Hip Fracture Surgery In Elderly Patients At A Designated COVID-19 Hospital In Hong Kong - A Retrospective Cohort Comparison

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Abstract

Hypothesis: There is a signi□cant increase in the perioperative risk of patients with concomitant COVID-19 infection undergoing hip fracture surgery compared to the control group.

Methods: This retrospective observational independent cohort study included all patients admitted to Queen Elizabeth Hospital (QEH) into the Department of Orthopaedics and Traumatology under the Geriatric Hip Fracture pathway and concomitant COVID-19 infection who underwent surgery during the □fth wave of the COVID-19 pandemic. The primary outcome investigated was 30-day postoperative mortality. The secondary outcomes included the incidence of pneumonia and chest infection during hospitalisation, acute coronary syndrome/myocardial infarction, cerebrovascular infarctions, date of admission until surgery (wait time), acute hospital total length of stay, convalescent length of stay, and total hospital length of stay.

Results: One hundred and twenty-six patients were identi□ed and included in this study. The majority of the cohort was female (68.3%), with a mean age of 85.4 years. The most prevalent diagnosis was acute closed traumatic (50 cases of trans-cervical, 49 intertrochanteric) fracture of hip and the most common operative procedure was a closed reduction and □xation (56 gamma nail cephalomedullary device; second most common being bipolar hemiarthroplasty (50 cases)). The majority of patients received subarachnoid anaesthesia. The most common ASA grading was class 3. There are an equal number of 30-day postoperative mortality cases in both COVID-19 negative and positive groups.

Conclusion: There was no signi□cant increase in the perioperative mortality risk of patients with concomitant COVID-19 undergoing hip fracture surgery compared to the control group. Our □ndings indicate no signi□cantly increased risk of 30-day postoperative mortality among patients with active COVID-19 infection; however, the risk of postoperative pneumonia increased in patients with an active COVID-19 infection. The acute hospital length of stay was also longer in patients with COVID-19.

INTRODUCTION

The global COVID-19 pandemic has severely impacted the healthcare industry since its emergence in late 2019 and the repercussions are resounding to this day (1). Early evidence suggests COVID-19 presents a signi□cantly higher risk for patients undergoing surgery, increasing the risk of complications and mortality (2). The □gures also indicate that elderly patients are at a higher risk of death and severe complications when undergoing surgery with associated COVID-19 infection (3).

Increasing age increases the risk of a fragility hip fracture in patients requiring surgery (4). Coupled with the rapidly ageing population, this has resulted in a substantial and increasing burden on the healthcare system (5). This is particularly relevant in patients who present with a concomitant COVID-19 infection alongside a fragility hip fracture (2, 3, 6). One of the earliest studies in 2020 comparing COVID-19 Positive, COVID-19 Suspected, and COVID-19 Negative cohorts in hip fracture surgery, showed an increased mortality rate (35.3% vs. 7.1% vs. 0.9%). There was also an increased length of hospital stay, a greater major complication rate, and a greater incidence of ventilator requirement postoperatively. It was concluded that

COVID-19 had a devastating effect on the care of patients with hip fractures during the pandemic (3, 7). Perhaps as an inadvertent consequence of shelter-in-place policies, a national study across America observed decreased numbers of hip fractures (16068 in 2019 vs 7498 in 2020). Moreover, amongst patients with hip fractures and concomitant COVID-19 diagnosis, it was noted that an increased number were administered non-surgical treatments, their hospitalisation and length-of-stay almost doubled, and a more than 10-fold increased mortality rate and higher complication rates compared with COVID-19-negative patients were reported (8).

In a meta-analysis of 11 studies from 2020, the overall pooled mortality rate in the early postoperative period for hip fracture patients with concomitant COVID-19 infection was 32.6%, more than 5 times higher risk of early mortality compared to hip fracture patients without COVID-19 infection. The relative risk for postoperative mortality in COVID-positive patients compared to non-COVID patients was 5.66 (95% CI 4.01-7.98; $p < 0.001$). The currently available literature demonstrates that COVID-19 infection represents a substantial risk factor for early postoperative mortality in the already susceptible hip fracture population (9). Meta-analysis done in 2021 looking at risk factors associated with mortality in hip fracture patients during COVID-19 found the case fatality rate for COVID-19-positive patients was 34.74%; this agrees with other studies done on the topic. Other risk factors identified subgroup heterogeneity for male gender ($p < 0.001$), diabetes ($p = 0.002$), dementia ($p = 0.001$), and extracapsular fractures ($p = 0.01$) increased risk of mortality in COVID-19-positive patients (10).

The fifth COVID-19 wave in Hong Kong, from January 2022 to June 2022, resulted in a large number of infected patients and increased mortality. As part of the city's approach to contain the pandemic, a large tertiary hospital in Kowloon - Queen Elizabeth Hospital, was designated as a COVID-19 hospital (11), converting 2000 beds to exclusively treat patients with COVID-19.

While there have been studies examining the impacts of COVID-19 on elderly patients undergoing hip fracture surgery (12), no local studies have been carried out in Hong Kong. Therefore, our study aims to quantify the increased perioperative risk of patients with concomitant COVID-19 infection undergoing hip fracture surgery in Hong Kong, as well as to identify the risk factors associated with mortality in hip fracture patients during the COVID-19 pandemic. These findings will facilitate identifying areas for pre-operative optimization of these patients and lower their mortality risk.

We hypothesise that there is a significant increase in the perioperative risk of patients with concomitant COVID-19 undergoing hip fracture surgery compared to the control group.

METHODOLOGY

Study Design

This retrospective observational independent cohort study was designed using the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines. Data was collected by reviewing the medical records of elderly patients (>60 years old) who underwent hip fracture surgery at a single tertiary hospital in Kowloon, Hong Kong, between January 2022 to June 2022. The extracted data was de-identified and tabulated on an encrypted spreadsheet accessible only by the research team.

Inclusion and Exclusion Criteria

All patients admitted to Queen Elizabeth Hospital (QEH) into the Department of Orthopaedics and Traumatology under the Geriatric Hip Fracture pathway and concomitant COVID-19 infection who underwent surgery during the peak of the fifth wave of the COVID-19 pandemic (01 February 2022 - 30 April 2022) were included in the study group. COVID-19 infection was defined as positive if either a Rapid Antigen Test (RAT) was returned positive, or Polymerase Chain Reaction (PCR) nasal swab had a CT value <35. This is in line with HKSAR Government guidance that PCR results with CT values >35 would not be classified as COVID-19 positive as these patients would not be issued isolation orders.

For the control group, patients under the same geriatric hip fracture pathway in the study period without COVID-19 infection who underwent surgery were included.

Patients were excluded if they were under 60 years old, were not under the geriatric hip fracture pathway, or did not undergo surgery. Hip fracture was identified using International Classification of Disease (ICD) 10th edition/Systematized Nomenclature of Medicine (SNOMED).

Surgery had to occur 7 days before or up to 30 days after diagnosis of COVID-19, consistent with the definition in the COVID-19 Surg Collaborative study. For patients with multiple surgeries, the first surgery was considered the index operation.

Sample Size

For an independent cohort study of equal size, based on existing data (7) and an approximated formula, the expected incidence in the unexposed population is 10% and 30% in the exposed population. A 95% confidence and desired power of 0.8 was utilized to compute the necessitated sample size. These data points, alongside a ratio of unexposed to exposed as 1, a study sample size of approximately 100 patients is required, with 50 patients in each group. The rationale for this sample size is based on both the Fleiss and Kelsey formulae.

Outcome measures

Primary outcome:

- 30-day postoperative mortality

Secondary Outcomes:

- Myocardial infarction or ACS
- Cerebrovascular accident or stroke
- Pneumonia or chest infection during hospitalisation
- Sepsis or septic shock in the perioperative period
- DVT or Pulmonary Embolism
- Need for postoperative ventilation
- Time of admission to surgery
- Postoperative length of stay
- Acute hospital length of stay
- Convalescent hospital length of stay (if any)
- Total hospitalisation duration
- Post-hospitalisation discharge destination (Home, residential facility, hospital readmission, death)
- Any readmission within 28 days to any HA acute hospital

The primary outcome investigated was 30-day postoperative mortality.

The secondary outcomes included the incidence of perioperative post-surgery complications i.e. pneumonia and chest infection, myocardial infarction & ACS, cerebrovascular accidents, sepsis, or need for postoperative mechanical ventilation. Other duration of stay outcomes measured include: date of admission until surgery (wait time), acute hospital total length of stay, convalescent length of stay, and total hospital length of stay. Finally, we also assessed rates of readmission to a Hospital Authority acute hospital within 28 days of discharge, and the post-discharge destination.

Data Collection and Analysis

Demographic and clinical data of patients was extracted from electronic medical records in the Clinical Management System of the Hospital Authority, Hong Kong, using a standardised data-collection form. All patients that were eligible during the study period from 01 February 2022 - 30 April 2022 with a Principal Procedure code

81.52 (Partial hip replacement) or 79.15 (Closed reduction of fracture with internal fixation, femur) were included. Patient comorbidities were assessed based on the existing diagnoses through examination of individual patient records and ICD (International Classification of Diseases) codes.

All data was handled by the primary author and stored on an encrypted drive, in accordance with data privacy guidelines, as set out by the Hospital Authority in Hong Kong. All data analysis was performed using STATA (Stata version 18 (Statacorp, LLC, College Station, TX, USA).

We presented continuous data as means with standard deviation. Patient characteristics were assessed overall and compared by COVID-19 status.

Comparison between the two groups of patients was performed using chi-squared (or a Fisher exact test if necessary), Student's t-test, and Mann-Whitney U test for categorical, parametric, and non-parametric data. A p-value of ≤ 0.05 is considered as significant.

Only factors that demonstrated significance, defined as $p \leq 0.05$, in the controlled weighted regression models and sensitivity analyses were considered independent predictors of mortality and complications.

Ethical Considerations

Ethical approval was sought and obtained from the Hospital Authority Central Institutional Review Board.

It is assured there was no impact on patient safety, welfare, or rights. The proposed study was purely retrospective and the study period was short with tight data security. Patients were treated according to the usual standard of care, with all medical decisions made on a purely clinical basis at the time of treatment.

To protect participants' privacy, all research data was handled in line with HA/Hospital's policy in handling,

storage, and destruction of patients' medical records. They were locked in cabinets where the department or ward currently keeps patients' con□dential information. Electronic data was saved on a secured computer of the hospital, with restricted access. The protocol complies with ICH-GCP. All research and personal data will be kept for 3 years upon study completion and can be made available on reasonable request.

Approval was granted by the Research Ethics Committee (Kowloon Central / Kowloon East) on 23 January 2024 (Ref: KC/KE-23-0193/ER-4).

RESULTS

Patient Demographics

Using the Hospital Authority Clinical Data Analysis & Reporting System (CDARS), one hundred and thirty-three (133) cases were identi□ed as ful□lling the eligibility criteria. After removing duplicate entries, one hundred and twenty-six (126) patients were included in this study.

A summary of their demographics, including gender, age, comorbidities, and infection status (at time of surgery) is described in Table 1. The majority of the cohort was female (68.3%) ($p<0.001$), with a mean age of 85.4 years ($p=0.756$).

The majority (78.6%) lived in their own homes whilst 21.4% were living in a residential elderly home at the time of admission ($p=0.480$)

Twelve cases were initially COVID-19 negative at the time of surgery, but were diagnosed with COVID-19 post-operatively between days 8 - 30. They were removed from the two comparison cohorts.

At the time of operation, □fty-two (45.6%) patients had an active COVID-19 infection, compared to 62 (54.4%) being COVID-19 negative. Vaccination rates were similar (48.4% vs 44.2%) between the two groups ($p=0.658$). However, our analysis only looked at whether patients had any history of COVID-19 vaccination (one or more vaccines taken) by the time of their surgery, but not whether they were fully vaccinated or had booster-shots according to the HKSAR government COVID-19 vaccination schedule. Nor did we analyse which vaccine the patient had received - both CoronaVac [Sinovac, Beijing, China]) and Comirnaty (BNT162b2 [Fosun Pharma-BioNTech]) were both available in Hong Kong at that time, which was outside the scope of the study.

The most prevalent comorbidity in this population was hypertension, with 76.3% of patients reporting a history of this condition. Interestingly, whether the patient had liver disease was a statistically signi□cant pre-morbid factor, with a $p=0.028$.

Surgical characteristics

Table 2 charts the operative diagnosis and operative procedure the patients received, as well as the laterality of injury.

All diagnoses were by de□nition acute closed traumatic fracture of the hip. The most common site of the fracture was either trans-cervical or trochanteric. Less commonly the fracture occurred at the femoral head or more distally as sub-trochanteric ($p=0.956$). This is in keeping with the most common types of geriatric hip fracture in elderly patients.

There was no signi□cant difference in fracture site between the two groups. There was noted to be a difference in the side of injury in the COVID-19 negative group (Left 64.5% vs Right 35.5%) however this was not statistically signi□cant ($p=0.247$).

The main operative procedure performed was Closed reduction and □xation with Gamma nail to proximal femur (49.1%) followed by Bipolar hip arthroplasty (43.9%). Screw □xation to proximal femur accounted for the □nal 7.0% ($p=0.472$).

Anaesthesia characteristics

Table 3 charts the ASA performance status of patients as assessed by the list anaesthetist, as well as the mode of anaesthesia patients received. We also charted whether a patient received an additional Peripheral Nerve Block for analgesia in addition to General anaesthesia or subarachnoid anaesthesia. Anaesthetic and surgical times were calculated (in minutes), as well as rates of blood loss (ml) and requirement for intraoperative blood transfusion, vasopressor use, and whether additional oxygen supplement was needed in cases not under General anaesthesia.

The most common grading was ASA class 3 in both groups, followed by ASA class

There was 1 case of ASA class 4 in each group. As expected

for geriatric hip fracture patients there was no one in ASA class 1, nor were there any patients in ASA class 5. (p=0.920)

Subarachnoid anaesthesia was most commonly used during surgery, accounting for 102 procedures (89.5%) (p=0.772). An additional peripheral nerve block (PNB) was administered in 16 cases (14.0%) across both groups (p=1.00). The nerve blocks performed were either Fascia Iliaca (FI) or Femoral Nerve (FN) blocks. No operations were done under nerve block alone.

In surgery done under subarachnoid anaesthesia (with or without PNB), 39 cases (62.9%) needed supplemental O2 in the control group compared to COVID-19 positive group (p=0.939).

In 44 cases (71.7%) in the control group, additional vasopressor drugs were used intraoperatively to support blood pressure targets of Mean arterial pressure (MAP) > 65mmHg. The choice of vasopressor was either Phenylephrine or Ephedrine. This compares to 33 cases (63.5%) in the COVID-19 positive group. (p=0.983). No cases required more invasive vasopressor or inotropic drugs such as Noradrenaline, Adrenaline, or Vasopressin.

The surgical time (50.0mins vs 48.6mins) and anaesthetic time (92.4min vs 96.3mins) comparing both groups were similar. Surgical time was shorter in the COVID-19 positive group, but the total anaesthetic time was longer. However, both variables were statistically insigni cant p>0.05.

Transfusion rates both intraoperatively (p=1.000), and for the entire duration of hospital admission (p=0.830), were largely similar too.

PRIMARY OUTCOME

There was no difference in the number of deaths within 30 days after operation across the two groups. There were 2 deaths within 30 days for each group. There was no statistical signi cance (p=1.000 across the two cohorts).

In actuality there were 3 deaths in the COVID-19 positive group, however the third death occurred at postoperative day 66. Conversely, in the COVID-19 negative arm there was only 1 death where the patient died after the operation during the same hospital episode/admission - they died postoperative day 17. The other death occurred where the patient was actually t enough to be discharged to a convalescent hospital on postoperative day 8, but developed complications at the convalescent hospital and eventually died postoperative day 10.

The low mortality precluded the use of Kaplan-Meier analysis.

SECONDARY OUTCOMES

Postoperative complications

There were substantial variations in the reported incidence of postoperative complications depending on COVID-19 status. As illustrated in Table 5, patients who did not have an active COVID-19 infection at the time of surgery had a decreased risk of perioperative morbidity compared to those with an active infection, but most measures were statistically insigni cant.

There were two (2) cases of ACS/AMI in the COVID-19 positive group. However, this was statistically insigni cant (p=0.206). One of these cases did eventually die, but on postoperative day 89. Acute Coronary Syndrome (ACS) was diagnosed when there was a change in serial ECGs, a rise in serum cardiac enzymes, or clinical symptoms suggestive of myocardial ischaemia.

Patients who were not infected with COVID-19 had a signi cantly reduced risk of pneumonia compared with other patients in this study group. This was statistically signi cant as p=0.001. Patients with pneumonia were diagnosed when there were bedside clinical symptoms of pneumonia, CXR changes, desaturation on pulse oximetry, or evidence of microbial infection on laboratory testing.

Postoperatively there were similar rates of sepsis across both groups, but the data was statistically insigni cant (p=0.834). For this report, cases were rst classi ed as “Suspected sepsis” when the ICD code for “sepsis” or “septic shock” was found in the discharge summary for the episode.

All of these cases had the full episode hospitalisation data assessed, and SOFA score calculated. The updated sepsis criteria from the SEPSIS-3 framework (20) were used. Only patients with either a suspected or documented evidence of infection, plus a SOFA score of >= 2 were classi ed into Con rmed sepsis as a perioperative complication. There was a difference between the COVID-19 positive and negative groups (3:2). Ultimately for both COVID-19 groups the data was statistically insigni cant (p=0.509).

There were no cases of postoperative Pulmonary Embolism.

Two cases required postoperative IPPV, both in the COVID-19 positive group (p=0.206). Both underwent surgery under subarachnoid anaesthesia. One patient was taken to HDU ventilator ward, and eventually succumbed in hospital on post-op day 66. The other patient was initially discharged to convalescent hospital for rehabilitation, but deteriorated and was readmitted and eventually intubated - they died at postoperative day 54. Neither case died within 30 days of operation.

Wait time and overall length of stay

Across both groups, the mean wait time from admission until surgery was 4.6 days, ranging from zero to 24 days. Acute hospital length of stay ranged from 3 to 68 days, with a mean of 12.5 days, convalescent length of stay ranged from zero to 191 days, with a mean of 28.0 days, and overall length of stay ranged from four to 206 days, with a mean of 39.8 days.

As evidenced in Table 6, patients with COVID-19 infection had longer pre-operative wait times before surgery, as well as increased length of stay at the acute hospital, subsequent convalescent hospital admission (if any), and total hospitalisation time. Most Length of stay data is statistically insigni□cant (p>0.05). However, the Length of Stay at the acute hospital is longer in the COVID-19 Positive group, 15.0 days compared to 11.1 days, and this is statistically signi□cant as p=0.001. We can conclude that COVID-19 infection is a risk factor for longer stay in the acute phase.

Emergency readmission rates and final discharge destination

There was an almost equal number of emergency readmissions to QEH within 28 days (9 vs 8) (p=0.897) after the patient was discharged post-operatively (either to convalescent hospital or home/elderly home).

Table 7 shows after discharge (either directly from QEH acute hospitalisation or after rehabilitation in convalescent hospital) where the □nal discharge destination/status of the patients was. Some need acute hospital emergency readmission (3 v 5 cases p=0.588). There was an equal number of cases (5 v 5 p =0.683) in both groups that were previously living at home prior to injury, but needed a new discharge destination to an old-aged home residence after hospitalisation.

DISCUSSION

In this research, we hypothesised that there will be a signi□cant increase in the perioperative risk of patients with concomitant COVID-19 undergoing hip fracture surgery compared to the control group. The □ndings of this study do not support this hypothesis and additional research is required to determine the effect of concomitant COVID-19 infection on the perioperative risk of patients undergoing hip fracture surgery. Our □ndings indicate no statistically signi□cant increase in risk of 30-day postoperative mortality among patients with active COVID-19 infection undergoing surgery.

The available evidence in the current literature suggests that an active COVID-19 infection at the time of surgery signi□cantly increases the risk of perioperative mortality, with Knisely et al. reporting a 16.7% perioperative mortality rate in those with COVID-19 compared to 1.4% in COVID-19 negative patients undergoing urgent and emergent surgery. Furthermore, in the same study, serious complications, including cardiac arrest, sepsis/septic shock, respiratory failure, pneumonia, acute respiratory distress syndrome, and acute kidney injury, were identi□ed in 58.3% of COVID-19 patients compared with 6.0% of COVID-19 negative patients (13). In our study, as shown in Table 5, the differences in perioperative complications were not as drastic. For example, in COVID-19 patients the incidence of myocardial infarction or cerebrovascular infarction was 3.8% and 1.9%, respectively. Additionally, although a high rate of suspected sepsis (as diagnosed by the clinical treating teams) was reported in COVID-19 positive patients at 28.8%, a slightly higher rate was observed in COVID-19 negative patients at 31%.

However, there was a statistically signi□cant increased risk of postoperative pneumonia observed in patients with an active COVID-19 infection, 6.5% in the uninfected cohort compared to 32.7%.

These results may represent a potential limitation of this study, as it was conducted at a single centre at a time of peak outbreak of COVID-19 in 2022. We recommend that any further studies can address this limitation and utilise data from multiple locations and over a longer period of time.

As expected, we found that an active COVID-19 infection had a small impact on the wait time until surgery and the

length of hospital stay. These findings mirror that of the current literature, with a large number of studies reporting that COVID-19 infections are only associated with a small but insignificant increase in length of stay (14-16). On the other hand, the high number of comorbidities reported in our patient population are more likely to contribute to increased length of hospital stay observed. Inabnit et al. stated that having at least one comorbidity was associated with a 13% greater length of hospital stay (17). Moreover, the literature describes that increasing age significantly extends the length of hospital stay and, the mean age of our cohort was 85.4 years (18, 19). Our study showed that acute hospital length of stay was significantly shorter - 11.1 days in the COVID-19 negative cohort compared to 15.0 days in the COVID-19 positive group. This has implications for both the patient as well as the overall healthcare burden on society and the tax-payer.

Although the findings of this study build on existing evidence, there are several results that differ from the current literature and do not support our hypothesis – it is possible that peri-operative risk of patients with concomitant COVID-19 infection undergoing hip fracture surgery may not be as significantly increased as previously thought. Further studies are warranted to quantify the perioperative risk of patients with concomitant COVID-19 undergoing hip fracture surgery compared to COVID-19 negative patients. However, with mass vaccination efforts in Hong Kong and across the globe, and the end of the peak infective wave of COVID-19 it may be difficult to complete such studies. These studies should be conducted across multiple centres and locations, and capture data over a longer period. Additionally, a larger pool of patients should be identified and followed-up to achieve greater statistical power and assess for possible medium to long-term complications. These results may have potential implications for hospital-based and territory-wide policies regarding risk stratification, resource allocation and timely arrangements of surgical care for hip fractures in COVID-19 patients.

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