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Original article

Descriptive analysis of pediatric orthopedic surgical emergencies during the COVID-19 lockdown: Single-center observational study in a pandemic red-zone area in France

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A B S T R A C T

Introduction: Lockdown involved strict confinement of children at home, radically affecting their way of life, with increased risk of domestic accidents and the temptation to step outside of the legal framework. The aim of the present study was to analyze the impact of lockdown on pediatric emergency turnover in a university reference center situated in a high-risk “red zone” and to describe specific management measures.

Hypothesis: Pediatric emergency turnover and the corresponding lesion mechanisms were altered by lockdown.

Materials and methods: All children undergoing emergency orthopedic surgery during lockdown (group 1) were prospectively included, then retrospectively compared to series operated on during the same period in the previous 3 years. Demographic and surgical data were analyzed, and the pathway changes that were developed were detailed.

Results: Turnover fell by a mean 33.5%, without change in indications. The most frequent lesions were wounds (54.3%), followed by fractures (34.3%) and infections (11.4%); the upper limbs were involved in 84.6% of cases. Lockdown had been infringed in 9.7% of traumas, mainly concerning fractures (55%). Postoperative management was modulated during lockdown in 34% of cases, without complications at the time of writing.

Discussion: Pediatric emergency turnover decreased, without major change in lesion mechanisms. Accidents associated with lockdown infringement were rare (<10%), demonstrating good adaptation on the part of these children living in an urban area. The adapted care pathway was beneficial, and will no doubt continue to optimize management in future, with accelerated circuits and use of telemedicine.

Level of evidence: IV, comparative retro-prospective study.

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1. Introduction

The lockdown instituted in France to combat the 2019 coronavirus (SARS-CoV-2) pandemic (COVID-19) included school closure and cancellation of out-of-school activities. Children were strictly confined at home, greatly affecting their way of life. In cities, accommodation is often cramped, and many families are without access to outdoor areas. There was thus an expected extra risk of domestic accidents, and a temptation to bypass the regulations [1,2].

Some local pediatric emergency departments adopted referral to university hospital centers, where adapted pathways were set up to protect children, accompanying adults and care staff, especially in theater [3–5]. In pediatrics, anesthesia induction by inhalation is best suited to emergencies, but also runs the greatest risk of viral contamination [3,4].

The aim of the present study was to analyze the impact of lockdown on pediatric emergency turnover in a university reference center situated in a high-risk “red zone”, and to describe specific management measures. The study hypothesis was that pediatric...
emergency turnover and the corresponding lesion mechanisms were significantly altered by lockdown.

2. Materials and methods

2.1. Population

With local review board approval, all consecutive patients aged <18 years undergoing pediatric orthopedic emergency surgery in our center between March 17 and May 11, 2020 were prospectively included (group 1), then retrospectively compared to series for the same period in 2019 (group 2), 2018 (group 3) and 2017 (group 4).

2.2. Demographic and surgical data for Group 1

All patients were from urban areas. Study data comprised: gender, age, family environment, siblings, and outdoor space such as a garden or patio. Lesion type, circumstances, mechanism and exact location with respect to lockdown restrictions were reported, with accidents more than 300 meters from home counting as infraction.

Surgical and postoperative data were analyzed. Early complications were noted: infection, secondary displacement, fixation hardware failure.

2.3. Operative and hospitalization pathways

Anesthesia practices needed to be altered to improve the safety of inhalation induction. Airway protection by a supraglottic device or orotracheal intubation run the highest risks of virus exposure. Following the guidelines of the French Society of Anesthesia and Intensive Care Medicine (SFAR) and the Association of French-Speaking Pediatric Anesthetists and Intensivists (ADARPEF), all patients were tested before transfer to the operative room, except in immediately life-threatening situations. In patients with negative test or no symptoms, inhalation induction adopted the precautionary principle with regard to staff. Operating room anesthesia staff were kept to a strict minimum of 2, and coming and going was minimized. Antiviral protective measures associated FFP2 filtering face-piece mask, facial screen or protective goggles, and gloves. In patients with positive test or strong clinical suspicion, a long-sleeved overcoat and apron were added to the above. Intravenous induction was used, to avoid viral aerosolization. Extubation or withdrawal of the supraglottic device was systematically performed in the operating room, and a surgical mask was positioned on the patient’s face before transfer to the recovery room, where ≥1-meter distancing between children was ensured. A dedicated ward and staff were allocated to Covid-positive or strongly suspected cases, with monitoring kept to a strict minimum. Postoperative stay was organized according to Covid test results, with negative patients in a conventional ward, and positive or pending patients (nights and weekends) in dedicated units with reinforced protection.

2.4. Statistics

Statistical analysis used SPSS statistics 23.0 software (SPSS Inc., Armonk, NY, USA). Quantitative variables were reported as percentage and compared on Kruskal-Wallis test, and qualitative variables as mean ± standard deviation and compared on Chi2 test, with the significance threshold set at \( p < 0.05 \).

3. Results

3.1. Epidemiology

Surgical turnover decreased less in pediatric orthopedics than in emergency, where the average decrease was 63% (\( p < 0.0001 \)), due to a marked decrease in presentation for medical reasons (Table 1). The rate of traumatology emergencies (mean 33%) was maintained (\( p = 0.6 \)). In all, 175 patients (60% boys, 40% girls) from urban areas underwent orthopedic surgery during lockdown: i.e., 33.5% down on average from previous years. Eight of the 443 patients operated on in emergency tested positive for COVID-19 (1.8%), including 2 of the 172 orthopedic cases (1.1%); all were symptomatic. Mean age was 5.9 ± 3.8 years, lower than in previous years (\( p = 0.06 \)). 78% of patients (\( n = 136 \)) had siblings, and 30% (\( n = 52 \)) disposed of a private outdoor space (garden or patio) (Table 2). 48% (\( n = 84 \)) were transferred from a different hospital structure within the Île de France administrative area.

There was a progressive increase in the weekly number of emergency admissions during the first 5 weeks of lockdown, and a decrease over the following 3 weeks (Fig. 1).

3.2. Lesion mechanisms

As in the 3 previous years, the most frequent lesions were wounds (54.3%), followed by fractures (34.3%) and infections (11.4%) (Table 1). Wounds mainly involved an upper limb; the main mechanism was finger door-crush injury (40% of wounds), but with a significant decrease compared to previous years (-15%; \( p = 0.04 \)), and in a context of domestic accident, despite the rate of domestic accidents being unchanged. Fractures were also mainly in the upper
Table 2
Characteristics according to lesion type in group 1 (lockdown).

| Trauma          | Wound (n = 95) | Fracture (n = 60) | Infections (n = 20) | p   |
|-----------------|---------------|------------------|---------------------|-----|
| Age (years)     | 5.6 (±3.7)    | 6.6 (±3.5)       | 5.1 (±4.4)          | 0.04*|
| Gender (% boys) | 61            | 60               | 55                  | 0.7 |
| Siblings (%)    | 80            | 59               | 70                  | 0.002*|
| Domestic accident (%) | 87 | 64             | 25                  | 0.009*|
| Rules infringement (%) | 8  | 15            |                     | 0.3 |

* p < 0.05, significant difference.

Table 3
Comparative epidemiology of fractures between the 4 groups (number of cases).

| Limb          | Group 1 n = 60 | Group 2 n = 112 | Group 3 n = 84 | Group 4 n = 84 | p   |
|---------------|----------------|-----------------|----------------|----------------|-----|
| Upper limb    |                |                 |                |                |     |
| Finger        | 5              | 10              | 3              | 3              | 0.4 |
| Wrist         | 6              | 9               | 10             | 13             | 0.05|
| Forearm       | 8              | 28              | 6              | 2              | <0.0001*|
| Elbow         | 28             | 41              | 43             | 38             | 0.02*|
| Upper arm     | 0              | 1               | 0              | 0              | 1   |
| Shoulder girdle| 1       | 1               | 0              | 0              | 1   |
| Toe           | 1              | 1               | 3              | 0              | 0.2 |
| Distal foreleg| 1              | 1               | 2              | 6              | 0.3 |
| Foreleg       | 0              | 8               | 1              | 4              | 0.03*|
| Knee          | 2              | 2               | 5              | 3              | 0.4 |
| Femoral shaft | 3              | 10              | 4              | 9              | 0.4 |
| Proximal femur| 2              | 3               | 7              | 6              | 0.5 |

* p < 0.05, significant difference.

3.3. Adaptation of management, and complications

In 34% of cases (n = 59), the patterns of usual care were altered. All elbow pins (n = 28) were left protruding, for removal in consultation rather than in the outpatient surgery room as previously. Only overriding frontally misaligned fractures of the distal quarter of the 2 forearm bones were reduced under general anesthesia, due to risk of acute carpal tunnel syndrome and long-term synostosis (mean age, 10.2 years) [6]. These patients did not have the usual day-10 screening for secondary displacement in the center, but at

limbs (83%) (Table 3), in significantly older children, and occurring in an outdoor space at home in 55% of cases.

The infection rate was stable over the years (Table 1); most were exclusively soft-tissue infections (65%), although there were also 6 cases of septic osteoarthritis and 1 of suppurating chronic osteomyelitis.

Lockdown rules were infringed in 9.7% of cases, mainly of fracture (53%), in boys (71% vs. 58%; p = 0.4) with siblings (88% vs. 77%; p = 0.4), significantly older than those who had stayed home (8.5 vs. 5.6 years; p = 0.004).
Table 4

| Population | Turnover decrease | Change in management | Mechanisms | Study methodology |
|------------|-------------------|----------------------|------------|-------------------|
| Present study (France) | 970 children (mean age, 6.6 years) Comparison over 4 years | 33.5% | 34% for surgery and follow-up. | Domestic injuries and outdoor trauma | Retrospective descriptive, comparative |
| Bram et al. [2] (US) | 1,745 children (mean age, 7.5 years) Comparison with 2018 and 2019 | 40% | 20% increase in non-operative treatment, and 18% decrease in cast immobilization | Increase in domestic (25%) and garden accidents (10% bike), decrease in sports (20%) and playground accidents (5%) | Retrospective descriptive, comparative |
| Iyengar et al. [10] (UK) | Pediatric and adult | - | Indications for non-operative treatment in children and adults | - | UK guidelines |
| Nunez et al. [5] (Spain) | 6,565 adults (mean age, 55.1 years). Comparison to 2 previous years and pre-lockdown period | 31% | No change | No change in osteoporotic fractures; decrease in work and road accidents | Epidemiologic descriptive, comparative |
| Christey et al. [9] (New Zealand) | Adult and pediatric Emergency department Comparison with pre-lockdown fortnight | 48% in pediatrics, 43% in all | Prevention of domestic and rural accidents | Falls at home | Descriptive, comparative, prospective |
| Sugand et al. [8] (UK) | 399 children. Comparison to 2019 | 32% | Teleconsultation | Decrease in sports accidents | Observational, longitudinal, retrospective |

Discharge were given a community radiography prescription for email feedback. Patients came back only for cast removal, dressing check (wound with risk of necrosis) or adverse events that could not be dealt with in teleconsultation. Only 1 patient failed to send the control radiograph, but cast removal went ahead as planned on day 45. There were no intolerable secondary displacements or wound infections at the time of writing. In case of bone and joint infection, biological and radiological controls and clinical progression were checked in teleconsultation. No revision surgeries were needed.

4. Discussion

Pediatric orthopedic emergency turnover decreased under lockdown, with no major change in lesion mechanisms [2,5,7]. Accidents associated with infringement of the lockdown rules were rare (<10%), confirming good adherence and adaptation to lockdown in children in urban areas. Anesthesia and treatment pathways, from operating room to discharge, were adapted to the new situation, without impact on the rate of complications.

4.1. Epidemiology and lesion mechanisms

The decrease in emergency turnover in our catchment resembled reports from other countries during the pandemic (27%-40%) [2,5]. Bram et al. reported 2.5-fold lower turnover compared to pre-lockdown [2]. The same trend was reported in other adult and pediatric series (Table 4) [2,5,8–10]. The present study chose to compare turnover between identical periods, due to seasonal variations in pediatric traumatology [11]. The most frequent lesions were wounds sustained in domestic accidents, and notably a finger door-crush injury (Table 1), the incidence of which decreased significantly, probably because parents were at home, and were less subject to the stress of managing their children when they got back from work. The rate of minor finger jamming is probably underestimated, but would not have been a reason for surgical intervention under normal circumstances. The distribution of lesion types did not significantly change with lockdown. The fracture rate did not decrease, perhaps as outdoor temperatures were still quite low during the study periods and children are usually at school; 25% of fractures were associated with infringement of the lockdown rules (Table 2). Lockdown seems to have been fairly well respected, especially during the final two weeks, when laxity might have been expected to set in, demonstrating good adaptation by urban families [1].

4.2. Patient pathways

Treatment, anesthesia and hospitalization pathways had to be adapted to minimize viral exposure of children, families and care staff [3,4,12]. All patients were tested preoperatively whenever possible, including at weekends. There are actually few extreme emergency situations in pediatric orthopedics, and PCR screening was possible in emergency without delaying treatment. However, the high false-negative rate in PCR (30%-40%), the rate of asymptomatic patients (30%) and the unfeasibility of systematic chest CT in children were systematically woken in the recovery room. Staff were trained in these protective measures, which were applied in all units dedicated to positive and doubtful cases.

4.3. Adaptation of surgery and follow-up

Although not usually recommended in our department, pins were systematically left protruding for removal in consultation [15,16]. This did not increase the rate of infection (Table 1). Likewise, indications for reduction under anesthesia were minimized, to free up the operating room (Table 3) [6]. Medium- and long-term consequences of these changes will need to be assessed.

Postoperative hospital appointments were minimized, restricted to cast removal and monitoring wounds at risk of necrosis or infection (joint wounds, phlegmon). Removable splints, as described by Boutis et al., could have further reduced the need for follow-up consultation, but we were unable to implement this in time [17]. For fractures, the usual follow-up appointments were replaced by e-mailing X-rays made in the community and by teleconsultation, without short-term impact on complications.
This pathway is now adopted, so as not to overload the consultation schedule in a specialty that is under tension, allowing prompt treatment of the most urgent cases [18,19]. We need to keep working on safety measures when lockdown is lifted, to avoid a new wave of the epidemic [20].

4.4. Study limitations

The main study limitation was the single-center design; however, our center was called upon to manage patients from the whole surrounding region when the catchment cartography was reorganized under the pandemic. Patients came exclusively from urban areas, and impact in rural areas could not be addressed; transfer rates for the previous years could also not be assessed, as this is not systematically recorded on admission to emergency. Follow-up is too short at present to assess complications and loss of chance for some patients who may not have come to the emergency department, but these can be addressed subsequently. Lastly, multivariate analysis could not be implemented on the retrospective data for previous years, as the computer files were incomplete for certain items: transfer, siblings, and location of trauma.

5. Conclusion

Patient pathway adaptation for the lockdown situation was effective, and will doubtless allow continued optimization of care, notably by accelerated pathways and use of telemedicine.

Disclosure of interest

The authors declare that they have no competing interest.

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Authors’ contributions

ALS: data analysis, article writing.
SKH: data collection and analysis, article writing.
FJM: article writing and re-editing.
AH: data collection and analysis.
Pj: data collection and revision of the final version.
JGD: data collection and analysis, article writing.
Bl: revision of the various versions.

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