The trend of fracture distribution in the SARS-CoV-2 era: organization and resource allocation in a level I trauma care center

Fabrizio Matassi [1], Niccolò Giabbani [1], Giacomo Sani [1], Lorenzo Ius [1], Francesco Raspanti [1], Alberto Galeotti [1], Matteo Innocenti [1], Luigi Zanna [1], Carlo Rostagno [2], Roberto Civinini [1]

[1] University of Florence, Orthopedic Clinic CTO – Florence (IT).
[2] University of Florence, Department of Experimental Clinical Medicine – Florence (IT).

ABSTRACT

Purpose: This study analyzes changes in the epidemiology of fractures during the SARS-CoV-2 era. Its aim was to better understand the workload of the orthopedic department, as well as the management of healthcare professionals, in this situation, with a view to ensuring optimal resource allocation in the event of any future epidemic emergency.

Methods: Admissions to the orthopedic emergency room for trauma care were analyzed with reference to the period January 2019 to April 2020. The rate of hospitalized patients (group A) and the rate of patients discharged pending delayed surgery (group B) were recorded. Furthermore, distribution of the various fracture types, and of different trauma dynamics, was also evaluated.

Results: The data show a reduction in the number of total admissions (from an average of 70.92/day to 21.15/day during the COVID period). In the pre-COVID era, patients requiring hospitalization accounted for 7.01% of all admissions; this rate increased to 12.47% in March 2020 and 15.67% in April 2020. No increase was found in the rate of patients assigned to delayed surgery: 1.31% in the pre COVID-era, 1.11% in March 2020, and 0.70% in April 2020. The frequency of proximal femoral fractures remained stable (53.71/month in the pre-COVID era, 47.5/month in the COVID era), while high-energy fractures decreased during the outbreak.

Conclusion: During epidemics such as the SARS-CoV-2 outbreak, trauma services must be guaranteed in order to treat fractures and orthopedic emergencies, while elective procedures should be discontinued to preserve resources and allow conversion of professionals in order to meet ICU needs. The epidemiology of fractures can change, but orthopedists must still ensure high quality of care and, at the same time, protect themselves and their patients from the risk of viral infection.

KEYWORDS

COVID-19, coronavirus, orthopedic management, fractures, epidemiology.

Introduction

The end of 2019 saw the appearance of a new respiratory disease (COVID-19) caused by a type of coronavirus (SARS-CoV-2) [1]. This virus mainly affects the lower respiratory tract and causes flu-like symptoms [2]. In severe cases, pneumonia, acute respiratory distress syndrome and septic shock can occur, which may require hospitalization and, in some cases, Intensive Care Unit (ICU) admission [3].

After the first cases were recorded in the Chinese province of Wuhan [4], COVID-19 quickly spread to the whole world. Within a few weeks of Italy's first recorded case, on 21st February, 2020 [5], the disease had spread all over the country [6].

Orthopedic surgeons, unlike their colleagues in the fields of infectious diseases, emergency medicine and family medicine, were not on the frontline in this pandemic. However, as part of the broader healthcare system, orthopedic practice had to be tailored to the needs of the emergency situation. All elective, non-urgent procedures were postponed with the aim of decreasing both inpatient care and long hospital stays, while trauma services and musculoskeletal tumor units were allowed to continue operating.

The virus outbreak prompted the application of significant restrictive measures; a large part of the population was obliged to stay at home, being permitted to leave the home only when absolutely necessary. People were also encouraged, through messages conveyed by the mass media, not to go to the emergency room (ER) except for real emergencies.

These changes affected the epidemiology of fractures and the need to access trauma care.

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Contact
Niccolò Giabbani; niccologiabbani@gmail.com
University of Florence, Orthopedic Clinic CTO – Florence (IT),
Tel: +39 340 5306168

The purpose of this study was to analyze changes in the epidemiological profile of patients admitted to the ER with orthopedic issues, and the number of them who required surgery during the acute pandemic period. It was thought that better understanding of the workload of the orthopedics department in this particular situation could help to ensure proper management of healthcare professionals during epidemics, and thus have important implications for resource allocation in the event of the healthcare system being faced, in the future, with a new epidemic-related emergency.

Methods

We retrospectively analyzed the admission data of all patients admitted to the orthopedic ER of our hospital's level I trauma care center from 1st January 2019 to 30th April 2020. The database contains demographic data, discharge status, and International Classification of Diseases (ICD-9-CM) procedures and diagnosis codes. These codes, used for reimbursement under the National Health Insurance system, were relatively broad and we were unable to classify them into detailed morphological or pathological types.

Patients were divided into three groups (A, B, C) on the basis of their main diagnoses and need of surgery, as well as their priority for receiving surgery, and thus their need of immediate or delayed hospitalization.

Group A comprises a portion of all the patients who required immediate hospitalization with the ICD-9-CM codes reported in Table I.

For analysis purposes, we considered a "high-energy fracture" subgroup, which includes patients with fractures of the shaft of the humerus, shaft of the forearm, shaft of the femur and shaft of the tibia, as well as tibial plateau and tibial plafond fractures.

Table I ICD-9-CM codes: group A (inpatients included) and group B (discharged for delayed surgery).

	ICD-9-CM	DIAGNOSIS
Inpatients (group A)	808.43	Multiple pelvis fracture
	810.00	Clavicle fracture
	811.00	Scapula fracture
	812.00	Proximal end humerus fracture
	812.21	Diaphyseal humerus fracture
	812.40	Distal end humerus fracture
	813.00	Proximal end radius and ulna fracture
	813.23	Diaphyseal radius and ulna fracture
	813.40	Distal end radius and ulna fracture
	817.00	Multiple hand fracture
	820.00	Femoral neck fracture
	820.20	Trochanteric fracture
	821.01	Diaphyseal femoral fracture
	821.22	Distal end femoral fracture
	822.00	Patella fracture
	823.00	Proximal end tibia fracture
	823.20	Diaphyseal tibia fracture
	824.00	Ankle and distal end tibia fracture
	825.20	Foot fracture
	996.44	Periprosthetic fracture
Discharged pending delayed surgery (group B)	727.60	Atraumatic tendon rupture
	831.00	Shoulder dislocation
	831.04	Acromioclavicular dislocation
	838.00	Foot dislocation
	844.09	Knee sprain
	845.00	Ankle sprain

Among the whole group of hospitalized patients, we excluded those with spinal, cranial or maxillofacial fractures that were treated by other departments, and patients who required hospitalization for any reasons other than fracture (e.g., joint infection or periprosthetic infection and any patients admitted for fracture sequelae such as non-union or hardware breakage).

Patients who were discharged, but required delayed surgery within 10 days were included in group B; patients included in this group also had ICD-9-CM codes reported in Table I.

Patients discharged at home with no need of surgery formed group C.

The patients were further classified according to the nature of the trauma: domestic injury; road traffic accident; work accident; sports injury; E) trauma not otherwise specified.

All the data in this study involving human participants were collected in accordance with the 1964 Helsinki Declaration and respecting the ethical standards of our institution.

The quantitative parameters (numbers of patients) were evaluated through calculation of mean values and standard deviations. Increases or reductions in incidence were reported as percentages (%) of the total.

Results

We analyzed 31433 consecutive patients admitted to the ER for trauma care in the period from 1st January 2019 to 30th April 2020. Of these, 2417 were hospitalized, including 2291 with fractures (group A); 406 patients were discharged pending delayed surgery (group B), while 28610 were discharged home (group C) (Fig. 1).

The number of ER admissions decreased from an average of 70.92 patients/day (range 39–112) in the pre-COVID era to averages of 23.29 patients/day (range 7–70) in March 2020 and 18.93 patients/day (range 9–29) in April 2020 (Fig. 2, Tab. 2).

The number of inpatients care (group A) that required operative management of the fractures were an average of 4.97 fractures/day (range 1–11) during the pre-COVID era compared to an average of 2.90 fractures/day (range 0–7) in the month of March 2020 and an average of 2.97 fractures/day (range 0–7) in the month of April 2020.

In the pre-COVID era, fracture patients requiring immediate hospitalization accounted for 7.1% of total admissions; this rate rose to 12.47% in March 2020 and 15.67% in April 2020 (Fig. 2, Tab. 2). The average proportion of patients requiring delayed surgery was 1.31% of total admissions during the pre-COVID era compared with 1.11% in March 2020 and 0.70 % in April 2020 (Fig. 2, Tab. II).

During the COVID era, proximal femur fractures were found to be the most frequent; these fractures fell from an average of 53.71/month (range 34–84) in the pre-COVID era to a total of 42 fractures in March 2020 and a total of 53 fractures in April 2020. Proximal humerus fractures decreased from an average of 17.64/month (range 11–25) in the pre-COVID-era to a total of 5 fractures in March 2020 and a total of 9 fractures in April 2020.

Figure 1 Overall ER admissions, total number of inpatients [including the excluded and the included (group A) ones], number of patients discharged pending delayed surgery (group B), and number of patients discharged home (group C).

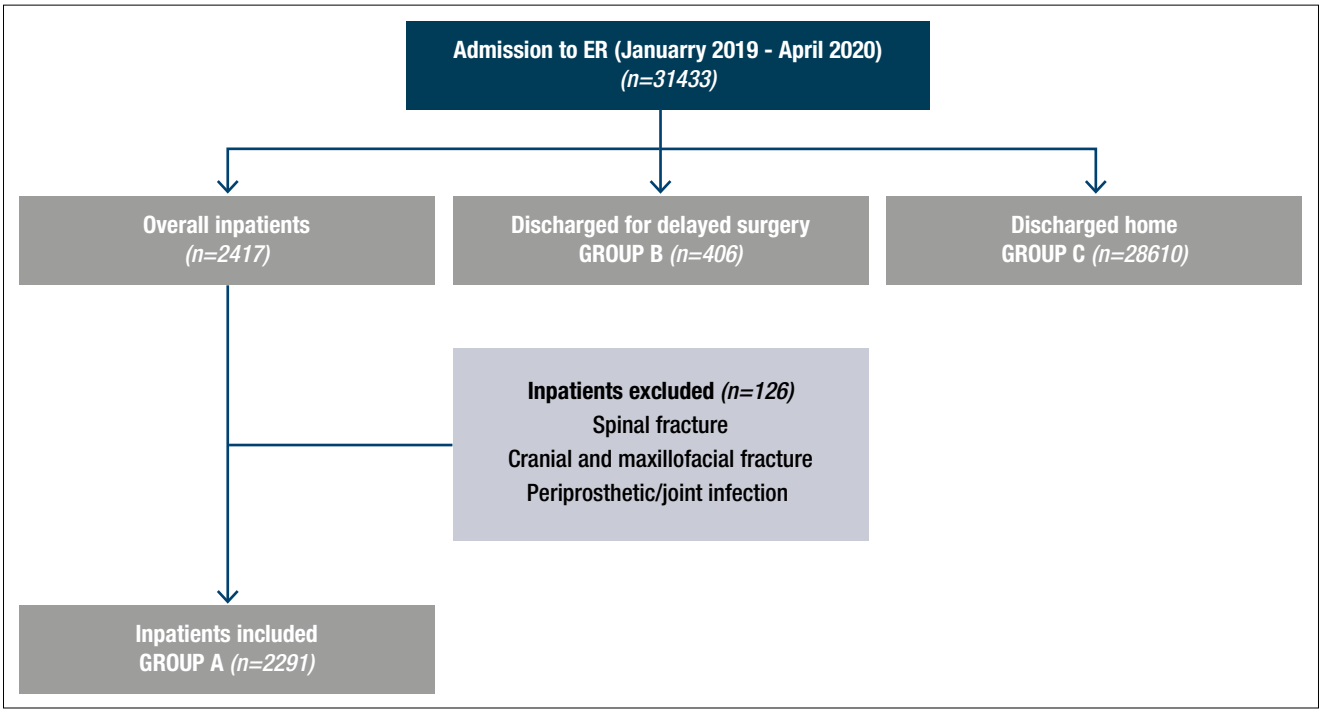
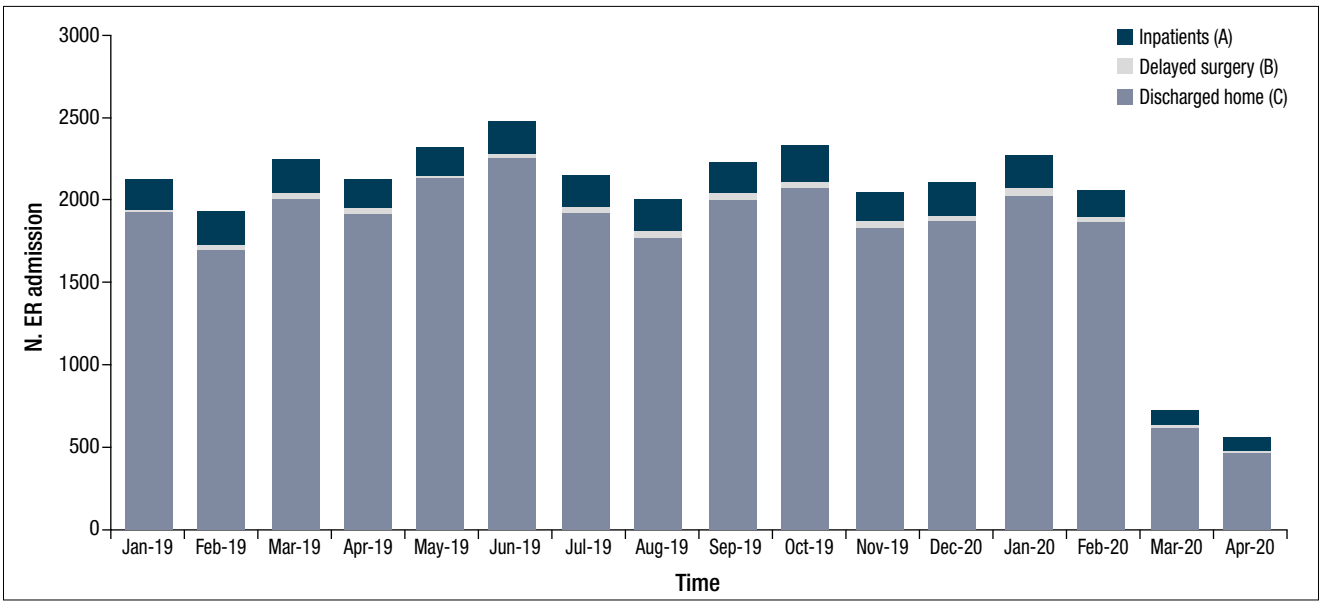


Figure 2 Month-by-month trend of ER admissions, showing, for each month: inpatients (group A), patients discharged pending delayed surgery (group B), patients discharged home (group C).



Regarding high-energy fractures, we found a reduction from an average of 31.79/month (range 21–43) in the pre-COVID era to a total of 11 fractures in March 2020 and a total of 5 fractures in April 2020.

The distribution of fracture types over time is reported in Figure 3. As regards the nature of the trauma, we found an increase in the percentage of domestic injuries from 38.23% in the pre-COVID era to 74.15% in the COVID era. March and April 2020 instead saw reductions in the incidence of fractures related to all the other types of activity (Fig. 4).

Discussion

In the battle against the spread of COVID-19, each medical specialty should be considered part of a team with a role to play in dealing with the tsunami that has overwhelmed us [7].

Due to the spread of the virus and the resulting strain on the healthcare system, all elective, non-urgent orthopedic procedures were postponed in order to preserve resources and reduce the rate of nosocomial diffusion of the virus [8]. However, trauma services were maintained and organized in such a way as

Table II ICD-9-CM codes: group A (inpatients included) and group B (discharged for delayed surgery).

	JAN 19	FEB 19	MAR 19	APR 19	MAY 19	JUN 19	JUL 19	AUG 19	SEP 19	OCT 19	NOV 19	DEC 19	JAN 20	FEB 20	MEAN PRE-COVID	MAR 20	APR 20
Inpatient (A)	189 (8.87%)	201 (10.42%)	208 (9.25%)	175 (8.25%)	175 (7.54%)	210 (8.47%)	192 (8.95%)	190 (9.50%)	188 (8.44%)	224 (9.61%)	175 (8.55%)	208 (9.85%)	199 (8.78%)	161 (7.83%)	193 (161-224)	90 (12.47%)	89 (15.67%)
Delayed surgery (B)	19 (0.89%)	30 (1.56%)	26 (1.16%)	24 (1.13%)	12 (0.52%)	14 (0.56%)	27 (1.26%)	38 (1.9%)	31 (1.39%)	34 (1.46%)	31 (1.52%)	30 (1.42%)	38 (1.68%)	28 (1.36%)	27 (12-38)	8 (1.11%)	4 (0.7%)
Discharged home (C)	1922 (90.23%)	1698 (88.02%)	2014 (89.59%)	1921 (90.61%)	2133 (91.94%)	2255 (90.96%)	1926 (89.79%)	1773 (88.61%)	2008 (90.17%)	2073 (88.93%)	1840 (89.93%)	1874 (88.73%)	2030 (89.55%)	1868 (90.81%)	1953 (1698-2255)	624 (86.43%)	475 (83.63%)
Total admissions	2130 (100%)	1929 (100%)	2248 (100%)	2120 (100%)	2320 (100%)	2479 (100%)	2145 (100%)	2001 (100%)	2227 (100%)	2331 (100%)	2046 (100%)	2112 (100%)	2267 (100%)	2057 (100%)	2172 (1929-2479)	722 (100%)	568 (100%)

to be able to manage patients with fractures needing orthopedic evaluation and treatment as soon as possible [9,10].

The orthopedic associations provided their members with continuously updated information on trauma and orthopedic care during the COVID-19 pandemic. Patients were classified into four categories:

1. obligatory inpatients who required admission and surgical management, avoiding pre-operation delays and organizing rapid rehabilitation in order to minimize the length of hospital stays;
2. non-operative patients with injuries that could be managed nonoperatively;
3. day-case patients with injuries that could be managed in the one-day surgery setting, allowing beds to be promptly freed up for more urgent cases;
4. first contact and clinic outpatients with minor injuries or wounds [11].

Our study shows that from the first day of the Italian lockdown (8th March 2020), ER admissions for orthopedic issues decreased progressively, falling from an average of 70.92/day in the previous months, to an average of 23.29/day in March and 18.93/day in April 2020 (Fig. 2).

During the acute pandemic period, the rate of patients who required hospitalization was 12.47% in March and 15.67% in April 2020. The proportion of patients who required delayed surgery was 1.11% in March and 0.70% in April. These data should be compared with the mean rates of patients who required hospitalization (7.01%) and delayed surgery (1.31%) during the previous months (Fig. 2).

A possible explanation of these data may be that emergency care admissions during the acute pandemic period were restricted to patients with high-energy traumas and a high probability of having a fracture. Accordingly, we observed a reduction in the inappropriate admissions of patients with low-energy or even no trauma and of patients with long lasting pain that usually congest emergency care services, impacting on the availability of resources, time and supplies. Moreover, there was no increase in the number of delayed surgery cases because the reduction of the total number of fracture admissions allowed immediate intervention even in some cases whose treatment could have been be deferred.

Fractures were managed surgically as soon as possible and cases were discharged using a fast-track method. Each patient who required hospitalization was screened with nasal swab tests. In negative cases, patients were hospitalized in orthopedic department; positive cases were instead admitted to the medical ward dedicated to COVID-19 care, and surgery was performed in a dedicated operating room. This separation was important to keep positive patients isolated from the rest of the department and thus minimize the risk of cross-contamination.

We observed different trends in the frequency of specific fractures. The frequency of proximal femur fractures remained substantially stable (changing from an average of 53.71 fractures/month in the pre-COVID months to an average of 47.50 fractures/month in the COVID period), as they are mainly caused by domestic low-energy falls (Fig. 3). We found a slight reduction in the number of femoral neck fractures (from an average of 27.50/month in the pre-COVID era to an average of 21.00/month in the COVID era) and a slight increase in the number of trochanteric fractures (from an average of 26.21/month in the pre-COVID era to an average of 26.50/month in the COVID era), but no explanation can be given for this trend

Figure 3 Trend over time of proximal femur fractures, proximal humerus fractures and high-energy fractures.

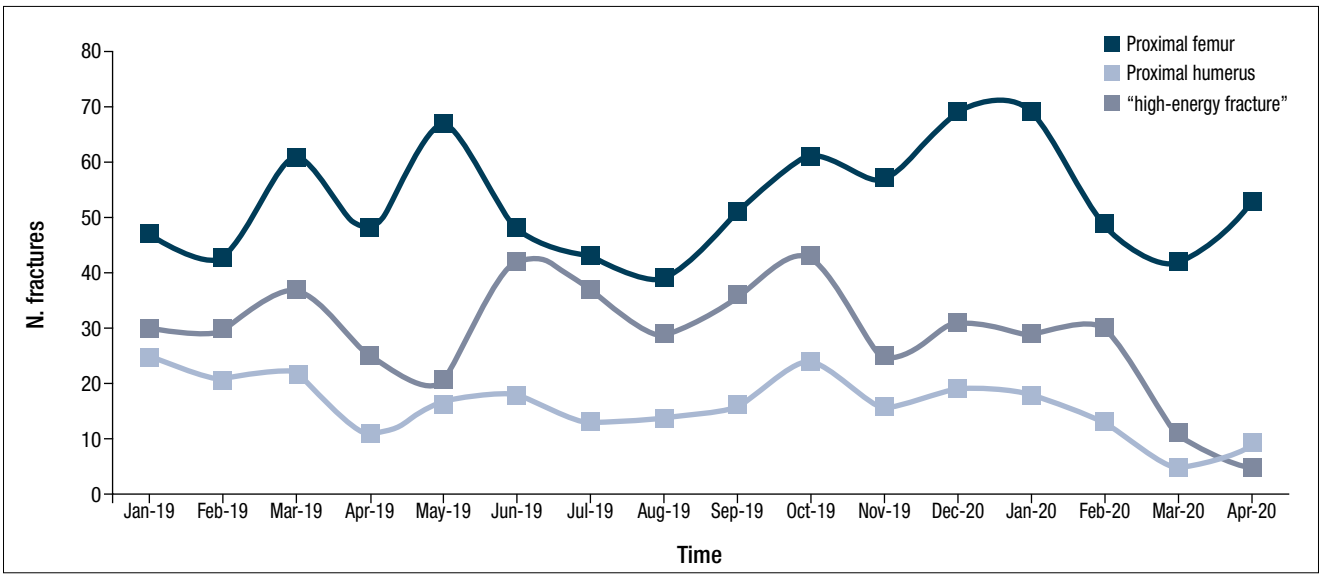
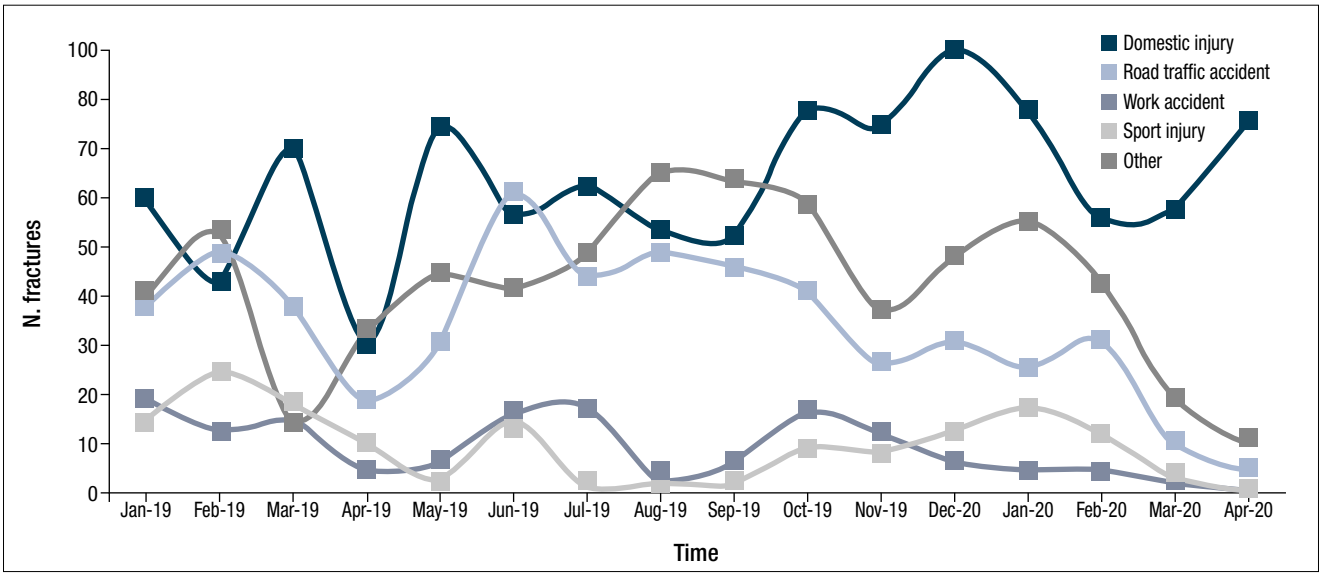


Figure 4 Trend over time of trauma dynamics responsible for fractures.



since the variation was minimal.

Conversely, the decreases observed in the rates of other fracture types, such as tibial plateau or shaft and distal femur or proximal humerus fractures, may be related to the changes in daily living during the lockdown imposed by the government (Fig. 3).

Finally, analysis of trauma dynamics showed a considerable increase in domestic injuries, expressed as a percentage of all the injury modalities considered: from 38.23% to 74.15%; conversely, all the other categories showed percentage decreases: road traffic accidents from 21.89% to 7.80%, work accidents from 6.04% to 0.98%, sports injuries from 5.90% to 1.46%, and dynamic of trauma not otherwise specified from 27.93% to 15.61% (Fig. 4).

To our knowledge this is the one of the first studies on fracture distribution in this new pandemic era. The lockdown of most services and the drastic reduction in traffic on the roads led to a reduction in high-energy traumas and fractures during the first months of the pandemic. However, elderly people continued to have falls during domestic and daily living activities, with the result that fractures in this group of patients remain a social problem with a high incidence.

The major limitation of this study is the heterogeneity in patient numbers between the pre-COVID-19 and COVID-19 periods. Indeed, the results may be due to the comparison of small and/or different-sized samples, and therefore should not be taken as a milestone. However, this limitation is strictly related to the completely new scenario that 21st century orthopedics has recently been facing.

In conclusion, in the battle against the spread of SARS-CoV-2, orthopedic surgeons must play their role as part of the healthcare system. The trauma service must be guaranteed so that fractures can be treated, keep the fast-track service for emergencies.

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