A cross-sectional study on the impact of the prevention and control response of the COVID-19 pandemic on children's orthopedic trauma in Shanghai

Chuang Qian
Children's Hospital of Fudan University
https://orcid.org/0000-0003-2375-3614

Yiming Zheng
Children's Hospital of Fudan University

Junrong Meng
Children's Hospital of Fudan University

Hao Li
Children's Hospital of Fudan University

Dahui Wang ( wangdahui@fudan.edu.cn )
https://orcid.org/0000-0002-3101-702X

Research

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Abstract

Background: The Chinese government has taken strong prevention and control measures against the COVID-19 pandemic, and has achieved phased victory in the fight against it. The outbreak of COVID-19 pandemic provides an opportunity to study the influence of governmental prevention and control response on orthopedic trauma in children.

Methods: We collected and reviewed data on orthopedic trauma from the first half of 2018, 2019, and 2020. The data were divided according to the time of prevention and control response level in 2020. By comparing the relevant data from orthopedic emergency and operating rooms from the past three years, the influence of governmental pandemic prevention measures on orthopedic trauma in children was analyzed.

Results: A total of 36301 children were included in the study cohort. Before the prevention and control response, the data of the orthopedic emergency department in 2020 was the same as the previous two years. Under the first-level response, the number of fractures, open injuries, radial head subluxation, and surgery were significantly reduced, and the severity of patients with surgery was also significantly reduced. Under the second-level response, the number of operations began to increase, and the severity of the disease also began to rise. Under the third-level response control, the number of fractures, open injuries, and operations have returned to the levels of the previous two years. The severity of the operation has also returned to its previous level. The number of subluxations of the radial head is still different from before.

Conclusion: The pandemic of COVID-19 has affected the social activities of Shanghai residents and reduced the incidence of orthopedic trauma in children. With the control of the pandemic, the living conditions of Shanghai residents have basically recovered.

Background

About a quarter of all children go to the emergency department every year due to accidental injuries. Fractures are the most common type of trauma in children, and about a third of all children will suffer from a fracture before they reach adulthood. The daily incidence of fractures in the United States is about 12.0-36.1/1000 per year. The type and severity of fractures are related to gender, region, country, weather, and culture.

Due to the outbreak of COVID-19 pandemics in the world, the Shanghai government launched first-level prevention and control response in January 24, 2020. With the change of the pandemic situation, the response level of Shanghai's government response is constantly changing. At present, there is no study on the impact of infectious disease prevention and control on pediatric orthopedic trauma, and this pandemic provides the best opportunity for related research.
With the reduction of the response level of prevention and control, we can assess whether the life of the residents in Shanghai has recovered to the situation before the pandemic from the aspects of economy, life and politics. Pediatric orthopedic trauma is closely related to children's family care and campus life. By analyzing the changes of pediatric orthopedic emergency department in 2020, we can understand the recovery status of the residents in Shanghai and provide some evidence for other governments to formulate relevant pandemic prevention policies.

**Methods**

This study reviewed data of orthopedic emergency patients at our hospital from January to June in 2018, 2019, and 2020. The number of emergencies, type of injuries, emergency surgeries, surgical sites, the cause of the injuries, and the severity of the injuries over the last three years were documented. We analyzed the changes of orthopedic trauma in children in recent three years to assess the impact of the pandemics on the life of the public. To ensure homogeneity of data over the last three years, patient information from February 29, 2020 was excluded.

**2.1 Statistics of injury types in the emergency room**

The diagnoses of emergency patients were categorized as fractures, open injuries, soft tissue injuries (including non-fracture and non-open injury), and radial head subluxations.

**2.2 Diagnostic statistics of surgical patients**

Based on the surgical site and type of injury, we divided the diagnoses of children who required surgical intervention into open fractures, open injuries, spinal fractures, fractures of the clavicle, pelvic fractures, fractures of the hand, forearm fractures, fractures of the upper arm, fractures of the thigh, fractures of the lower leg, and fractures of the foot.

**2.3 Severity of injury**

In order to distinguish the severity of injuries in surgical patients, we further divided the condition of all patients into three levels: moderate, severe, and critical. Unstable fractures with incomplete cortical fractures were defined as moderate injuries (including type I humeral lateral condyle fractures, angled phalanx fractures, type II supracondylar fractures of the humerus, and epiphyseal fractures after reduction). A complete cortical fracture of a single limb was defined as a severe injury (including type III humeral supracondylar fractures, radial and ulnar fractures, and fractures of the tibia and fibula). Spinal and pelvic fractures, multiple fractures, or fractures with other systemic injuries were identified as critical injuries (including lumbar burst fractures, pelvic fractures, and supracondylar fractures of the humerus combined with an injury of the median nerve).

**2.4 Cause of injury**
In this study, we collected the data of children who had been operated on due to traffic accident injuries, injury caused by falling from a height, and open injuries that occurred in the past three years; we then compared the causes.

2.5 Unified timeline

Due to different spring festival holidays and school opening dates in the past three years, we rearranged the data for the three years using the Chinese New Year as a reference point. According to the level of response in 2020, the data of three years are divided into four groups ‘before response’, ‘first-level response’, ‘second-level response’ and ‘third-level response’. After rearrangement, the date segments of each group in the past three years are shown in the table (Table 1).

2.6 Statistical method

IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp., Armonk, NY, USA), was used for statistical analysis. Relevant data from the emergency room (total number of daily emergencies, fractures, open injuries, radial head subluxations) and volume of daily operations were analyzed by multiple sample pairwise comparison analyses of variance, and a sample variance homogeneity test was conducted. Age and severity of injuries in surgical patients were compared using a rank-sum test with multiple samples; the statistically significant results were further compared. A chi-square test was used to analyze the differences in causes of injury (open injury, falling from a height, and traffic accidents) in surgical patients over the past three years. P <0.05 was considered statistically significant.

Results

3.1 General data

A total of 36301 children were included in this study. There were 7093 cases of fracture, 23982 cases of soft tissue injury (including 7019 radial head subluxations); 5226 cases of open injury; and 1793 surgeries. The surgery rate was 4.93%.

3.2 Emergency room data

There were 14866 emergency cases in 2018, 13944 in 2019, and 7491 in 2020. There were statistical differences in the number of emergency cases between 2020 and the previous two years (P <0.01), but no significant difference between 2018 and 2019 (P=0.22). The detailed data of the emergency room visits for three years are shown in Figure 1.

There was no significant difference between the total number of emergencies among the three years before the response (P=0.249, P=0.988). During the response, included first-level, second-level response and third-level response, there were significant differences in the total number of emergency treatments in 2020 compared with the previous two years (P <0.01).
Before the response, there were no significant differences in the number of emergency fractures in 2020 compared with the previous two years (P=0.06, P=0.937). During first-level and second-level response, the number of emergency fractures in 2020 decreased significantly compared with those in the previous two years (P < 0.01). Until third-level response started, the number of emergency fractures began to rise. There was no significant difference between the number of emergency fractures in 2020 and that of the previous two years (P=0.262, P=0.394).

Before the response, there was no significant difference between the number of open injuries in 2020 and those of the previous two years (P=0.122, P=0.712). During first-level and second-level response, the number of open injuries in 2020 decreased significantly compared with those in the previous two years (P < 0.01). During third-level response, the number of open injury in 2020 was still significantly lower than that of 2018 (P < 0.01), but there was no statistical difference with that of 2019 (P=0.357).

Before the response, there was no significant difference between the number of radial head subluxations in 2020 and the previous two years (P=0.392, P=0.128). In response to all levels of prevention and control, the number of radial head subluxation in 2020 decreased compared with the previous two years.

### 3.3 Operating room data

In the past 3 years, our department has carried out a total of 1793 orthopedic emergency operating procedures, including 671 in 2018 (4.22 sets/day), 615 in 2019 (3.62 sets/day), and 507 (2.85 sets/day) in 2020; there were significant differences between the three years (P < 0.01). The proportion of different body parts operated over the three years is shown in Figure 2.

Before the response, there was no significant difference between the number of operations in 2020 and the previous two years (P=0.134, P=0.366). Under first-level response, the number of operations in 2020 decreased significantly (P < 0.01); under second-level response, the operation volume in 2020 was significantly different from that in 2018 (P < 0.01), but there was no statistical difference between 2020 and 2019 (P = 0.941). At third-level response, the number of operations recovered in 2020. There was no significant difference compared with the previous two years (P = 0.233, P = 0.168) (Figure 3).

After our analysis, there was no significant difference between the severity of surgical patient in 2020 and that of the previous two years before the response, under second-level response and under third-level response (P = 0.736, P = 0.528, P = 0.334). During first-level response, the severity of surgical patients in 2020 decreased significantly compared with that in the previous two years (P = 0.001) (Table 2-5).

For the years 2018, 2019, and 2020, 25, 19, and 10 cases of injuries by falling from a height were treated in our center, respectively, and there were significant differences between them (P=0.016). The number of patients undergoing surgery due to open injuries was 218, 167, and 122, respectively. The number of patients who underwent surgery for motor vehicle accidents was 60, 53, and 30, respectively. There was no significant difference in the number of open injuries and traffic accidents between the three years (P=0.78, P=0.563) (Table 6).
Discussion

As a serious global public health emergency, the impact of the COVID-19 on people's lives all over the world has greatly exceeded that of Ebola virus in 2014, Middle East respiratory syndrome (MERS) in 2015 and SARS in 2003. COVID-19 has a long duration and a wide range of spread, which is far beyond the previous global public health events in recent years. Under the strong control by the Chinese government, the pandemic of COVID-19 did not break out in Shanghai. On January 24, 2020, the Shanghai government announced to launch the first-level response of prevention and control. Subsequently, residents in Shanghai have experienced the whole process from first-level response to third-level response (Shanghai still hasn't stopped third-level response of prevention and control). In the process of fighting the pandemic, the economy, life and politics will change with the changes of the pandemic situation. The hospital's treatment process has also been optimized\(^7\). In this study, we found that children's orthopedic emergency also changed with the pandemic situation.

Before the response, the data about pediatric orthopedic trauma in Shanghai kept at the same level as the previous two years in terms of emergency number, emergency diseases, number of operations, severity of surgery or injury mechanism. The disease spectrum did not change significantly in different years. With the change of climate and semester, the number of orthopedic trauma in children in Shanghai increased with the rise of temperature and the beginning of school.

Under first-level of prevention and control response, schools and classes were suspended and all public places were closed. Without outdoor activities and campus life, the injury probability of children living at home is significantly reduced, so the number of emergency and surgery are significantly reduced. Moreover, the severity of the disease in children undergoing surgery was lighter than that in the previous two years. With family care, especially with the care of parents (most people stop work under first-level response), orthopedic trauma in children can be effectively avoided, and even if injured, the severity of the injury is less than that after school beginning. Interestingly, starting with the response, this decrease in the number and severity of injuries is not only reflected in trauma, but also in the number of subluxations of the radial head. The incidence rate of radial head subluxation in girls is higher than that in boys because girls are more likely to be pulled by their parents\(^8\). Similarly, we can speculate that outdoor activities and campus life will increase the probability of guardians pulling children's arms. Therefore, parents and preschool teachers should pay more attention to the correct posture when protecting their children in outdoor activities, and avoid direct arm pulling.

After the response level of prevention and control was adjusted to second-level, Shanghai began to recover gradually. But, most of the children are still staying at home. In the late stage of second-level response, older students from the graduating class returned to the campus (on April 27, 2020, the ninth grade and senior three in Shanghai was resumed). At this time, we found that the number of orthopedic emergency and surgery increased slightly, and the severity of surgical children has begun to be the same as that in previous years. The increase of trauma is directly related to the return of guardians to work and
the reduction of family care for young children, which reflects the importance of parents for children's family care.

Under third-level response, public places and stadiums have been reopened in Shanghai, and non-graduating students are recommended to the campus. At this stage, the number of orthopedic emergency and surgical operations this year are the same as those in previous years. The severity of the damage has also returned to the level of previous years. We can infer from the data of pediatric orthopedic trauma that most of the children's study and life have recovered under third-level response in Shanghai. It should be noted that the number of cases undergoing surgical treatment due to falling from height has increased compared with previous years. We compared the opening date of school and the date of falling building in recent three years and found that the visiting time of children with high falling injury was concentrated in the middle of the semester. For example: Although the age and school start date of the 10 high falling patients in 2020 are different, they are all injured in the middle of the semester after the beginning of school in their grade (Table 7). We can infer that the pressure on students caused by academic pressure will gradually increase with the progress of the semester. This provides guidance for the future school targeted psychological counseling.

Conclusion

The prevention and control response for COVID-19 in Shanghai has indeed affected the normal life of the residents in Shanghai. The response reduced the incidence of pediatric orthopedic emergency trauma. With the control of the pandemic, resident’s lives in Shanghai have been basically restored.

Declarations

7.1 Ethics approval and consent to participate

This study was approved in ethics Council of Children's Hospital of Fudan University. Written permission was also obtained from the academic research office of Children's Hospital of Fudan University before data collection. The consent for participation in the study was obtained from patient's guardian at the first emergency visit.

- Consent for publication

Not applicable.

- Availability of data and materials

Data supporting the conclusions and outcomes of this article are included in the article. The raw datasets presented and analyzed in this study are available upon request from the corresponding author.

- Competing interests
The authors declare that they have no competing interests and no potential conflicts of interest regarding the publication of this article.

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- **Authors' contributions**

CQ, YZ and JM contributed to data collection and statistical analysis. CQ, HL and DW contributed to study design and performed measurement. CQ and HL contributed to writing the manuscript.

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Not applicable.

**Abbreviations**

COVID: Corona Virus Disease

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**Tables**
Table 1. The time line after unification

|                          | 2018       | 2019       | 2020       |
|--------------------------|------------|------------|------------|
| Before the response      | 01/21-02/14| 01/12-02/03| 01/01-01/23|
| First-level response     | 02/15-04/13| 02.04-04/02| 01/24-03/22|
| Second-level response    | 04/14-05/29| 04/03-05/18| 03/23-05/07|
| Third-level response     | 05/30-06/30| 05/19-06/30| 05/08-06/30|

Table 2. Comparison of the severity of surgical patients before the response

| Year | moderate | severe | critical |
|------|----------|--------|----------|
| 2018 | 6        | 25     | 8        |
| 2019 | 8        | 36     | 19       |
| 2020 | 4        | 36     | 12       |

Overall comparison P=0.736

Table 3. Comparison of the severity of surgical patients under the first level response
| Year | moderate | severe | critical |
|------|----------|--------|----------|
| 2018 | 28       | 153    | 49       |
| 2019 | 25       | 94     | 42       |
| 2020 | 29       | 35     | 12       |

Overall comparison  \( P=0.001 \)

- 2020 VS 2019  \( P=0.002 \)
- 2020 VS 2018  \( P<0.01 \)
- 2019 VS 2018  \( P=0.6 \)

Table 4. Comparison of the severity of surgical patients under second-level response

| Year | moderate | severe | critical |
|------|----------|--------|----------|
| 2018 | 34       | 152    | 60       |
| 2019 | 26       | 122    | 34       |
| 2020 | 21       | 108    | 32       |

Overall comparison  \( P=0.528 \)

Table 5. Comparison of the severity of surgical patients under third-level response
| Year | moderate | severe | critical |
|------|----------|--------|----------|
| 2018 | 24       | 85     | 43       |
| 2019 | 35       | 124    | 48       |
| 2020 | 20       | 122    | 50       |

Overall comparison $P=0.334$

Table 6. Comparison of the causes of injury

|                  | Vehicle accident | Fall from a height | Open injury |
|------------------|------------------|--------------------|-------------|
| 2018             | 60               | 25                 | 218         |
| 2019             | 53               | 19                 | 167         |
| 2020             | 30               | 10                 | 122         |

P Value 0.563 0.016 0.78

Table 7. Information about patients with high falling injure in 2020
| Patient No. | Gender | Age(y) | Opening Date (mm/dd) | Injury Date (mm/dd) | Diagnose                      |
|------------|--------|--------|----------------------|---------------------|-------------------------------|
| 1          | male   | 10     | last term            | 01/07               | fracture of femur             |
| 2          | male   | 14     | last term            | 01/13               | multiple injuries             |
| 3          | male   | 3      | -                    | 02/06               | Fracture of upper arm         |
| 4          | female | 10     | 06/02                | 03/07               | Fracture of tibia and fibula  |
| 5          | male   | 16     | 04/02                | 05/07               | Fracture of spine             |
| 6          | female | 16     | 04/27                | 05/10               | Fracture of pelvis            |
| 7          | male   | 17     | 05/06                | 05/16               | Multiple injuries             |
| 8          | male   | 15     | 04/27                | 05/18               | Fracture of femur (bilateral) |
| 9          | male   | 14     | 05/06                | 05/20               | Multiple injuries             |
| 10         | female | 13     | 05/18                | 06/07               | Fracture of femur             |