

Optimum early orthopaedic surgery in COVID-19 patients

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Multiple guidelines have been established regarding the management of COVID-19 patients.^{1,2} However, there remains a paucity regarding specific guidelines on the optimal timing for surgeries in COVID-19 patients requiring early orthopaedic surgery. This paper aims to provide evidence-based recommendations regarding the timing to proceed with early orthopaedic surgeries in COVID-19 patients.

Haemodynamically unstable patients. In an unwell patient, the clinical urgency of the operation should be weighed against the overall health of the patient. A balance needs to be maintained between the benefits of early surgery and the possibility of worsening the patient's respiratory function from anaesthetic and surgical stresses. This is especially so as COVID-19 is a respiratory condition that can cause multi-organ dysfunction in symptomatic patients, significantly increasing the risk of the surgeries. Symptomatic patients under treatment for COVID-19 may also be on medications such as high-dose steroids and anticoagulants, which can significantly increase the risk of surgeries, necessitating the need to balance between the benefits of early surgery and the overall health of the patient. Haemodynamically unstable patients should undergo immediate surgery as soon as possible if the surgery may improve their condition, for example in unstable pelvic fractures, exsanguinating injuries, compartment syndrome or necrotising fasciitis. Other non-emergent surgeries should be postponed until the patient is stabilised.

Open fractures. The British Orthopaedic Association, British Association of Plastic Reconstructive and Aesthetic Surgeons, American College of Surgeons and Orthopaedic Trauma Association have released guidelines for open fracture management.^{3,4} Immediate surgical exploration for open fractures are recommended in the presence of gross contamination, compartment syndrome, vascular compromise and in a multiply injured patient, with full personal protective equipment (PPE) as soon as possible.³ In the absence of the above, initial debridement can be safely performed

within 24 to 48 hours without adverse effects, once the patient's COVID-19 status is confirmed.^{3,4}

Whenever possible, skin defects overlying open fractures should be closed during the initial debridement and internal fixation can be performed.^{3,4} If required, subsequent soft tissue reconstruction is recommended to be performed on day 7 before vessels become friable and fibrosed, with definitive internal fixation in the same setting.^{3,4} This is to maximise the duration for the treatment of COVID-19 while mitigating the risks of further delay.

Without soft tissue reconstruction, consideration should be given to definitive management of the fractures with external fixators. This is to decrease the risk of respiratory failure in COVID-19 patients during anaesthesia and intramedullary nailing of diaphyseal fractures, protect healthcare workers and conserve resources. Should subsequent skeletal stabilisation be required without soft tissue reconstruction, the surgery is recommended to be performed on day 14 to maximise the duration for the treatment of COVID-19 while mitigating the risks of further delay.³

Closed fractures and dislocations of extremities. Immediate surgical intervention with full PPE is recommended for closed fractures and dislocations with compartment syndrome or vascular compromise. This is to prevent irreversible muscle damage, with subsequent revascularisation possibly causing systematic complications including myoglobinuria, renal failure and death. The other indication for immediate intervention is that of a multiply injured patient who require other immediate surgery. However, this should be decided according to the surgical duration and the possibility of performing it after confirming or treating the COVID-19.⁵

Urgent surgeries are indicated for irreducible large joint dislocations. These include shoulder, elbow, hip, knee, ankle and subtalar dislocations.⁵⁻¹⁰ Whenever possible, joint dislocations should be reduced as soon as possible at bedside with full PPE. Failure of closed

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reduction then necessitates closed reduction under general anaesthesia or open reduction with full PPE. This is to avoid traction or compressive injuries to neurovascular structures.⁵⁻¹⁰

Early surgeries for closed fractures and dislocations are warranted in 6 scenarios. (1) Posterior sternoclavicular joint dislocations are recommended to be reduced within 48 to 72 hours as risk of failure of closed reduction increases beyond.¹¹ (2) Floating elbows and knees are recommended to undergo early fixation to improve functional outcomes.^{12,13} (3) Closed fractures or dislocations with suspected nerve lacerations are recommended to have exploration and nerve repair early as Wallerian degeneration occurs within 24 to 48 hours.¹⁴ (4) Hip fractures are recommended to undergo surgery within 48 hours with a significant decrease in fatality and risk of pressure sores.¹⁵ (5) Though controversial, if fixation is decided for proximal humerus fractures, early fixation can be performed as studies report a decreased rate of avascular necrosis when performed within 48 hours.¹⁶ Recent meta-analyses, however, identified that the timing of surgery has no bearing on the risks of avascular necrosis for young neck of femur fractures and talar neck fractures. Therefore, decision to proceed with early surgery is dependent on the consultant's practice.^{17,18} (6) Closed fractures and dislocations with skin tenting and impending conversion to open fractures are warranted early surgery as per open fractures.

Other closed fractures and dislocations are recommended to have their surgeries on day 14 if decision is made for surgical fixation. This is to maximise the duration for the treatment of COVID-19 while mitigating the risks of further delay. An exception is for acromioclavicular joint dislocations, where surgeries can be performed on day 21 and still be associated with good functional outcomes and reduction.¹⁹ Anterior sternoclavicular joint dislocations can also be left unreduced should closed reduction fails.⁵

Septic arthritis and periprosthetic joint infections. British Orthopaedic Association, British Society for Rheumatology, British Health Professionals in Rheumatology, Royal College of General Practitioners and British Society for Antimicrobial Chemotherapy published guidelines for septic arthritis.²⁰ They recommended early removal of intra-articular pus followed by antibiotics.²⁰ Options include repeated needle aspiration to dryness or surgical drainage done arthroscopically or open, with limited evidence to suggest one over another.²⁰ In the setting of COVID-19 patients, bedside aspiration is therefore recommended as soon as possible with full PPE, and early surgical drainage could

be performed after confirming the COVID-19 status if surgical drainage is the institution's practice.

The International Consensus on Orthopaedic Infections published guideline for periprosthetic joint infections.²¹ They recommended for surgery to be performed urgently once the patient is optimised, but not as an emergency.²¹ The exact cut-off time for surgery to be performed has not been established, but a shorter duration of symptoms is significantly correlated with higher success rates of surgery. Therefore surgery should be performed once the COVID-19 status of the patient is confirmed.²¹

Infected wounds or abscesses. Superficial infection can be managed with trial of medical therapy with close observation for progression to deep tissue infection. Deep tissue infections are, however, recommended early surgery to minimise the risk of ascending infection and compartment syndrome once the COVID-19 status of the patient is confirmed. These interventions may be required urgently in the presence of systemic toxicity.

Lacerations or deep abrasions. Newer studies and guidelines have demonstrated no relationship between the timing of surgery and infection risk up until 19 hours after injury.²² Wounds that require surgery should therefore be operated after confirming the COVID-19 status of the patients.

Tendon ruptures or muscle tears. The effect of the timing of tendon repair or muscle tears remain controversial.²³ Two studies showed no difference in outcomes even if the surgery is delayed for 3 weeks, while the last study demonstrated a decrease in final active range of motion of 0.3 degree with each day of delay for flexor tendon repair.²³ Accordingly, closed tendon ruptures or muscle tears should be operated after confirming the COVID-19 status, with the exact timing dependent on the consultant's practice. Patients with a wound overlying the tendon rupture or muscle tear should have early surgery as per the recommendations for lacerations and deep abrasions.

Locked joints. Locked joints are advised to have early surgeries to minimise stiffness and limited range of motion. However, there is limited evidence regarding the exact timing for these surgeries. The surgeries should be done after confirming the COVID-19 status, though the exact timing can be decided by the consultant in view of the controversial evidence.

Spinal trauma, cord compression or cauda equina. There is agreement that incomplete spinal cord injury may result in better neurological outcomes following early surgery, ideally within 6 hours.²⁴ Patients with incomplete spinal cord injury or cauda equina should therefore have their surgery performed immediately with

full PPE, or after confirmation of the COVID-19 status of the patient if possible within 6 hours.

In complete neurological deficit, however, some studies show no neurological improvement after early surgery, though surgery within 72 hours had lower risk of complications and length of stay.²⁵ Therefore, patients with complete neurological deficit or no neurological deficits can have their surgery after confirming the COVID-19 status, with close neurological monitoring to ascertain if there is worsening neurology.

Patients with central cord syndrome, without any fractures or dislocations rendering the cervical spine unstable, generally have better prognosis.²⁶ In the absence of evolving neurological deficits, they can have surgery after confirming the COVID-19 status as deemed appropriate by the consultant.

In the event of haemodynamic instability due to neurogenic shock, the optimal timing of surgery is as per recommended for other haemodynamically unwell patients.

Elective surgeries. Elective surgeries, except for oncological surgeries, should be postponed in the face of the pandemic. Oncological surgeries should be performed after confirmation of COVID-19 status, and if possible, after treatment of COVID-19. If any of the patients scheduled for other elective surgeries become a suspected or confirmed COVID-19 patient, the operation should be postponed until treatment is completed.

Evidence-based recommendations regarding the timing to proceed with early orthopaedic surgeries in COVID-19 patients are summarised in Table 1. These are made based on 3 main principles. Firstly, when faced with an unwell patient, saving lives takes precedence over saving limbs. Secondly, in a well patient, the clinical urgency of the operation should be weighed against the possibility of delaying the operation until the infectivity of the patient's COVID-19 is eliminated or lowered, or at least until the COVID-19 status of the patient is known. Lastly, elective surgeries, except for oncological surgeries, should be postponed during the pandemic.

Table 1. Summary of recommendations for the optimal timing for early orthopaedic surgeries in COVID-19 patients

Condition	Recommendation
Haemodynamically Unstable Patients	
Unstable pelvic fractures	Immediate surgery
Exsanguinating injuries	Immediate surgery
Compartment syndrome	Immediate surgery
Necrotising fasciitis	Immediate surgery
Other conditions	Postponed until the patient is stabilised
Open Fractures	
Gross contamination	Immediate surgery
Compartment syndrome	Immediate surgery
Vascular compromise	Immediate surgery
Initial debridement of open fractures without gross contamination, compartment syndrome or vascular compromise	Within 24 to 48 hours ^a
Subsequent soft tissue reconstruction with definitive skeletal stabilisation	7 days following injury ^b
Skeletal stabilisation without soft tissue reconstruction	14 days following injury if surgery is required ^b
Closed Fractures and Dislocations of Extremities	
Impending conversion to open fractures	As per open fracture recommendations above
Vascular compromise	Immediate surgery
Multiply injured patient who require other immediate surgery	Decided according to the surgical duration and the possibility of delaying surgery
Irreducible large joint dislocations	As soon as possible ^a

Table 1. Summary of recommendations for the optimal timing for early orthopaedic surgeries in COVID-19 patients (Cont'd)

Condition	Recommendation
Posterior sternoclavicular joint dislocations	Within 48 to 72 hours ^a
Floating elbows and knees	Within 24 to 48 hours ^a
Closed fractures with nerve lacerations	Within 24 to 48 hours ^a
Hip fractures	Within 48 hours ^a
Proximal humerus fixation	Within 48 hours ^a
Young neck of femur fractures	Dependent on consultant's decision ^{a,b}
Talar neck fractures	Dependent on consultant's decision ^{a,b}
Acromioclavicular joint dislocations	21 days following injury ^b
Anterior sternoclavicular joint dislocations	Leave unreduced should closed reduction fails
Other closed fractures and dislocations	14 days following injury ^b
Septic Arthritis and Periprosthetic Joint Infections	
Septic arthritis bedside aspiration	As soon as possible
Septic arthritis surgical drainage	After confirming COVID-19 status of patients
Periprosthetic joint infections	After confirming COVID-19 status of patients
Infected Wounds or Abscesses	
Superficial infections	Managed with trial of medical therapy
Deep tissue infections	After confirming COVID-19 status of patients
Lacerations or Deep Abrasions	
Lacerations or deep abrasions	After confirming COVID-19 status of patients
Tendon Ruptures or Muscle Tears	
Open tendon ruptures or muscle tears	As per lacerations or deep abrasions recommendations above
Closed tendon ruptures or muscle tears	After confirming COVID-19 status of patients, but exact timing dependent on consultant's decision
Locked Joints	
Locked joints	After confirming COVID-19 status of patients, but exact timing dependent on consultant's decision
Spinal Trauma, Cord Compression or Cauda Equina	
Incomplete spinal cord injury	Within 6 hours ^a
Complete spinal cord injury	Within 72 hours ^a
Spinal trauma with no neurological deficit	After confirming COVID-19 status of patients
Central cord syndrome without any fractures or dislocations	After confirming COVID-19 status of patients if deemed appropriate by the consultant
Neurogenic shock	As per haemodynamically unstable recommendations above
Elective Surgeries	
Oncological procedures	After confirming COVID-19 status of patients, and if possible, after treatment of COVID-19
Other elective surgeries	Postponed in the face of pandemic

^a Confirmation of COVID-19 status should be obtained during the timeframe if possible^b Treatment should be started for COVID-19 positive patients during the timeframe if possible

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