Case Report

Timing and Tips for Total Hip Arthroplasty in a Critically Ill Patient With Coronavirus Disease 2019 and a Femoral Neck Fracture

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ABSTRACT

Expedited time to surgery after hip fracture is associated with decreased morbidity and mortality in appropriately optimized patients. However, the optimal timing of surgery in patients with the novel coronavirus disease 2019 (COVID-19) infection remains unknown. This case report describes a patient with COVID-19 pneumonia complicated by multiorgan system failure requiring intubation who sustained a femoral neck fracture that required total hip arthroplasty. This patient had a significant, deliberate delay in time to surgical intervention because of his critical state. When deciding the optimal timing for total hip arthroplasty in patients with COVID-19, we recommend using inflammatory markers, such as procalcitonin and interleukin-6, as indicators of disease resolution and caution operative intervention when patients are nearing the 7-10th day of COVID-19 symptoms. Furthermore, implant cementation and spinal anesthesia in critically ill COVID-positive patients should be approached cautiously in the setting of pulmonary disease and multiorgan system failure. Close follow-up with medical doctors is recommended to minimize long-term sequelae and delay to baseline mobility.
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Introduction

The novel coronavirus disease 2019 (COVID-19) pandemic has called into question many of the heuristics orthopaedic surgeons use when designing treatment plans for operative injuries. Expedited surgical intervention is recommended for hip fractures as there is associated increased morbidity and mortality with delayed intervention [1-4]. However, the need for expedient surgical intervention must be balanced with a patient's overall clinical picture, such as COVID-19 infection status. Because asymptomatic or mildly symptomatic patients with COVID-19 have rapidly developed severe complications, such as acute respiratory distress syndrome (ARDS), days after admission and apparent clinical stabilization, the question for surgical intervention in patients with COVID-19 and hip fracture remains uncertain [5]. Currently, there is a paucity of evidence regarding perioperative COVID-19 infections in patients with hip fracture [6,7]. This case describes a patient with a displaced femoral neck fracture and active COVID-19 infection who had a deliberate delay in total hip arthroplasty (THA). Furthermore, this case describes early follow-up and sheds light on unique considerations such as trending inflammatory markers to guide timing of surgery, the decisions to perform a press-fit THA over cemented THA and to use general anesthesia over spinal anesthesia, and the potential for prolonged postoperative monitoring.

The patient's health-care proxy was informed that this case would be submitted for publication and provided consent.

Case history

A 67-year-old male with hypertension, hyperlipidemia, prior myocardial infarction requiring percutaneous coronary intervention, and heart failure with reduced ejection fraction (20%) presented to our emergency department after sustaining a ground level fall with right hip pain and inability to ambulate. At baseline, the patient was fully ambulatory and independent. Two days before presentation, the patient reported a new, nonproductive cough with chills, myalgia, fatigue, and decreased appetite.

On arrival to the emergency department, the patient was febrile, tachycardic, and hypoxemic on room air. His physical examination

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was notable for altered mental status and shortening and external rotation of his right lower extremity. Given the timing of his injury with the COVID-19 pandemic, his presentation was concerning for COVID-19 pneumonia complicated by an acute hip fracture. He had notable elevation in our institution's standard COVID-19 panel, which included a COVID-19 reverse transcriptase polymerase chain reaction, complete blood count, coagulation panel, erythrocyte sedimentation rate (ESR), c-reactive protein, procalcitonin, interleukin-6, lactate dehydrogenase, creatinine phosphokinase, high-sensitivity troponin, ferritin, d-dimer, and lactate (Fig. 1) [8]. His chest radiograph demonstrated multifocal patchy airspace opacities (Fig. 2), and his right hip imaging confirmed a displaced basicervical femoral neck fracture (Fig. 3). The patient was admitted to the medical service while awaiting results of COVID-19 testing, which eventually returned positive. In conjunction with the medical team's evaluation, the patient was deemed "higher risk" and not medically cleared for THA.

To optimize this patient for surgery, on hospital day (HD) 1, the medical team began aggressive, experimental treatment of his COVID-19 pneumonia with hydroxychloroquine, azithromycin, and ceftriaxone to prophylactically treat against a superimposed bacterial pneumonia. On HD 2, operative intervention of his hip fracture was considered, as he appeared clinically stable. Our pulmonary/critical care and COVID-19 infectious disease services were concerned that the patient was just reaching the 7-10th day of COVID-19 infection, when many acutely decompensate, and cautioned against surgical intervention [9]. They recommended follow-up COVID studies (listed earlier) and the chest radiograph to objectively characterize his disease course and inflammatory state. Owing to new increases in ESR, procalcitonin, and lactate (Fig. 3), with no significant changes on the chest radiograph, surgical management was deferred.

On HD 4, the patient's oxygen requirement increased to 15L using a non-rebreather mask. He subsequently developed hypoxemic respiratory failure and on HD 5 was transferred to the intensive care unit (ICU). On HD 6, his respiratory status continued to worsen, and he was rapidly intubated. His ICU stay was complicated by septic shock requiring significant vasopressor support, ARDS, seizures, and acute renal failure requiring hemodialysis.

By HD 10, the patient was clinically improving. He was weaned off vasopressors, required minimal ventilator support, and had downtrending inflammatory markers when compared with peak ICU values (Fig. 3). The ICU team felt he was nearing medical optimization and reconsulted orthopaedics for surgical intervention. To optimize the patient's care, a multidisciplinary discussion
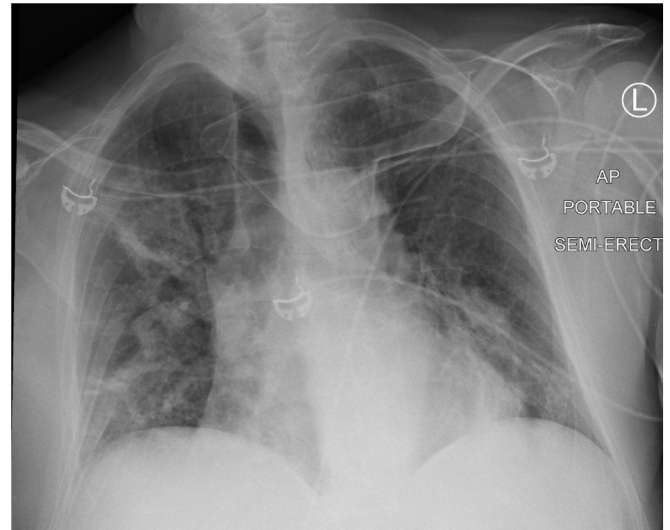

Figure 2. Portable chest radiograph on hospital day 0.

was had with pulmonary/critical care, anesthesia, and orthopaedic surgery teams. The anesthesia and pulmonary/critical care teams recommended surgery before extubation to prevent unnecessarily repeated anesthesia and intubation. The anesthesia team also recommended against spinal anesthesia, given the risk of transient hypotension and subsequent end-organ ischemia. Press-fit right THA was scheduled on HD 13.

Unfortunately, the patient self-extubated on the morning of surgery because of inadequate sedation. He was immediately sedated, reintubated, and later brought to the operating room. The patient was given general anesthesia, positioned supine on a regular radiolucent table, and a direct anterior approach was performed. A standard press-fit THA was performed to avoid possible pulmonary complications from cementing [10]. Positioning of the components was confirmed fluoroscopically (Fig. 4). The procedure lasted approximately 1 hour with an estimated blood loss of 350 mL.

The patient was taken to the ICU postoperatively and was successfully extubated 7 hours after surgery, on postoperative day (POD) 0. He remained medically stable, requiring no further pressor support and on POD 2 was transferred to a general medical floor. While on the general medical floor, the patient had persistent altered mental status, thought to be secondary to ICU delirium.
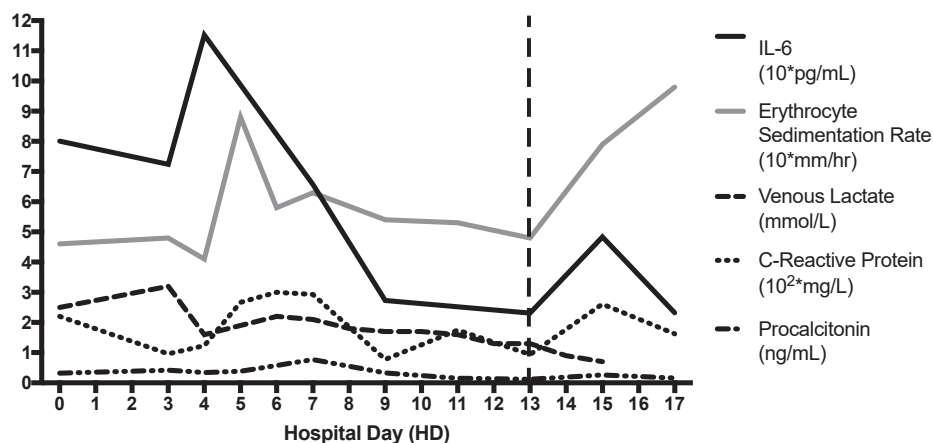

Figure 1. Inflammatory marker trends across the hospitalization. (vertical dotted line represents the day of surgery).

Figure 3. Portable anteroposterior (AP) pelvis radiograph demonstrating femoral neck fracture.

Electroencephalogram and magnetic resonance imaging were performed to evaluate for an acute process; both were negative. Physical therapy (PT) was initiated on POD 3; however, the patient's fluctuating mental status made him unable to participate consistently. It was not until POD 17 when PT was able to successfully ambulate the patient.

On POD 17, the patient's mental status returned to baseline and he successfully ambulated with PT. On POD 20, he was successfully discharged to a subacute nursing facility (SNF) on 28 days of enoxaparin 40 mg daily for deep vein thrombosis (DVT) prophylaxis. Throughout this prolonged postoperative course, the patient had no additional oxygen requirement and required no acute medical interventions.

On interval 2-month postoperative follow-up, the patient has since had a complicated recovery period. At the SNF, he was unable to ambulate without the assistance of PT and there has been reported sporadic compliance with DVT prophylaxis. On POD 44, the patient re-presented to our emergency room from the SNF reporting 1 week of decreased appetite and brown/black emesis,
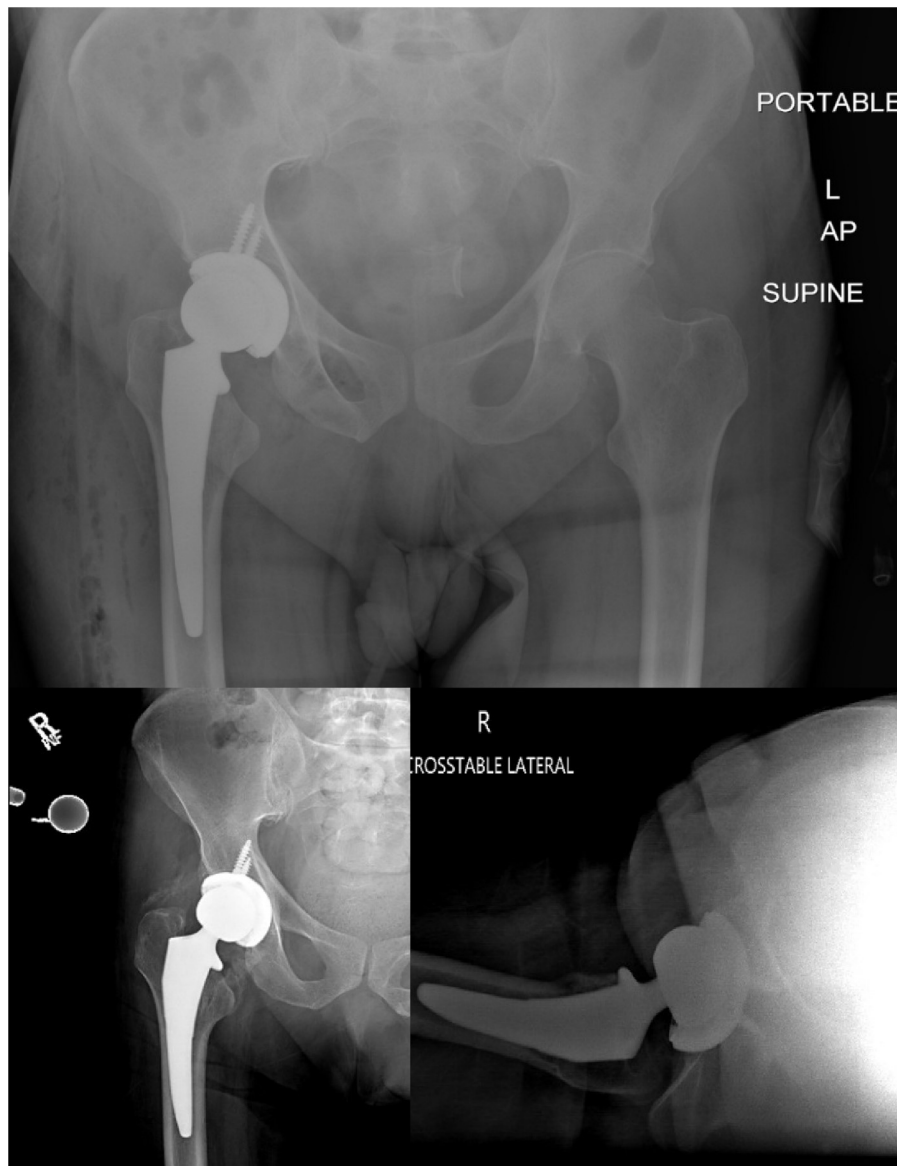
Figure 4. Postoperative portable AP pelvis, AP hip, and cross-table lateral radiographs.

one episode of bright red blood per rectum, and 1 day of tachy-cardia, hypotension, and hypoxemia. The patient was admitted to the ICU for septic shock secondary to a urinary tract infection and/or stercoral colitis. The patient rapidly recovered with empiric antibiotic therapy and fecal disimpaction. During this hospitalization, the patient was incidentally found to have nonocclusive thrombi in the right femoral and anterior tibial vein and an occlusive thrombus in the right popliteal vein. In the setting of a potential gastrointestinal (GI) bleed, before starting therapeutic anticoagulation, the GI team was consulted for comanagement. Follow-up computed tomography abdomen and pelvis showed bright red blood per rectum was likely secondary to proctocolitis, and further GI imaging was deemed unnecessary. The patient was started on a heparin drip at 1300 units/hour titrated to partial thromboplastin time goals of 80-120. The patient recovered well and was discharged back to the SNF on POD 49 on apixaban for anticoagulation.

Discussion

Hip fractures require expedient surgical intervention [1-3] as each day with immobility can increase the risk of in-hospital mortality [4]. Amidst the COVID-19 pandemic, orthopaedic surgeons must answer challenging questions, such as when is the optimal time for surgical intervention in COVID-positive patients with hip fracture? This case describes one strategy for timing and technique of THA in a patient with an acute femoral neck fracture and complex, life-threatening COVID-19 infection. It provides four unique insights: (1) trending inflammatory markers can be useful in characterizing infection resolution; (2) a press-fit (cementless) over cemented THA strategy in COVID-19—positive patients with severely decompensated pulmonary function may avoid dangerous pulmonary complications; (3) avoiding spinal anesthesia in patients who recently recovered from critical illness may prevent intraoperative hypotension and minimize end-organ ischemia; and (4) patients with COVID who underwent orthopaedic surgery may require closer follow-up with a medical team to prevent adverse outcomes, given evidence of prolonged hyperinflammatory state and procoagulable state after infection [11].

Currently, there is a paucity in the literature regarding perioperative COVID-19 infections in patients who underwent orthopaedic surgery. Early in the pandemic, Liu et al. [12] and Tang et al. [13] from Wuhan, China, described strategies for triaging orthopaedic trauma cases. Both felt COVID-positive patients with hip fracture should be definitively fixed within a 24-hour window if not critically ill. Among the limited available literature regarding COVID-positive patients with hip fracture, mortality rates appear significant. Rabie et al. from Iran investigated 4 proximal femur fractures in COVID-positive patients with orthopaedic trauma. Of these, 1 patient with intertrochanteric fracture received operative intervention and was discharged home on POD 9. The remaining 3 were treated non-operatively, and 2 (66.6%) expired (1 femoral neck and 1 inter-trochanteric fracture) [7]. This study concluded that once COVID-19's fulminant phase had passed (identified through history and/or chest radiograph), surgical intervention was appropriate. Mi et al. studied 7 proximal femur fractures (5 intertrochanteric, 1 femoral neck, and 1 unspecified) with COVID-19 infection [6]. Three cases (1 femoral neck and 2 intertrochanteric fractures) underwent surgical intervention. Of these, 1 patient with intertrochanteric fracture expired (33.3%). Of the 4 nonoperative cases, 2 patients with intertrochanteric fracture expired (50.0%). All living patients remained in the hospital 3 months after admission. In our case, we opted for surgical repair to restore this previously ambulatory patient's functional status and used laboratory markers of infection resolution to inform surgical timing to minimize perioperative mortality risk.

We trended ESR, c-reactive protein, procalcitonin, interleukin-6, and lactate to help dynamically characterize the patient's disease course. On HD 3, the patient's procalcitonin, ESR, and lactate were elevated as compared with HD 1. This indicated disease progression and a worsened inflammatory state. These objective values helped inform our decision to delay surgery. On HD 10, the patient's inflammatory state seemed to be improving from its peak on HD 8. This indicated infection resolution and allowed reconsideration of surgical intervention (Fig. 3). One group of Singaporean orthopaedic surgeons have similarly suggested looking at inflammatory markers when planning surgery, but they suggested using only isolated preoperative values of TNF-α, IL-1, and IL-10 [14].

Once our patient was medically optimized for surgery, a press-fit femoral component was chosen over a cemented component, given our patient's recent recovery from hypoxemic respiratory failure. Overall, the literature has demonstrated equivalent outcomes between cemented and press-fit THA [15,16]. However, cemented THAs have been documented to have higher rates of cardiopulmonary complications. Potential complications include cement extravasation to the vasculature, bone cement implantation syndrome (BCIS), and a 5.7 times risk of pulmonary embolism when compared with press-fit THA [17,18]. In this case, the senior author chose a press-fit implant because even moderate hypotension secondary to BCIS or minor cement emboli could have been devastating in a patient with limited cardiopulmonary reserve [19-21]. Among the existing literature, there has been no discussion of cemented vs press-fit THA strategy for COVID-positive patients, but we opted for press-fit over cemented THA to avoid unnecessary pulmonary insult.

With regard to THA vs hemiarthroplasty, we recommend using pre-established indications [22]. In this relatively young patient, who was ambulatory at baseline and adequately volume resuscitated in the ICU, our team decided to conduct a THA to give the patient the most favorable long-term outcome.

A multidisciplinary discussion between anesthesia, pulmonary/critical care, and orthopaedic surgery teams was also important to this patient's positive perioperative outcome. To minimize medical risks in this high-risk patient, anesthesia and pulmonary/critical care teams felt surgery should be scheduled for immediately before extubation to prevent repeated airway insult. Regarding the technique, the anesthesia team chose general anesthesia over spinal anesthesia. For patients who underwent standard THA, spinal anesthesia was associated with decreased complication rates when compared with general anesthesia [23]. Spinal anesthesia, however, carries a known risk of hypotension [24,25], and one study has demonstrated that up to 72.2% of patients who underwent hemi-arthroplasty develop mild BCIS after femoral cementation [10]. For a patient who recently recovered from septic shock, our critical care team suggested avoiding spinal anesthesia to prevent further hypotension-induced complications.

This patient's early postoperative course also highlights increased postoperative risks associated with operating on post-COVID patients. Patients with COVID may be more fragile and have difficulty returning to baseline functional status. This has been documented among the medical literature [26,27]. In this case, the patient has still not returned to baseline functionality. Furthermore, he developed septic shock and had DVTs identified 2 months postoperatively. This highlights the need for close follow-up with medical doctors to tailor individual treatment plans postoperatively. Extension of DVT prophylaxis from the standard 1 month may be warranted in patients with COVID because COVID-related coagulopathies are well documented [11,28]. When planning operative interventions, the potential for prolonged postoperative complications should be considered by the surgeon and these risks should be explained to the patient.

Although expedited THA is critical in reducing mortality in patients with hip fracture, deliberate surgical delay may be

appropriate in the setting of a critical ill patient with COVID-19 infection. If THA had been performed immediately before the patient's decompensation, there may have been a catastrophic outcome by compounding ARDS and shock with postoperative inflammation and acute operative blood loss.

Summary

This case describes a patient who presented with a femoral neck fracture and acute COVID-19 infection, later complicated by multiorgan system failure. THA was deliberately delayed. We recommend using objective inflammatory markers to identify disease resolution, having a multidisciplinary discussion approach to anesthesia including spinal and thoughtful consideration of the risks and benefits of the use of cement, and caution against surgically intervening during the cytokine storm during COVID-19 infection when a patient may acutely decompensate.

Conflict of interest

The authors declare there are no conflicts of interest.

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