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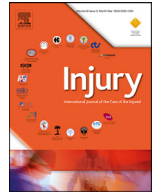
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Review

Epidemiologic characteristics of traumatic fractures during the outbreak of coronavirus disease 2019 (COVID-19) in China: A retrospective & comparative multi-center study



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ARTICLE INFO

Article history:

Received 21 May 2020

Accepted 13 June 2020

Keywords:

Covid-19

Epidemic

Fracture

Epidemiology

ABSTRACT

Purpose: Amid the outbreak of coronavirus disease 2019 (COVID-19), effective measures have been taken in China to suggest people wearing masks and staying at home. The majority of the people stayed at home, which had an obvious impact on the occurrence of traumatic fractures. This study aimed to describe the epidemiologic characteristics of traumatic fractures during the COVID-19, and provide reference for targeted control measures for the whole world by proposing China's experiences.

Methods: This was a retrospective & comparative multi-center study with data obtained from 11 hospitals in five provinces of China. Patients were enrolled into this study, who sustained fractures from 20 January to 19 February 2020 and the same period in 2019 (based on Chinese lunar calendar). All patients were divided into two groups: epidemic group (admitted in 2020) and control group (admitted in 2019). The data of patients' demographics (age and gender), injury related data (fracture type, fractured site, osteoporosis fracture, concurrent fractures, injury mechanism, places where fracture occurred, ISS score, Gustilo-Anderson Classification for open fracture), mortality and treatment modality were compared between the two groups.

Results: A total of 2,489 patients with 2,590 fractures were included. In the epidemic group, there were 865 patients, including 483 (55.8%) males and 382 (44.2%) females with an average age of 53.1 ± 23.1 years (range, 1 to 105). In the control group, there were 1,624 patients, including 876 (53.9%) males and 748 (46.1%) females with an average age of 51.2 ± 21.5 years (range, 1 to 98). Patients in the epidemic group was significantly older than those in the control group ($t = -2.046$, $P = 0.045$). For epidemic group, the mostly commonly involved age group was elderly patients, whereas it was middle-aged adults for the control group ($\chi^2 = 14.642$, $P = 0.002$). For epidemic group, a total of 576 (66.6%) patients had their fracture occurring at home, while in the control group there was 183 (11.3%). The proportion rates of low energy injuries (79.1%, 684/865), osteoporotic fractures (32.5%, 294/906) and closed fractures (94.5%, 817/865) in the epidemic group were significantly higher when compared to the control group, respectively (34.4%, 559/1624; 26.9%, 453/1684; 91.9%, 1,493/1692; all $P < 0.05$). The proportion rates of Gustilo-Anderson classification (5.5%, 16/865), concurrent fractures (2.3%, 20/865), and injury severity score (15.6 ± 6.7) in epidemic group were significantly lower than those in the control group, respectively (52.8%, 199/1624; 3.9%, 63/1624; 20.1 ± 8.7 ; all $P < 0.05$). No positive case with COVID-19 was diagnosed in the epidemic group. The mortality rate in the epidemic group (0.46%) was similar with that in the control group (0.43%).

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Conclusions: Our findings confirmed the importance of the measures to restrict people's movement and wear masks in the prevention of the spread of COVID-19. The epidemiological characteristics of traumatic fractures amid the epidemic changes dramatically, and more attempts should be focused on the prevention of low energy injuries of elderly population.

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Introduction

Currently, there is a pandemic caused by the coronavirus disease (COVID-19), which has swept the whole world within a period of several months [1-5]. By 18 May 2020, the outbreak of COVID-19 has generated more than 4,805,545 confirmed cases in 208 countries, including 316,760 deaths (<https://voice.baidu.com/act/newpneumonia/newpneumonia>). A number of countries have implemented strict control measures to restrict the transmission among local residents, such as traffic control, self-isolation at home, and strict access to the community, amongst others. Although China suffered from COVID-19 outbreak since 20 January 2020, it has been well controlled by the implementation of prevention measures to restrict people's movement.

Noteworthy, due to the changes of people's life style and psychological state secondary to the COVID-19 crisis, great changes have taken place in demography, basic sociological data and causes of injuries of traumatic fractures. Epidemiology, as an important indicator of disease distribution and health status, is the basic prerequisite to avoid or reduce the occurrence of traumatic fractures [6]. However, there is still a lack of large-scale and standardized fracture related epidemiological investigation, especially during the period between 20 January to 19 February of 2020 when the outbreak was at its pick in China. Consequently, the experience from China can provide reference for the rest of the world and this could lead to the introduction of targeted preventive measures to reduce the occurrence of traumatic fractures.

The purpose of this study therefore is: (1) to scientifically and objectively summarize the epidemiological status of fractures in China during the pre-specified period of time; (2) to compare epidemiological characteristics of traumatic fracture during the covid-19 with those occurred in the same period of 2019; (3) to provide data support for clinicians and government to evaluate the management and prevention strategies of traumatic fractures more accurately and reasonably during outbreak and non-outbreak period.

Patients and methods

Data sources

All the data were obtained from the 11 hospitals of China mainland from 5 provinces near Hubei in China, including the Third Hospital of Hebei Medical University, the Second Affiliated Hospital of Zhejiang University School of Medicine, The Affiliated Hospital of Southwest Medical University, Jiangning Hospital Affiliated to Nanjing Medical University, Shanxi Bethune Hospital, General Hospital of Jizhong Energy Xingtai Mining Group, Baoding First Central Hospital, Hengshui Halison International Peace Hospital, The Second People's Hospital of Hengshui, Jingxing County Hospital, People's Hospital of Lincheng County. Out of all of them, there were 8 tertiary referral hospitals and 3 secondary referral hospitals.

This study was approved by The Institutional Review Board of the Third Hospital of Hebei Medical University in compliance with

the Helsinki. Declaration and consent were waived for its retrospective nature.

Inclusion and exclusion criteria

The inclusion criteria were as follows: ① definite diagnosis of new onset fracture; ② fracture time between 20 January to 19 February of 2020 (from the 26th day of December 2019 to the 26th day of January 2020 according to the lunar calendar), and between 31 January to 2 March of 2019 (from the 26th day of December 2019 to the 26th day of January 2020 according to the lunar calendar). The epidemic period covered the traditional Spring Festival in 2020 in China, and people's living and travel habits have changed a lot compared with usual time. Therefore, the comparison time in 2019 is the same as in 2020 according to the lunar calendar. The exclusion criteria were: ① pathologic (metastatic) fracture, ② secondary fracture caused by various reasons, including poor union, nonunion or readmission, periprosthetic fracture, etc.

Data collection and groups

The collected data of interest included: demographics (age and gender), the fractured sites, osteoporosis fracture, open or closed fracture, the mechanism of injury, the place where fractures occurred, the concurrent fractures and treatment modality. For patients with open fractures, Gustilo-Anderson classification was used to assess the injury severity. Injury severity score (ISS) was calculated to assess the condition of patients who sustained multiple injuries. All medical charts and radiographs for fracture patients in each participating hospital were evaluated by two local orthopedic surgeons and were addressed by discussion if there was any inconsistency.

All patients were divided into two groups: epidemic period group (patients admitted in 2020), and control group (patients admitted in 2019 of the corresponding period). Based on age, they were also divided into 4 subgroups: children (≤ 14 years), young adults (15–44 years) and middle-aged adults (45–64 years) and elderly patients (65 years and over).

The fracture sites were recorded as proximal, shaft and distal fracture for each limb long-bone (humerus, ulnar and radius, femur, tibia and fibula), pelvic and acetabular fracture, scapula, clavicle, patella, cervical vertebra, thoracolumbar fracture, hand and wrist fracture, foot and ankle fractures. The patients who met the following three criteria were considered as having sustained osteoporotic fracture: ① occurred in one of the four sites (hip, thoracic and lumbar vertebra, distal radius and proximal humerus) ② ≥ 65 years old, ③ low energy injury [7-11].

The injury mechanism included fall from standing height, fall from a low height (< 1 m, e.g. bed, chair, stool), fall from a height > 1 m (e.g. roof or tree), bicycle injury, motor vehicle injury (including electronic bike), and others. The low energy fracture was defined as a fracture caused by fall from standing height, low height (< 1 m), or bicycle injury, and high energy fracture as a fall from high height, electronic bike (E-bike) injury, motor vehicle injury and others.

Management principles for traumatic fractures during COVID-19

During the epidemic period, a detailed history was asked from each patient in relation to the trauma sustained. If the patient during the previous 14 days had a direct or indirect contact history with a person from the epidemic area, or had clinical symptoms related to COVID-19, isolation measures were taken immediately. Symptoms related to COVID-19 include the followings: 1. patients with fever and/or respiratory symptoms; 2. the imaging features of COVID-19, including multiple patches and interstitial changes, especially in the extrapulmonary zone in the early stage, lung consolidation in severe cases and pleural effusion in rare cases; 3. normal or decreased number of leukocytes lymphocyte in the early stage of the disease. Consultation was then conducted by a multidisciplinary team consisted of orthopedist, respiratory physician, anesthetist and intensive care unit physician to implement the precise personal treatment concept. At the same time, imaging examinations (Chest computed tomography) and necessary laboratory tests and were carried out, including blood routine test (full blood count, Lymphocyte count), liver and kidney function, inflammation index (plasma inflammation cytokines, C-reactive protein, Erythrocyte sedimentation rate, procalcitonin, etc.), Ferritin levels and virus nucleic acid test. These tests will be completed within 12 h, during which the suspected patient will stay in an isolation ward alone. The medical observation can be released if twice consecutive nucleic acid tests (at least 24 h apart between two sampling time) are negative. The objective was that COVID-19 should be excluded before the patient transferred to the orthopedic ward.

Once COVID-19 is confirmed, the patient should be transferred to the designated hospital immediately. For patients who need emergency treatment and cannot be transferred to the designated hospital, strict three-level protection measures should be implemented. The patient must stay in a single isolation ward and will be treated and nursed by a special team. A special stretcher car, disposable protective cover, special passage and special elevator must be used to transport the patient. All disposable medical consumables of the patients must be handled strictly following the national instructions for the management of COVID-19. Conservative treatment is suggested for patients with COVID-19 if indicated. Selected operations will be done when patients cured from COVID-19. Emergency operations will be suggested for patients with the indications as follows: open trauma, fracture with vascular and nerve injury, partial unstable pelvic fracture, limb or life-saving surgery (such as limb necrosis, amputation, fracture resulting in serious disability if not treated in time, etc.). Emergency operations should be performed in a dedicated negative pressure operating room, and the operating room will be thoroughly disinfected immediately after the operation.

Statistics

Statistical analyses were performed with the use of SPSS 23.0 (IBM, armonk, New York, USA). The Kolmogorov-Smirnov test was used to check whether the continuous variables was in accordance with the normal distribution. Student-t was used to compare the data with the normal distribution between two groups, which were expressed by the $\bar{x} \pm s$. The categorical data were expressed as number and percentage (%). Differences in the constituent ratios of different age groups, sex ratio, place where fracture occurring, osteoporosis fracture, concurrent fracture, injury mechanism, fracture type and treatment modality between epidemic group and control group were tested using the Pearson chi-square test. A P value of <0.05 was considered significant.

Results

Age- and gender-specific characteristics

During the study timeframe, there were a total of 2489 patients with 2590 fractures, including 68 patients each having 2 concurrent fractures, 12 patients each with 3 concurrent fractures, 3 patients each with 4 concurrent fractures. There were 1359 (58.1%) male patients and 1130 (41.9%) female patients, with an average age of 51.9 ± 22.1 years (range, 1 to 105). The age of males was 45.7 ± 20.4 years, significantly younger than that (59.3 ± 21.7) of females ($t = -16.073, P < 0.01$). In the epidemic group, there were 865 patients with 483 (55.8%) males and 382 (44.2%) females. In the control group, there were 1624 patients with 876 (53.9%) males and 748 (46.1%) females. The age of the epidemic group was 53.1 ± 23.1 years (range, 1 to 105), significantly older than that (51.2 ± 21.5 years; range, 1 to 98) of the control group ($t = -2.046, P = 0.045$). For the epidemic group, the most commonly involving age group was elderly patients, while it was middle-aged adults for the control group, with a statistically significant difference ($\chi^2 = 14.642, P = 0.002$). The detailed characteristics stratified by age and group were presented in Fig. 1.

This study collected 194 children, 685 young adults, 829 middle-aged adults and 781 elderly patients. The ratio of male to female was 1.5, 3.7, 1.2 and 0.5 in each age group, and the trend was significant statistically ($\chi^2 = 306.006, P < 0.01$). For the epidemic group, the ratio of male to female was 1.7, 3.4, 1.1 and 0.5, while it was 1.3, 4.4, 1.4 and 0.6 for the control group. The detailed characteristics stratified by sex ratio and group are presented in Fig. 2.

In the epidemic group, there were 9 suspected cases on admission, among whom six patients had direct or indirect contacting histories with persons in the epidemic area during the previous 14 days and three had fever with suspicious pulmonary imaging feature. Among them, there were five femur fractures, two foot fractures, one spine fracture and one humerus fracture. Three-level protective operation was carried out on one patient with open foot fracture. Selected operations were done on the other eight patients after they were excluded with COVID-19. No patient was confirmed with COVID-19 when discharged from hospital.

Place where fracture occurred

For the epidemic group, a total of 576 patients had their fracture occurring at home, taking a proportion of 66.6%. 125 (14.5%) patients had their fracture occurring at the community, and 103 patients (11.9%) had their fracture occurring on the way to or from outside. In addition, 6 fractures (0.7%) occurred on sports field, 39 fractures (4.5%) occurred at the staircase, and 16 fractures (1.8%) occurred in the market, park, hospital et al. For the control group, a total of 183 patients had their fracture occurring at home, taking a proportion of 11.3%; 92 (5.7%) patients had their fracture occurring at the community; 1039 patients (64.0%) had their fracture occurring on the way to or from outside. Other places included public sites (market, park, hospital et al.; 239, 14.7%), staircase (63, 3.9%) and sports field (8, 0.5%). There was a significant difference in the place where fracture occurred between two groups ($\chi^2 = 162.565, P < 0.01$).

Fracture site, type and injury mechanism

Among 906 fractures in the epidemic group, there were 296 femur fractures, accounting for 32.7%, followed by tibia and fibula fracture (137, 15.1%), hand and foot fracture (130, 14.3%). Among 1684 fractures in the control group, there were 434 femur fractures, accounting for 25.8%, followed by hand and foot fracture

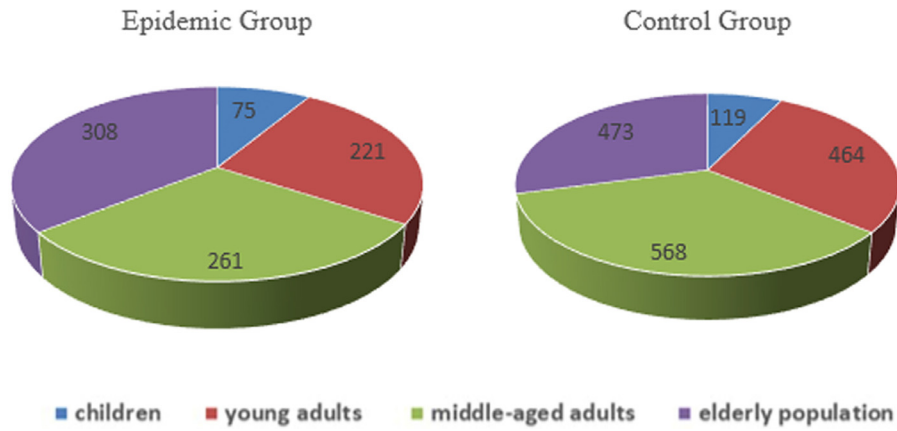


Fig. 1. Frequency distribution of age groups of patients with epidemic fractures between two groups.

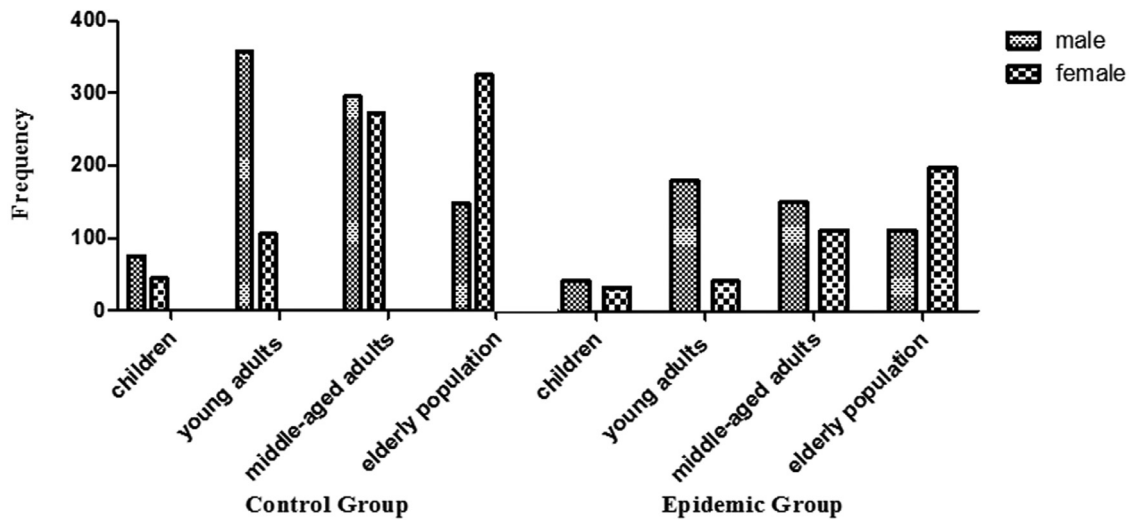


Fig. 2. Gender comparison between two groups of patients in different age groups.

Table 1
The distribution of fracture sites in each group [n (%)].

	Humerus	Ulna and Radius	Femur	Tibia and Fibula	Spine	Pelvic and acetabulum	Hand and foot	Other locations
Epidemic Group	83 (9.2)	71 (7.8)	296 (32.7)	137 (15.1)	93 (10.3)	22 (2.4)	130 (14.3)	74 (8.2)
Control Group	130 (7.7)	149 (8.8)	434 (25.8)	289 (17.2)	203 (12.1)	38 (2.3)	304 (18.1)	137 (8.1)
χ^2 value	22.040							
P value	0.003							

(304, 18.1%), tibia and fibula fracture (289, 17.2%) (Table 1). The proportion of osteoporotic fracture (32.5%, 294/906) in the epidemic group was significantly higher than that (26.9%, 453/1684) of the control group ($\chi^2 = 8.841, P = 0.003$). Among 294 osteoporotic fractures in the epidemic group, there were 201 hip fractures, accounting for 68.4%, followed by thoracolumbar vertebra fracture (50, 17.0%), proximal humerus fracture (29, 9.9%), and distal radius fracture (14, 4.8%). Among 453 osteoporotic fractures in the control group, there were 262 hip fractures, accounting for 57.8%, followed by thoracolumbar vertebra fracture (110, 24.3%), distal radius fracture (52, 11.5%) and proximal humerus fracture (29, 6.4%). The proportion of concurrent fracture (2.3%, 20/865) in the epidemic group was significantly lower than that (3.9%, 63/1624) of the control group ($\chi^2 = 4.300, P = 0.038$).

For the epidemic group, the proportion of fall from standing height causing fractures was 59.8% (517/865), followed by fall from

a low height (98, 11.3%), motor vehicle injury (92, 10.6%), others (81, 9.4%), bicycle injury (69, 8.0%) and fall from a height (8, 0.9%). For the control group, the proportion of motor vehicle injury causing fractures was 51.2% (831/1624), followed by fall from standing height (356, 21.9%), others (212, 13.1%), bicycle injury (139, 8.6%), fall from a low height (<1 m; 64, 3.9%) and fall from a high height (≥ 1 m; 22, 1.4%). The proportion of low energy injuries in the epidemic group (79.1%, 684/865) was significantly higher than that (34.4%, 559/1624) of the control group ($\chi^2 = 450.151, P < 0.01$).

For the epidemic group, there were 817 cases of closed fractures, taking a proportion of 94.5%. Among the 48 (5.5%) open fractures, 29 involved the hand, which were caused by chainsaw injury at their respective home, 3 by machine crush, 10 by motor vehicle injury and 6 were caused by a fall from roof or a tree. For the control group, there were 1425 cases of closed fractures, taking a proportion of 87.7%. Among the 199 (12.3%) open fractures, 105 caused

Table 2

Comparison of composition ratio of open fracture patients of different types between epidemic group and control group [n (%)].

Gustilo-Anderson Classification	Epidemic group			Control group			χ^2 value	P value
	Male	Female	Total	Male	Female	Total		
Type I	3 (50.0)	3 (50.0)	6 (12.5)	6 (75.0)	2 (25.0)	8 (4.0)		
Type II	19 (73.1)	7 (26.9)	26 (54.2)	70 (81.4)	18 (20.9)	86 (43.2)		
Type III	13 (81.3)	3 (18.8)	16 (33.3)	85 (81.0)	18 (17.1)	105 (52.8)		
Type IIIA	8 (80.0)	2 (20.0)	10 (52.6)	42 (80.8)	10 (19.2)	52 (50.5)		
Type IIIB	2 (66.7)	1 (33.3)	3 (26.3)	10 (90.9)	2 (18.2)	11 (10.7)		
Type IIIC	3 (100.0)	0 (0.0)	3 (21.1)	33 (78.6)	6 (14.3)	42 (40.8)		
Total	35 (100.0)	13 (100.0)	48 (100)	161 (80.9)	38 (19.1)	199 (100.0)	8.909	0.012

by motor vehicle injury, 61 involved the hand, which were caused by chainsaw injury, 17 by machine crush, and 16 were caused by a fall from roof or a tree. The proportion of open fractures in the epidemic group (5.5%, 48/865) was significantly lower than that (12.3%, 199/1624) of the control group ($\chi^2 = 28.381$, $P < 0.01$).

Treatment modality

For the epidemic group, most fractures (93.1%, 805/865) were treated surgically, and 6.9% (60/865) were treated by plaster of paris or traction. Open reduction and internal fixation (ORIF) was the most used surgical method, taking a proportion of 41.7% (361/865), followed by closed reduction and internal fixation (34.5%, 298/865), joint replacement (7.5%, 65/865), percutaneous vertebroplasty (3.2%, 27/865), percutaneous kyphoplasty (2.8%, 24/865), external fixation (1.4%, 12/865), fusion (1.2%, 10/865) and debridement (0.9%, 8/865). For the control group, most fractures (98.2%, 1604/1624) were treated surgically, and 1.8% (20/1624) were treated by plaster of Paris or traction. Open reduction and internal fixation (ORIF) was the most used surgical method, taking a proportion of 49.4% (802/1624), followed by closed reduction and internal fixation (28.7%, 465/1624), joint replacement (8.5%, 139/1624), debridement (5.5%, 90/1624), percutaneous vertebroplasty (3.7%, 59/1624), percutaneous kyphoplasty (1.5%, 25/1624), fusion (1.2%, 19/1624) and external fixation (0.3%, 5/1624). The proportion of minimally invasive surgery in the epidemic group (45.0%, 361/805) was significantly higher than that (34.8%, 554/1595) of the control group ($\chi^2 = 23.449$, $P < 0.01$).

Severity of trauma and modality

The average ISS was 15.6 ± 6.7 in epidemic group and 20.1 ± 8.7 in control group, showing a statistical difference ($t = 13.261$, $P < 0.01$). In the epidemic group, there were 363 (42.0%) slight injury cases (ISS < 16), 432 (49.9%) serious injury cases ($16 \leq \text{ISS} < 25$) and 70 (8.1%) critical injury cases (ISS ≥ 25). In the control group, there were 506 (31.2%) minor injury cases, 738 (45.4%) serious injury cases and 380 (23.4%) critical injury cases. By Gustilo-Anderson classification, type II open fractures were the most ones in epidemic group, taking up 54.2% (26/48), and which was type III in control group, taking up 52.8% (105/199). There was statistical significance in the item of Gustilo-Anderson classifications between both groups ($\chi^2 = 8.909$, $P = 0.012$, Table 2). Nine suspected patients were all successfully discharged from hospital after excluding COVID-19 infection. In the epidemic group, there were 4 patients died during the duration of hospital stay. There were 1 male patient and 3 female patients, with an average age of 69.3 ± 15.5 years (range, 51 to 91). The mortality rate was 0.46% and the timing of death was 6.3 ± 2.3 d (range, 4 to 9) after injury. In the control group, there were 7 patients died during hospital stay, including 5 male patients and 2 female patients with an average age of 26.9 ± 17.9 years (range, 6 to 61). The mortality rate

was 0.43% and the timing of death was 13.9 ± 12.3 d (range, 3 to 40) after injury.

Discussion

After the outbreak of COVID-19 in China, the Chinese government implemented multi-aspect prevention measures to restrict people's movement and avoid contacting with suspected cases. These measures have been demonstrated to be highly effective. Compared with the non-epidemic period, the injury mechanism and epidemiological characteristics of traumatic fractures have changed dramatically in China. Under the current global pandemic of COVID-19, knowledge of these trends is of most important than ever before, because of the high morbidity and mortality. This study compared the data on fractures of 11 hospitals in China within a month of the worst COVID-19 outbreak and the corresponding period last year, showing the age, fracture location, osteoporosis fracture, fracture type, severity of trauma, injury mechanism, places where fracture occurred and treatment modality during the epidemic period is very different from that during the non-epidemic period.

During the epidemic period, a series of measures taken by governments to restrict travel reduced the flow of people. In many cities of China, the passenger volume of supermarkets and shopping malls was less than 5% during the non-epidemic period on January 23, 2020 (<https://baijiahao.baidu.com/s?id=1659210676897303602&wfr=spider&or=pc>). Up to 19 February, almost all the residents were isolated at their own home, except for staff working on prevention, doctors and administrators. Our findings suggest that the age in the epidemic period was significantly older than that in the non-epidemic period. The most commonly involving age group was elderly patients in the epidemic period, while it was middle-aged adults in non-epidemic period. During the epidemic period, most industries stopped production, and outdoor activities and unnecessary travel and transportation were canceled. The young and middle-aged adults were the mainstay of these activities. Therefore, the fracture risk for those population was significantly reduced. However, the elderly people who ordinarily stay at home were more likely to have low-energy fractures due to the decrease of exercise and the change of sedentary lifestyle during the epidemic period. Therefore, compared with the non-epidemic period, the proportion of fracture patients in this age group has increased significantly. During the epidemic period, fractures occurring at home took a proportion of 66.6%, while it was 11.3% during the non-epidemic period. This finding is consistent with the strict anti-epidemic measures. We also found that the proportion of low energy injuries (79.1%), especially slip, trip, or fall at home, was significantly higher than that (34.4%) in the non-epidemic period. Therefore, targeted measures at home, especially for the elderly, should be considered for effective prevention of traumatic fractures during the epidemic period. These measures could include preventing insufficient lighting and slippery and uneven ground in living room and washing room, appropriate

walking aids and antiskid shoe being worn on a daily basis and reasonable arrangement of furniture. We also suggest that, for individuals who have basic comorbidities, such as hypertension and diabetes, should be used rational drug timely, avoid taking multiple drugs at the same time, and reduce the types and dosage of drugs. The use of psychoactive drugs like sleeping pills should be reduced or eliminated.

In this study, the significant increase of osteoporosis fracture was a concern, which will not only increase the consumption of medical resources that might be already scarce, but also impair quality of life and cause disability and death of patients [12–14]. In addition, long-term medical care makes the patients susceptible to or infected with COVID-19 via the way of transmission in the hospital [15–18]. There is already a great deal of evidence demonstrating that the morbidity and mortality rate in elderly patients who were infected with COVID-19 was high [19–21]. Furthermore, in the context of COVID-19, the less physical work, more sedentary life styles, and psychological state of panic and depression generally place the elderly population at increased risk of fall and related fractures [22,23]. Therefore, we should pay attention to the prevention of osteoporosis fracture during the epidemic period. The diagnosis and treatment of osteoporosis as well as post-fracture management are still insufficiently managed in China [24]. In order to avoid the occurrence of osteoporotic fracture during the epidemic, we should actively take anti-osteoporosis treatment, timely supplement calcium agent, and supplement active vitamin D3 to promote the absorption and utilization of calcium [25–27]. Meanwhile, it is necessary to scientifically guide people's safe and healthy sports, and self-regulation of emotions and psychology during their stay at home.

In this study, the proportion rates of closed fractures and type I and II Gustilo–Anderson classification in the epidemic period were significantly higher than those of the non-epidemic period. The concurrent fracture and ISS score in epidemic group was significantly lower than that in control group. The proportion of minimally invasive surgery in the epidemic period (45.0%) was significantly higher than that (34.8%) of the non-epidemic period. Based on our treatment policy which was special during outbreak of COVID-19, minimally invasive should be selected as much as possible for fracture fixation in a fast fashion, such as closed reduction and external fixation or traction fixation. While recovering limb length and correcting deformity, it can also reduce the sufferings and hospital stay of patients, and the work-load burden of health-care providers. There are three key points. Firstly, the deformity of the fracture should be corrected and the basic alignment of the fracture end should be maintained. Secondly, reduce the pain of the patient as much as possible without obvious psychological discomfort. Finally, ensure that the fracture is stably fixed. During the current epidemic of COVID-19, the treatment of traumatic fracture should adopt simple and effective treatment methods to complete the bone and soft tissue repair following the infectious disease prevention and control procedures [28].

There are some potential limitations that should be considered. Firstly, the inherent limitation of retrospective design might compromise the accuracy of data collection. However, the variables in this study were relatively few, including demographics, injury-related characteristics and treatment modality. Therefore, recall bias for patients might be little. Secondly, some indexes directly related to osteoporosis fracture, such as bone density and bone mass, are not included. Thirdly, due to the limitation of inclusion and exclusion criteria, the sample size is comparatively small.

In conclusion, non-confirmed cases with COVID-19 were identified in the 11 selected hospitals, and all fractures were treated following the national instruction for the management of COVID-19 as well as orthopedic principles. The current study presented the epidemiological characteristics of traumatic fractures between

COVID-19 epidemic and non-epidemic periods. During the epidemic of COVID-19, the most commonly involving age group was elderly patients, and low-energy injuries (such as slips, falls) were the most prevalent injury mechanism. Surgery was the most frequently used treatment modality for in-patients. Our findings confirmed the importance and effectiveness of the measures to restrict people's movement in the prevention of the spread of COVID-19. The epidemiological characteristics of traumatic fractures amid the epidemic changes dramatically, and more attempts should be focused on the prevention of low energy injuries of elderly population.

Funding

This study was supported by the Hebei Province Medical Science Special Major Projects Research Fund (2015ZD01), the Support Program for the Top Young Talents of Colleges and Universities of Hebei Province (Grant No.BJ2016035), the Hebei National Science Foundation-Outstanding Youth Foundation (Grant no. H2017206104) and the Support Program for the Top Young Talents for Hebei Province (Grant No. 2013–2018). The funding source has no role in study design, conduction, data collection or statistical analysis.

Acknowledgments

We thank the patients who took part in this study and the information provided by all of the authors.

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