dedicated to patients with definite COVID-19 infection. These rooms had the best

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protection equipment and all physicians and staff had the highest personal protection including special dressing covering the neck and head, N-95 masks, face shield and disposable shoes protection and gloves. The entrance and corridor of these rooms were also special for such patients which lowered the spreading risks.

The casting unit in clinic of our trauma center was also re-decorated during this time. An appropriate waiting room with social distancing indexes was designed for patients and only one patient (casting or splint) at the time was permitted to enter the room. Before COVID-19 crisis, casting was performed mostly by the orthopedic resident who visited the patients in the clinic of our trauma center but during this time, casting was performed mostly by professional personnel while before COVID-19 outbreak, this duty was on the orthopedic resident's shoulders. Due to the production of aerosols by the saw and other casting tools, all of the staff in casting room had N-95 masks, disposable gloves, gown and face shields.

We should also note that all of the physicians and orthopedic residents who were visiting the patients in clinics had to wear disposable surgical cap and mask, disposable gloves and protective clothing. Post-operation visits for evaluation of surgical sites and patient's conditions were also performed using remote communication tools. It was also suggested that physicians should prolong the time interval between non-urgent follow-ups. We also encouraged patients to use home delivery services for their medications rather than physical attendance in drug stores.

Managements of traumatic patients in emergency department

The emergency department of our trauma center was divided into 4 main divisions. By the time of admission, all patients except those who required immediate surgical actions were examined for body temperature and also oxygen saturation. Patients with fever or flu-like symptoms and patients with possibilities of COVID-19 infection were transmitted to COVID-19 emergency division.

Outpatient emergency division: The outpatient emergency division was designed for patients

who required conservative treatments without hospitalization including wounds and injuries which could be treated with plaster. Treatments of these patients started with the condition of normal body temperature and lack of flu-like symptoms. Otherwise, the patient was referred to COVID-19 division. These patients were discharged within hours with the required recommendations. Personal protection strategies were performed using disposable surgical masks and gloves for physicians and surgical masks for patients. The priority of patient's admission was for children and elderly in the outpatient emergency division during COVID-19 outbreak and the reason for this issue was that injured children had at least 2 co-patients and old patients were most vulnerable for infection.

Sub-acute emergency division: Sub-acute emergency division was designed for patients with musculoskeletal injuries who require surgical therapies without fever or flu-like symptoms. Tibial fractures, tendon ruptures, finger lesions, fractures of calcaneus, lateral or medial malleolus and distal of radius were examples of injuries who were admitted in sub-acute emergency division. The managements of these patients had higher sensitivity than other divisions. We made our efforts to discharge the possible cases as soon as we could in order to minimize infection risks. On the other hand, the essential surgical procedure was planned for patients. Those patients who required consultations with cardiologists or internists due to anesthetic issues were asked to perform these consultations in framework of outpatients. We must add that before COVID-19 outbreak, such procedures were performed one or two days before surgeries and during pre-operative hospitalization. For special occasions such as double tibial fractures or unstable clinical situation or severe pain, in which we couldn't discharge the patients, they were immediately transferred to the ward and further processes including consultations were followed there. Personal protection against COVID-19 was administered by the usage of disposable surgical masks and gloves plus disposable gown for physicians and surgical masks for patients. Outpatient operation room or commonly known as suture room in our trauma center admitted patients suspicious to tendon injuries. After exploring the injury site, patients were discharged if no prob-

lems were found. For some patients with extensor tendon cuts, the injury site was explored, debridement was performed and treated as soon as possible and the patient was discharged the same night or the next morning. We should declare that “fast-tracking” was performed for eligible patients during COVID-19 crisis. This strategy was also led to reduced chances of exposure. Other injuries such as the volar side of hand and dorsal side of forearm were managed by operation procedures.

Acute emergency division: Patients who required immediate surgical actions were admitted in an acute emergency division. Most of these patients had severe and acute trauma and surgical and neurosurgical consultations were essential for them. Evaluation of body temperature and flu-like symptoms were performed by the time of admission and simultaneously with other life-saving efforts. The acute emergency division of our trauma center was equipped with the highest protection equipment and intubation procedures were performed by emergency specialists and the help of one emergency resident and one healthcare staff who were all wearing N-95 masks, face shield, protective disposable gown and gloves. The presence of other physicians and students not involved in the intubation procedure was restricted meanwhile. Essential operation and invasive procedures were then performed. Patients with acute traumas were immediately visited by senior orthopedic resident and graphy and paraclinical actions were performed at once in order to minimize contacts. Required surgical and neurosurgical actions were also performed meanwhile in acute emergency division so that all of the required consultations were performed before operations. We should also explain that such actions were performed by junior orthopedic residents and proofed by senior residents before COVID-19 outbreak. We should note that patients highly suspicion to COVID-19 infection were then transferred to special isolation rooms in ward. Personal protection equipment for all staff in this division included: N95 masks, protective disposable gown, gloves and protective glasses.

COVID-19 emergency division: COVID-19 emergency division was appropriate for all patients with a definite diagnosis of COVID-19 or patients having fever or flu-like symptoms who

referred to our trauma center. In this division, patients were admitted for the maximum time of 3-4 hours based on their problems and were immediately evaluated with imaging methods such as computed tomography (CT) scan. After a full evaluation of clinical and paraclinical issues, patients were transferred to COVID-19 ward and managed with consultation of infectious diseases specialist.

Actions including splint, close reduction and plastering were also performed with special protection equipment in emergency and patients were discharged immediately if possible. Post-operation visits were performed with the help of telemedicine and social networks. Surgery sites, range of motion in affected joints and other issues were investigated via social media and connections between orthopedic residents and patients. Before COVID-19 crisis, emergency division used to be visited by the senior residents for almost 5-6 times every day. During this time, these visits were reduced to 2-3 times to minimize the risks and further managements were performed using virtual communications. Presence of junior residents was also limited to 1 resident from 2 residents before COVID-19 crisis and the shifts were divided between 2 residents. They could also achieve help from the senior resident who was always present in our trauma center. The pavilion of senior orthopedic residents was also located above the emergency department in order to facilitate the communications. The goal of patient's management during COVID-19 crisis in emergency division was to minimize the infection risks. Management protocols of our trauma center especially in emergency division were based on IOA guidance provided by Abolghasemian and colleagues [15].

Operation room

The operation rooms of our trauma center used to give service to patients without any pause before COVID-19 pandemic. Almost all of the trauma centers in other countries have been affected by COVID-19 [16]. After COVID-19 outbreak, particular plans and protocols were made in order to protect both the staff and patients. Protection protocols were the most important strategies inside our operating rooms. The use of surgical masks, disposable gowns and gloves and also shoe protection was

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essential for all staffs. Wearing surgical masks was also essential for patients. Body temperature and presence of flulike symptoms were checked every day for all of operation room staff and if any suspicious case to COVID-19 was detected, they were not allowed in the hospital for 2 weeks and had to perform home quarantine with the consultation of infectious disease specialist.

A new isolated changing room was also designed for surgeons and surgical nurses. We should also note that anesthesiologists avoided general anesthesia as the patient's conditions allowed and most of the limb surgeries performed using nerve blocks (including Bier block, axillary block and spinal block). In necessary cases, a video laryngoscope was used for intubation procedures. Orthopedic surgeons also avoided suction and drilling as they could. The main reason for such strategies was to prevent possible disease spreading through the production of droplets and aerosols.

During acceleration time, scheduled elective surgeries and also invasive procedures were postponed as long as physicians could or even canceled. These elective surgeries included: meniscus repair, anterior cruciate ligament (ACL) repair, non-urgent arthroplasty, rotator cuff repair and also tendon transfers. On the other hand, the operation rooms were designed and planned to admit only urgent cases that require immediate surgical operations during the days. Patients with massive trauma, musculoskeletal infections and tumors were planned for surgeries during the daytime. Patients who had metacarpal or metatarsal fractures and patients with phalangeal fractures operated during evening or night shifts and were mostly discharged the next morning and as soon as possible. A special COVID-19 operation room was also designed for patients with a definite diagnosis of COVID-19. This room had a special corridor an elevator, appropriate air conditioning with special staff and the highest protection equipment and was sterilized after every operation.

Post-operation care was performed in the recovery division for patients. We made our best efforts to minimize the time of stay for patients in recovery section. Special isolation rooms were designed for COVID-19 patients in

recovery section and other patients were transferred to the orthopedic ward.

Patients infected with COVID-19 who had severe injuries and required limb saving action, such as patients with arterial injuries or compartment syndrome were operated immediately and transferred to COVID-19 ward afterward. Other cases were transferred to COVID-19 ward and waited for 24-48 hours before operations for special COVID-19 managements. Definite diagnosis of COVID-19 was made by the means of TaqMan probe-based real-time reverse transcription-polymerase chain reaction (PCR) and evaluation of 2 genes areas of SARS CoV-2 (2019 nCoV).

Patients who required suture extractions within 1 week or 2 weeks after surgeries were also advised to refer to the nearest healthcare center to extract their sutures without referring to the clinic of our trauma center. But we should also note that these patients and also those patients who required to be visited every week or every 3 days sent the photos of the surgical sites and explained their possible problems and issues to the junior resident via social media and phone applications including Telegram and WhatsApp. These actions were also suggested by Chaves and colleagues [17].

Orthopedic ward (hospitalization)

Orthopedic ward of our trauma center had great importance in avoiding disease spreading. At the beginning of COVID-19 crisis in Isfahan, special rooms, pathways and also elevator were designed for COVID-19 patients admitted in the ward after being operated or even direct admission from emergency division. Body temperature and presence of flu-like symptoms were checked for all patients and co-patients entering the ward and patients suspicious to COVID-19 entered the special ward with a special corridor and air conditioning. We should also note that the co-patients were fixed during hospitalization and they were not allowed to be replaced.

Each room was changed to include 2 patients at most and the presence of co-patients were restricted. No visits were allowed for families during hospitalization. Meetings and morning reports were canceled because involving a large number of physicians and residents could

increase the risk of COVID-19 infections. Training programs and the presence of medical and nursing students restricted in orthopedic ward and new protocols were used for discharging the patients. Educational program, and daily morning reports continued during COVID-19 crisis with the help of Skyroom educational application version 12 which was provided by faculty of medicine of Isfahan University of Medical Sciences. Orthopedic residents, medical interns and students had installed this application on their personal computer (PC) or mobile phones. Educational videos and cases were shared and reported in this program and this information could also be shared with other educational hospitals in Isfahan. Using Navid application, the students and interns could be educated by professors by the means of uploading different educational data, videos and slides. Tele-education was one of the important principals during COVID-19 outbreak in our trauma center. These efforts were based on IOA guidance which suggested tele-education as an important basis [15, 18].

Most of the surgeons lowered their improvement expectations and as a result, patients were discharged from the hospital as soon as possible. They were also recommended to perform in-house rehabilitation instead of hospital stay. Appropriate follow-up protocols were also used. Patients with special conditions such as heavy surgeries, high possibility of infection and also patients with psychological disorders such as treated Obsessive-compulsive disorder (OCD) or anxiety received the phone number of their own senior or junior resident. They were advised to contact the residents and send them the photos of their surgical site and the residents consulted the surgeons if any problems occurred.

Discharging the patients positive with COVID-19 had also great importance and required special attention. COVID-19 cases were visited daily by infectious disease specialists and discharged under their provision. The discharge of those patients was not directly related to orthopedic surgeons. Absence of fever for at least 72 hours, respiratory rate less than 22, oxygen saturation >96% and 94% for patients with chronic obstructive pulmonary disease (COPD) and normal chest X-ray were the most important discharge criteria for these patients which

were suggested in related guidelines [19]. **Figure 1** indicates the chart of the patient's management during COVID-19 crisis in our trauma center. Patients with acetabulum fractures without dislocations who had enough criteria for conservative treatments and those who were cooperative were also discharged and followed up at home. They were also recommended to obtain radiographic images in the nearest healthcare center and send them to orthopedic residents via social media applications for follow-ups. They were also suggested to use wavy mattresses and recruit a nurse at home if required. We should also note that IOA guidance also emphasized minimizing the number of outpatient and inpatient rehab referrals [15]. Our actions and policies were completely in line with this guidance. Before COVID-19 pandemic, 6-7 medical interns were being educated in orthopedic ward of our trauma center each by one of the orthopedic surgeons at the time. But during COVID-19 crisis, only 2 medical interns were present in orthopedic ward and also dividing the shifts. The most important limitation of our study was that we were not able to evaluate the changes and managements of other departments such as neurosurgery and neurology departments in our medical center which could indirectly influence our conditions.

Discussion

Due to this fact that Covid-19 virus is a new introduced virus to the world and has a sudden and unpredictable outbreak pandemic, there are still few studies in this field and a huge number of our articles are progressing, so our article is one of these articles to protect the traumatic patients from the effects of this virus. In this field, we have used the experiences and procedures of different articles which are produced in countries like china, Italy and France. All of these articles try to present a safe and easy and reliable way to face with this virus with minimum burden to healthcare services.

In a study conducted in Hong Kong, by Janus Siu Him Wong and others, the data and statistics of trauma related accidents and emergency attendances before and during the COVID-19 pandemic have been gathered. Based on this study, the number of emergency orthopedic surgeries and elective orthopedic opera-

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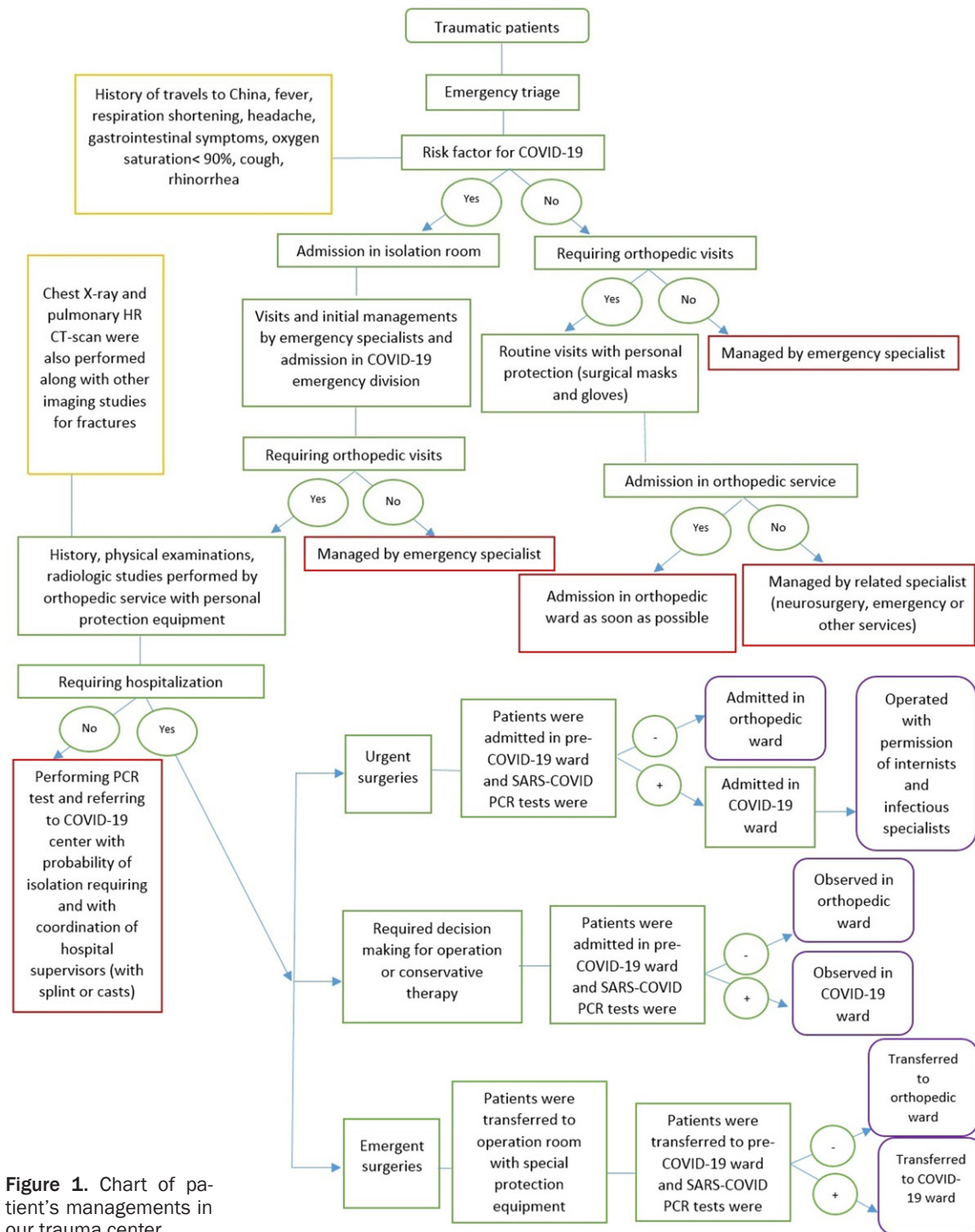


Figure 1. Chart of patient's managements in our trauma center.

tions decreased during COVID-19 pandemic with the rate of 21.2% and 73.5% respectively ($P < 0.001$). Also in this study domestic trauma decreased 38.2% ($P < 0.001$) and industrial trauma decreased 45.6% ($P < 0.001$). As it was predictable, traffic traumas and sport traumas decreased 26.4% and 59.3% respectively

($P < 0.001$). These effects were probably because of the vast quarantine in the country, orthopedic clinic attendances decreased 29.3% ($P < 0.001$) [20].

Based on the Impact of COVID-19 on orthopedic and trauma service article by Janus Siu Him

Wong, the criteria for identifications the patients with COVID-19 were respiratory distress syndromes, fever, abnormal chest X-Ray imaging and normal or decreased leukocyte count (specially lymphopenia) in the early stage of onset [20]. And in our trauma center the confirmation of the COVID-19 diagnosis was with PCR.

Personal protection of medical staff varied upon their exposure to the patients. They divided into three groups. The group of staffs that were exposed with the patients with unverified status for COVID-19, patients suspected for COVID-19 involvement and staffs with exposure to the patients with confirmed for COVID-19. Based on the group of the patients, the level of protections of the medical staff were different. First group use hair net, isolation gown and surgical mask. Second group use FFP mask instead of surgical mask and also eye protection, and shoe covers. And third group use double gloving with the second pair of gloves covering the protective clothing sleeve in addition to previous protections.

Operation room equipment that were used for suspected patients were also disinfected with peracetic acid or hydrogen peroxide spray. The same managements for anesthetic devices such as laryngoscope were performed. In Kashani and Alzahra hospitals, when a COVID-19 positive patient was admitted to the operation room, one staff was dedicated to the surgeon (scrub) and we had two circulars for every COVID-19 positive room. One of them was protected by special equipment was in the room and one of them outside the room managed the transfer of equipment and sets that surgeon wanted to the circular inside the room. Before COVID-19 crisis, we had one circular for each operating room.

In the study by Simon Randelli and others which was performed in Italy, they dedicate two centers for minor trauma or non-deferrable elective orthopedic surgeries [21]. We allocated Kashani hospital for orthopedic surgeries which had complete ICUs and separated neurosurgery wards and ENT and maxiofacial surgery ward which was necessary for managing of the traumatic patients. The chief of the hospital was aware of all protocols and made it the most referable trauma center in the state. We had some limitation in our trauma center i.e. we had

no infectious resident service in the hospital and their specialists were called to the wards when they were needed. Number of ICU beds were limited so (45 beds for all of the trauma services). We had anesthetic resident in the hospital and all of the ICU patients were monitored carefully by the anesthetic service. We made a complementary center for our hospital which was Al-Zahra medical center which had all of the resident services as needed and more ICU beds and equipment for managing of the patients for traumatic patients having COVID-19 at the same time. So we sent the complicated traumatic COVID-19 positive patients who were multi traumatic and needed management of more services that we have in our hospital to the Al-Zahra medical center. And a special line between the supervisors of two centers was made for facilitating the transportation of the patients and the routine official limitation for transporting the patients from our hospital to Al-Zahra hospital was removed and some number of ambulances were dedicated for facilitating this transportation. Due to the prolongation and spread of the corona virus and the possibility of its survival, all our experiences and other trauma centers can help to reduce the incidence of the virus among medical staff and other hospitalized patients. We should note that the important point of the current study was that our medical center is located in Isfahan province which had a red and highly dangerous COVID-19 situation based on Iranian ministry of health for months and the mentioned strategies cause a reduced rate of infection and disease transmission in patients.

Conclusion

During the first 3 months after COVID-19 pandemic, almost 2500-3000 surgeries (including major or minor surgeries) were performed in our trauma center. Our data showed that almost 25 patients suspicious to COVID-19 were operated during this time, 10 of them were limb-saving surgeries such as compartment syndrome (in the emergency operation room). The surgeries in 10 other patients could be postponed after stabilization of medical conditions and were performed afterward (urgent operations). 5 patients were referred to other medical centers (another educational hospital in Isfahan) before surgeries due to the severity of their medical conditions and under consulta-

tion of infectious disease specialists. They were transferred where they could receive consultations from other specialists and where more ICU beds were available and other COVID-19 patients were operated and discharged from our trauma center under the guidance of infectious disease specialists. We should also declare that no positive case of COVID-19 was reported among staff and personnel of our trauma center. We believe that this resulted from our management and personal protection equipment and also protection guidelines. Compared to other studies, we observed that in Italy, the number of infection and mortality among medial staff was as double as reports from China and the main cause was lack of routine tests [14, 21]. In our center, routine COVID-19 tests were performed for every suspected personnel if only fever or other symptoms were detected. Here we declare that our protocols caused that none of the healthcare professionals in our trauma center was infected to COVID-19. Personal protection protocols and guidelines were the most important principle of our hospital during COVID-19 epidemic. Changes in our hospital continue and physicians and residents are managing the patients.

Disclosure of conflict of interest

None.

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