



# Prolonged social lockdown during COVID-19 pandemic and hip fracture epidemiology

Pablo A. Slullitel<sup>1</sup> · Carlos M. Lucero<sup>1</sup> · Maria L. Soruco<sup>2</sup> · Jorge D. Barla<sup>2</sup> · Javier A. Benchimol<sup>3</sup> · Bruno R. Boietti<sup>3,4</sup> · Gerardo Zanotti<sup>1</sup> · Fernando Comba<sup>1</sup> · Danilo R. Taype-Zamboni<sup>2</sup> · Guido S. Carabelli<sup>2</sup> · Francisco Piccaluga<sup>1</sup> · Carlos F. Sancineto<sup>2</sup> · Maria Diehl<sup>5</sup> · Martin A. Buttaro<sup>1</sup> · for the HipFEIR [Hip Fracture in the Elderly – Institutional Register] Study Group

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## Abstract

**Purpose** To analyse the impact of prolonged mandatory lockdown due to COVID-19 on hip fracture epidemiology.

**Methods** Retrospective case-control study of 160 hip fractures operated upon between December 2019 and May 2020. Based on the date of declaration of national lockdown, the cohort was separated into two groups: ‘pre-COVID time’ (PCT), including 86 patients, and ‘COVID time’ (CT), consisting of 74 patients. All CT patients tested negative for SARS-CoV-2. Patients were stratified based on demographic characteristics. Outcome measures were 30-day complications, readmissions and mortality. A logistic regression model was run to evaluate factors associated with mortality.

**Results** Age, female/male ratio, body mass index and American Society of Anaesthesia score were similar between both groups ( $p > 0.05$ ). CT patients had a higher percentage of Charlson  $\geq 5$  and Rockwood Frailty Index  $\geq 5$  scores ( $p < 0.05$ ) as well as lower UCLA and Instrumental Activities of Daily Living scores ( $p < 0.05$ ). This translated into a higher hemiarthroplasty/total hip arthroplasty ratio during CT ( $p = 0.04$ ). Thromboembolic disease was higher during CT ( $p = 0.02$ ). Readmissions (all negative for SARS-CoV-2) were similar between both groups ( $p = 0.34$ ). Eight (10.8%) casualties were detected in the CT group, whereas no deaths were seen in the control group. Logistic regression showed that frailer ( $p = 0.006$ , OR 10.46, 95%CI 8.95–16.1), less active ( $p = 0.018$ , OR 2.45, 95%CI 1.45–2.72) and those with a thromboembolic event ( $p = 0.005$ , OR 30, 95%CI 11–42) had a higher risk of mortality.

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This work was performed at the Italian Hospital of Buenos Aires, Argentina. All authors have participated in the research. The article has not been submitted elsewhere. It is a new manuscript submission.

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Level of Evidence: Prognostic level 3, case-controlled study.

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✉ Pablo A. Slullitel  
pablo.slullitel@hospitalitaliano.org.ar

Carlos M. Lucero  
carlos.lucero@hiba.org.ar

Maria L. Soruco  
maria.soruco@hiba.org.ar

Jorge D. Barla  
jorge.barla@hiba.org.ar

Javier A. Benchimol  
javier.benchimol@hiba.org.ar

Bruno R. Boietti  
bruno.boietti@hiba.org.ar

Gerardo Zanotti  
gerardo.zanotti@hiba.org.ar

Fernando Comba  
fernando.comba@hiba.org.ar

Danilo R. Taype-Zamboni  
danilo.taype@hiba.org.ar

Guido S. Carabelli  
guido.carabelli@hiba.org.ar

Francisco Piccaluga  
francisco.piccaluga@hiba.org.ar

Carlos F. Sancineto  
carlos.sancineto@hiba.org.ar

Maria Diehl  
maria.diehl@hiba.org.ar

Martin A. Buttaro  
martin.buttaro@hiba.org.ar

Extended author information available on the last page of the article

**Conclusion** Despite testing negative for SARS-CoV-2, CT patients were less active and frailer than PCT patients, depicting an epidemiological shift that was associated with higher mortality rate.

**Keywords** Hip fracture · COVID-19 · Frailty · Mortality · Readmissions · Total hip arthroplasty · Hemiarthroplasty

## Introduction

The outbreak of coronavirus disease 2019 (COVID-19) produced an unprecedented impact on every country's health care system [1]. This has inevitably disrupted usual treatment pathways and protocols at both elective and emergency services, including the route of hip fracture care delivery [2]. Like many other clinical diseases, osteoporotic hip fractures have maintained their incidence during the pandemic [3], making governmental contingency plans play a key role in the re-allocation of limited health care resources in order to face the pandemic demands while keeping with the standards of regular health provision [4]. Hip fracture patients represent a very vulnerable population since older age has been associated with a higher morbi-mortality rate when concomitant COVID-19 is diagnosed [5].

The Spanish HIP-COVID Observational Study has recently reported a high (10%) in-hospital mortality rate even for fractured patients who tested negative for COVID-19 [6]. Kayani et al. reported a similar mortality rate for COVID-negative hip fractures [7]. This rate has been previously reported to be as high as 3–5% during non-COVID times [8, 9]. This raises the controversial issue of whether SARS-CoV-2 detection is sensitive enough or not in hip fracture patients [10]. Wang et al. reported that real-time reverse transcriptase-polymerase chain reaction (rRT-PCR) test may have a considerably high (32–72%) false-negative rate [11].

Similarly, some have reported on the influence of prolonged mandatory quarantine on hip fracture epidemiology and mortality rate, independently of testing positive or not for SARS-CoV-2 [12, 13]. Prolonged lockdowns have restricted physical activity as well as health care access and surveillance of chronic medical conditions [14]. In Argentina, a nationwide lockdown was implemented at a very early stage (i.e. 1 week after the confirmation of the first positive case), yielding one of the longest mandatory quarantines worldwide (> 120 days).

To our knowledge, the effect of prolonged mandatory lockdown on hip fracture care during COVID time has not been analysed in-depth. The aim of this study was to analyse the impact of social lockdown during COVID-19 pandemic on the epidemiology of hip fracture patients operated at a tertiary care centre in Argentina, by comparing those operated on immediately before COVID-19 pandemic with those treated after 30 days of social lockdown.

## Materials and methods

We retrospectively analysed a consecutive series of 183 hip fracture patients operated upon at our institution between December 2019 and May 2020. We excluded ten patients for not having a minimum follow-up of 30 days since fracture diagnosis. Intertrochanteric fractures were classified using the Orthopaedic Trauma Association (OTA) classification system [15], while neck of femur fractures were classified with a modified Garden classification (displaced vs. undisplaced) [16]. Based on the date of declaration of the national state of alarm (March 19, 2020) in which a mandatory lockdown was established, we separated our cohort into two groups: 'pre-COVID time' (PCT), including 86 patients, and 'COVID time' (CT), consisting of 95 patients. To ensure CT cases included in this analysis could have had a clinically significant epidemiological impact of quarantine, we additionally excluded 21 CT fractures operated within the first 30 days following lockdown, leaving 74 cases in the CT group.

A new institutional clinical pathway was created for hip fractures since social lockdown was introduced. This included a specific wing of the emergency service destined for hip fractures separated into two sections in case incoming fractures had COVID-19 symptoms or history of positive contact. Nevertheless, all fractures were tested using rRT-PCR test upon admission. In this cohort, all cases tested negative for SARS-CoV-2. Patients were not transferred to their corresponding bed/floor until the test was ready. Median time to rRT-PCR results was six hours (interquartile range [IQR], 3–19). No surgeries were performed with a pending rRT-PCR result. Patients were re-tested in cases of readmission or in-hospital contact with a positive subject. However, in this cohort, we did not register any contact with COVID-19-positive patients admitted for other reasons. All fractures received a prophylactic dose of 40 mg subcutaneous enoxaparin until 24 hours before surgery.

The type of surgery and implant used were extracted from each patient's digital operative protocol. Criteria for implant indication remain the same after lockdown. Intertrochanteric fractures were treated with an intramedullary nail (IMN) regardless of the patient's prior level of activity or fracture pattern. Undisplaced neck of femur fractures were treated with cannulated screws, whereas displaced ones were treated with either hemiarthroplasty or total hip arthroplasty (THA), depending on each patient's prior level of activity and independence. Using the Lawton Instrumental Activities of Daily

Living (IADL) scale [17], surgeons selected THA if patients were able to do at least five of the following activities independently: ability to use the telephone, laundry, bathing/toileting, transportation, shopping, food preparation, house-keeping, responsibility for own medication and ability to handle finances. The two only surgical practices that changed during COVID time were replacing surgical helmets for surgical face masks and performing a different skin closure, done with intradermal 2–0 Vicryl rapid absorbable suture (Ethicon, Johnson & Johnson) plus Dermabond (Ethicon, Johnson & Johnson) in all CT patients.

All surgeries were done by fellowship-trained orthopaedic surgeons. Hypotensive spinal anaesthesia was used in all cases. Post-operative rehabilitation protocol remained the same during lockdown, with hemiarthroplasty, THA, and IMN patients weight-bearing as tolerated from post-operative day 1; and cannulated screw patients doing toe-touch weight-bearing for 45 days. All patients received post-operative thromboprophylaxis with one dose of subcutaneous enoxaparin daily during one month, starting on post-operative day one.

Demographic data including the modified Charlson Comorbidity Index ([CCI], categorized into three grades: mild, with CCI scores of 1–2; moderate, with CCI scores of 3–4; and severe, with CCI scores  $\geq 5$ ) [18], Rockwood Frailty Index (considering frail patients as those scoring  $\geq 5$ ) [19], American Society of Anaesthesia ([ASA], categorized into two groups: I–II/III–IV) [20], Lawton IADL (with active patients scoring at least 5 points) scale [17, 21] and University of California, Los Angeles (UCLA) activity scale [22] were extracted from the digital medical charts. In-hospital stay and time to surgery were also computed. All data were retrieved from our prospectively collected electronic database. This study was Research Ethics Board-approved (IRB00010193) and did not require informed consent. The STROBE guidelines for case-control studies were followed.

Outcome measures included 30-day post-operative surgical and medical complications, 30-day readmissions and 30-day mortality.

## Statistical analysis

Continuous variables were described as median and IQR, and categorical variables as percentage and absolute frequency. Continuous and categorical data were analysed utilizing analysis of variance and chi-square analysis. The Mann–Whitney *U* test was used to compare non-parametric continuous variables. Statistical significance was set at  $p < 0.05$ . A logistic regression model was run to evaluate independent factors associated with mortality. Statistical analysis was performed utilizing SPSS v25.0 (IBM Corp).

## Results

### Comparison of demographic characteristics

Age (86 [IQR, 78–90] vs. 86 [IQR, 80–91];  $p = 0.83$ ), female/male ratio (1.22 vs. 1.12;  $p = 0.10$ ), body mass index ([BMI], 24 [IQR, 21.7–26.6] vs. 24.5 [IQR, 22.3–27.3;  $p = 0.11$ ]) and ASA score (ASA III–IV: 74.4% vs. 84%;  $p = 0.149$ ) were similar between PCT and CT patients (Table 1).

A significant difference between both groups was detected when comparing the pre-operative CCI (moderate: 36% vs. 17.6%; severe: 60.5% vs. 79.7%;  $p = 0.030$ ), UCLA activity scale (2 [IQR, 2–3] vs. 3 [IQR, 2–4];  $p = 0.037$ ), IADL score (3 [IQR, 2–4] vs. 5 [IQR, 3–6];  $p = 0.001$ ) and frailty index (37.2% vs 56.8%;  $p = 0.013$ ), with the CT patients being more comorbid, less active and frailer.

### Comparison of surgical outcomes and post-operative complications

The median time to surgery was 16.5 [IQR, 9–30] vs. 24 [IQR, 24–48] hours for the PCT and CT patients, respectively ( $p = 0.0001$ ). There was a strong association between time to surgery and timeframe ( $p = 0.00001$ ) (Fig. 1). The type of surgery and selected implant are shown in Table 2. There was a statistically significant difference in the implants selected for displaced neck of femur fractures, with a higher hemiarthroplasty/THA ratio during CT and a lower indication of cannulated screws for non-displaced femoral neck fractures ( $p = 0.04$ ) (Fig. 2). PCT fractures had a significantly lower length of stay when compared with CT fractures (5 [IQR, 4–7] vs. 6 [IQR, 5–8] days;  $p = 0.00001$ ).

Postoperative complications were similar between both groups ( $p > 0.05$ ), as shown in Table 3.

The advent of thromboembolic disease was higher in CT fractures (0% vs. 6.75%;  $p = 0.02$ ). All thromboembolic events were confirmed with a combination of Doppler ultrasound and computed tomography angiography. There was a significant association between length of stay and the advent of TED ( $p = 0.002$ ) (Fig. 3).

## Readmissions

Readmissions ( $n = 15$ ), which all tested negative for SARS-CoV-2, were similar between both groups (8.1% vs. 10.8%;  $p = 0.34$ ) (Table 3). Of all 15 readmissions, only one died due to low gastrointestinal bleeding during COVID-19 time. The most common causes for readmission during pre-lockdown time were periprosthetic joint infection (2/7, 28.6%) and lower respiratory tract infection (LRTI [2/7, 28.6%]); whereas after lockdown, the most common ones were fever of unknown origin (2/8, 25%) and LTRI (2/8, 25%).

**Table 1** Demographic data of the series divided by group

Variable	Total cohort ( <i>N</i> = 160)	Pre-COVID time fractures ( <i>N</i> = 86)	COVID time fractures ( <i>N</i> = 74)	<i>p</i> value
Median age (IQR)	86 (79–91)	86 (78–90)	86 (80–91)	0.83
Female patients (%)	132 (82.5%)	67 (78%)	65 (88%)	0.1
Median BMI (IQR)	24.5 (22–27)	24 (21.7–26.6)	24.5 (22.3–27.3)	0.11
Median time (hours) to rRT-PCR (IQR)	–	–	6 (3–19)	–
ASA score (%)				
I–II	34 (21.3%)	22 (25.6%)	12 (16.2%)	
III–IV	126 (78.7%)	64 (74.4%)	62 (84%)	0.15
CCI (%)				
Mild	4 (2.5%)	3 (3.5%)	1 (1.3%)	
Moderate	44 (27.5%)	31 (36%)	13 (17.6%)	
Severe	111 (69.4%)	52 (60.5%)	59 (79.7%)	0.03
Median UCLA scale (IQR)	3 (2–4)	3 (2–4)	2 (2–3)	0.037
Median IADL score (IQR)	4 (2–6)	5 (3–6)	3 (1.75–4)	0.001
Rockwood Frailty Score $\geq$ 5 (%)	74 (46.3%)	32 (37.2%)	42 (56.8%)	0.013

*BMI*, body mass index; *rRT-PCR*, reverse transcriptase-polymerase chain reaction; *IQR*, interquartile range; *ASA*, American Society of Anesthesia; *CCI*, Charlson Comorbidity Index; *UCLA*, University of California Los Angeles Activity scale; *IADL*, Instrumented Activities of Daily Living

## Mortality outcomes

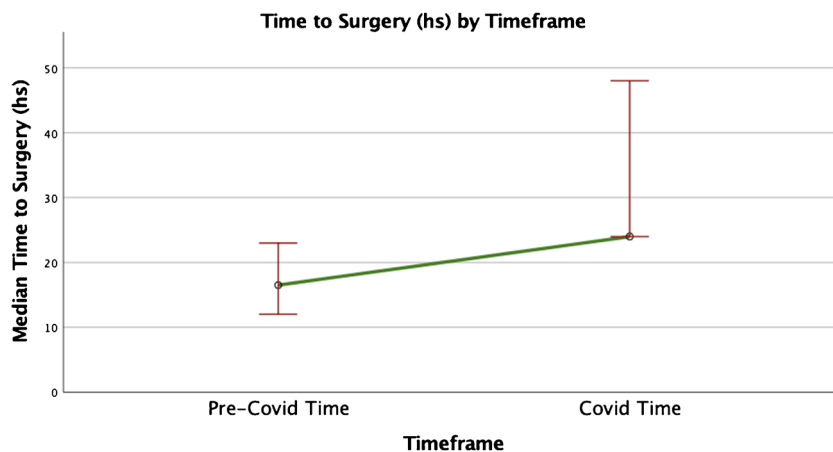
Eight (10.8%) casualties were detected in the CT group, whereas no deaths during in-hospital stay were seen in the control group ( $p = 0.002$ ) (Table 3). Five of them happened during in-hospital stay whereas three occurred after discharge. No additional 30-day casualties were detected after discharge. The most common cause of death was respiratory failure secondary to TED (4/8; 50%), followed by acute coronary syndrome (2/8; 25%), haemorrhagic stroke (1/8; 12.5%) and low gastrointestinal bleeding (1/8; 12.5%). The logistic regression model showed that frailer (lower Frailty Index values:  $p = 0.006$ , odds risk [OR] 10.46, 95% confidence interval [CI]

8.95–56.1), less active (lower UCLA scale values:  $p = 0.018$ , OR 2.45, 95%CI 1.45–2.72) and those with a thromboembolic event ( $p = 0.005$ , OR 30, 95%CI 11–42) had a higher risk of mortality (Table 4).

## Discussion

The results of this study show that COVID-19 pandemic has definitely impacted on the epidemiology of hip fractures after lockdown. Despite testing negative for SARS-CoV-2, CT fractures were more comorbid, less active and frailer than PCT patients, depicting an epidemiological shift. Such

**Fig. 1** Graph showing median time to surgery for hip fracture resolution during pre-COVID and COVID timeframes with their corresponding 95% CIs



**Table 2** Surgical variables divided by group

Variable	Total cohort (N = 160)	Pre-COVID time fractures (N = 86)	COVID time fractures (N = 74)	p value
Median time (hours) to surgery (IQR)	24 (12.25–36)	16.5 (9–30)	24 (24–48)	0.0001
Median surgical time (minutes) (IQR)	45 (32.7–60)	45 (40–60)	40 (30–60)	0.17
Type of fracture (%)				
31A1	25 (16%)	19 (22.1%)	6 (8.1%)	
31A2	48 (30%)	22 (25.6%)	26 (35.1%)	
31A3	5 (3.1%)	0	5 (3.1%)	
32A1	2 (1.25%)	0	2 (1.25%)	
32A2	2 (1.25%)	0	2 (1.25%)	
Displaced neck of femur	66 (41.3%)	35 (40.7%)	31 (41.9%)	
Undisplaced neck of femur	12 (7.5%)	10 (11.7%)	2 (2.7%)	0.004
Type of implant (%)				
Cannulated screws	13 (8.1%)	11 (12.8%)	2 (2.75%)	
Hemiarthroplasty	34 (21.3%)	14 (16.3%)	20 (27%)	
THA	29 (18.1%)	19 (22.1%)	10 (13.5%)	
Girdlestone	1 (0.6%)	1 (1.1%)	0	
IM nail	82 (51.2%)	41 (47.7%)	41 (55.4%)	
Not operated	1 (0.6%)	0	1 (1.35%)	0.04
Median length (days) of stay (IQR)	5 (4–7)	5 (4–7)	6 (5–8)	0.001

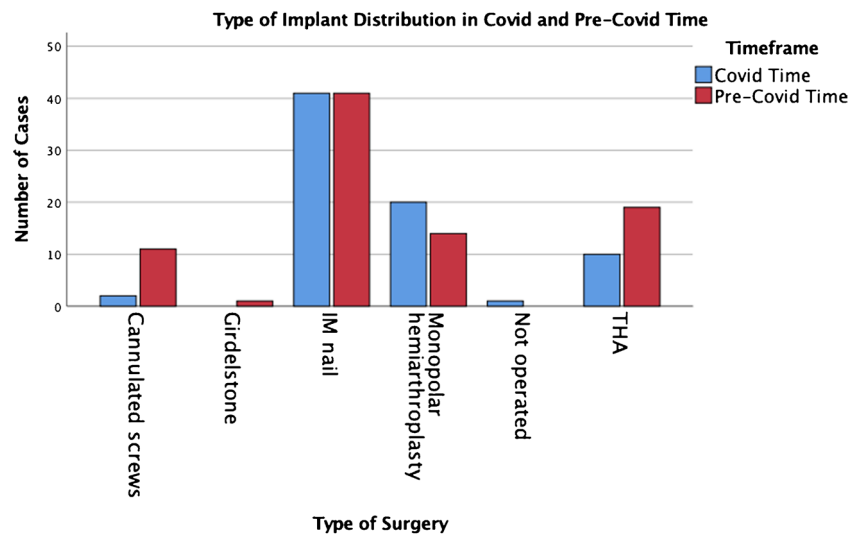
IQR, interquartile range; THA, total hip arthroplasty; IM, intramedullary

epidemiological changes have also been reported in other surgical specialties during the pandemic [23, 24]. The degree of frailty and the number and severity of associated comorbidities have already been described as a useful tool to predict outcomes in elderly patients with COVID-19 [25]. In Argentina, an early and lengthy mandatory quarantine was imposed, leaving the elderly in isolation for a considerable period of time. This was associated with a higher in-hospital

mortality rate seen in CT fractures, despite age and ASA scores being similar to pre-CT fractures.

Although this issue is likely multifactorial, we believe that social lockdown had a significant influence, regardless of new clinical pathways specifically designed for hip fracture care during the pandemic. Hall et al. recently reported that apart from the length of stay, no significant differences in pre- and post-lockdown hip fracture patients were detected, including

**Fig. 2** Graph depicting the type of implant distribution during pre-COVID and COVID timeframes



**Table 3** Complications, readmissions and mortality outcomes divided by group

Variable	Total cohort ( <i>N</i> = 160)	Pre-COVID time fractures ( <i>N</i> = 86)	COVID time fractures ( <i>N</i> = 74)	<i>p</i> value
Intraoperative periprosthetic fracture	3 (1.88%)	1 (1.16%)	2 (2.7%)	0.43
Dislocation (%)	1 (0.63%)	0	1 (1.35%)	0.34
Surgical site infection (%)	2 (1.25%)	2 (2.32%)	0	0.45
Thromboembolic disease (%)	5 (3.13%)	0	5 (6.75%)	0.014
Readmission (%)	15 (9.38%)	7 (8.1%)	8 (10.8%)	0.56
FUO		1	2	
Cholecystitis		0	1	
Ischemic stroke		0	1	
LGB		0	1	
PDD		2	2	
LRTI		2	0	
PJI		1	0	
CHF				
Mortality (%)	8 (5%)	0	8 (10.8%)	0.002

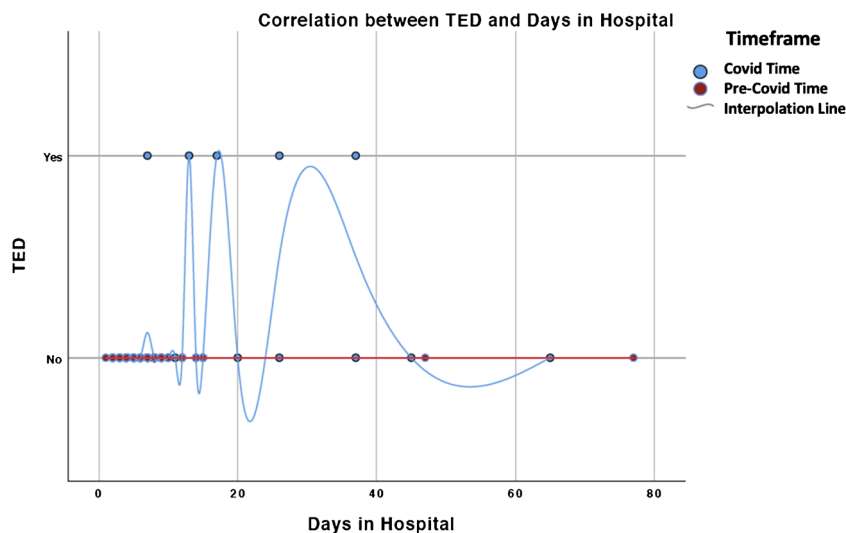
*FUO*, fever of unknown origin; *LGB*, low gastrointestinal bleeding; *PDD*, psychiatric disorder decompensation; *LRTI*, lower respiratory tract infection; *PJI*, periprosthetic joint infection; *CHF*, congestive heart failure

demographic characteristics, Nottingham Hip Fracture Score, time to surgery, ASA score or fracture management [12]. Therefore, and to our knowledge, our study is the first to report a true epidemiological impact of COVID-19 mandatory lockdown on hip fracture care.

The epidemiological dissimilarities detected between both groups in terms of Frailty Index as well as in IADL, UCLA and CCI scores translated into a significant difference in the type of surgery and implant selected, mostly for intracapsular fractures. After lockdown, we noticed a decreased number of undisplaced femoral neck fractures (treated with cannulated screws), while there was an increase in the relative percentage

of hemiarthroplasties over THAs for displaced fractures. In this sense, a change in practice due to the pandemic has not only involved the use of special personal protective equipment, use of absorbable skin sutures (in order to minimize unnecessary follow-up) and systematic PCR testing of all surgical patients [26, 27] but has also affected implant selection, though the criteria for indication remained the same. Stinner et al. have emphasized on how to mitigate in-person clinic visits adjusting surgical variables (e.g. absorbable sutures) during CT [28]; furthermore, our study adds relevant information on how the pandemic has (indirectly) influenced implant selection.

**Fig. 3** Graph portraying correlation between in-hospital stay and the advent of thromboembolic disease (TED) per timeframe



**Table 4** Risk factors for mortality

Variable	Odds risk	95% Confidence interval	<i>p</i> value
ASA	2.88	0.18–4.33	0.453
Charlson score	0.61	0.22–1.68	0.338
Frailty index	10.46	8.95–16.1	0.006
Time to surgery	1.03	0.99–1.08	0.093
Thromboembolic disease	30	11–42	0.005
UCLA scale	2.45	1.45–2.72	0.018
IADL score	0.35	0.12–1.07	0.066

Equally, CT fractures waited longer for surgical resolution than PCT ones. This suggests that our institution's contingency measures (i.e. new clinical pathway with PCR testing) had a disadvantageous effect on the ability to provide timely hip fracture care. Although accelerated surgery (< 6 h) has not proved to help decrease morbi-mortality rate, hip fractures should not wait for more than 24–48 hours to undergo surgery [29]. Whether the delay is higher than 48 hours, the risk of three day and one year mortality is significantly increased [30]. Longer term, large-cohort studies will be necessary in the near future to understand the true impact of surgical delay on readmissions and mortality in both COVID-19 positive and negative hip fracture patients.

Though the readmission rate remained unchanged, we detected a higher rate of thromboembolic events and in-hospital mortality in hip fracture patients operated upon during the pandemic. In fact, neither TED events nor casualties were computed in the pre-lockdown timeframe. Kayani et al. recently reported that COVID-19-positive hip fracture patients had a 13.4% rate of TED at 30-day follow-up [7]. However, Vannini et al. also reported on a higher rate of acute embolic events in COVID-19-negative patients, associating it to prolonged immobility due to rigid quarantine dispositions [31]. Extended confinement times leading to both reduced physical activity [14] and family care may exacerbate sedentary behaviours and indirectly contribute to thromboembolic events in an already vulnerable population [32]. Like others, our institution has created a new clinical pathway for pre-operative screening of COVID-19 fractures [33]. However, a more concise approach to these more inactive patients might consider the use of routine pre-operative Doppler ultrasound as a screening method.

This study presented several limitations. First, a low number of cases included in each group correlated with the incapacity of making more accurate statistical analyses. However, our number of cases is similar to that of recent multicentre studies reporting on mortality rates amid COVID-19-related hip fractures [6, 10]. Additionally, we decided to compare the CT cohort with an immediately consecutive series of PCT patients that had similar age and ASA score. Although there may be an implicit seasonal variation, we decided not to compare the CT cohort with controls operated during the same season in 2019 since our institution is Joint Commission International-

approved and slight pathway modifications done yearly to improve quality would have affected the standard of hip fracture care delivery. Second, all patients in the CT cohort tested negative for SARS-CoV-2 and given the limited sensitivity of rRT-PCR [11], all of our negative test results should be considered the best-case estimates. Additionally, we did not analyse pre-operative and post-operative laboratory results in this series. Hall et al. suggest that platelet count at admission was useful to predict subsequent COVID-19 status [12]. In this sense, we were able to correlate our findings only with the prolonged mandatory lockdown established in our country and not with the virus per se. However, whether there is a causative effect still needs to be proven. Finally, our mortality rate should also be considered a best case estimate since deaths were analysed only up to 30 days post-operatively. Moreover, patients that died due to respiratory failure secondary to TED were not re-tested for SARS-CoV-2 if TED was diagnosed during index admission. Patients were only re-tested in cases of readmission or in-hospital contact with a positive subject.

In summary, this was an in-depth analysis of the impact of extended mandatory lockdown on the epidemiology of hip fractures amid COVID-19 pandemic, finding that during this stage, patients were less active and frailer and that this issue was not only associated with a higher mortality rate but also influenced implant selection.

**Author contributions** PA Slullitel: co-designed the study, conducted data analysis and wrote the manuscript.

C Lucero: conducted data analysis and wrote the manuscript.

L Soruco: assisted with data analysis and edited the manuscript.

J Barla: co-designed the study and edited the manuscript.

JA Benchimol: co-designed the study and edited the manuscript.

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D Taype: data entry, assisted with data analysis and edited the manuscript.

G Carabelli: data entry, assisted with data analysis and edited the manuscript.

F Piccaluga: data entry and assisted with data analysis.

C Sancineto: data entry and assisted with data analysis.

M Diehl: data entry, assisted with data analysis and edited the manuscript.

MA Buttaro: co-designed the study, led data analysis and edited the manuscript.

## Compliance with ethical standards

This study was Research Ethics Board-approved (IRB00010193) and did not require informed consent. The STROBE guidelines for case-control studies were followed.

**Conflict of interest** The authors declare that they have no conflict of interest.

**Ethical review statement** IRB approved, IRB00010193.


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## Affiliations

Pablo A. Slullitel<sup>1</sup>  · Carlos M. Lucero<sup>1</sup> · Maria L. Soruco<sup>2</sup> · Jorge D. Barla<sup>2</sup> · Javier A. Benchimol<sup>3</sup> · Bruno R. Boietti<sup>3,4</sup> · Gerardo Zanotti<sup>1</sup> · Fernando Comba<sup>1</sup> · Danilo R. Taype-Zamboni<sup>2</sup> · Guido S. Carabelli<sup>2</sup> · Francisco Piccaluga<sup>1</sup> · Carlos F. Sancineto<sup>2</sup> · Maria Diehl<sup>5</sup> · Martin A. Buttaro<sup>1</sup> · for the HipFEIR [Hip Fracture in the Elderly – Institutional Register] Study Group

<sup>1</sup> ‘Sir John Charnley’ Hip Surgery Unit, Institute of Orthopaedics ‘Carlos E. Ottolenghi’, Italian Hospital of Buenos Aires, 4190 Peron St., C1199ABH Buenos Aires, Argentina

<sup>2</sup> Trauma Unit, Institute of Orthopaedics ‘Carlos E. Ottolenghi’, Italian Hospital of Buenos Aires, 4190 Peron St., C1199ABH Buenos Aires, Argentina

<sup>3</sup> Department of Geriatric Medicine, Italian Hospital of Buenos Aires, 4190 Peron St., C1199ABH Buenos Aires, Argentina

<sup>4</sup> Department of Health Informatics, Italian Hospital of Buenos Aires, 4190 Peron St., C1199ABH Buenos Aires, Argentina

<sup>5</sup> Department of Endocrinology, Italian Hospital of Buenos Aires, 4190 Peron St., C1199ABH Buenos Aires, Argentina