



■ ARTHROPLASTY

Morbidity and mortality in patients undergoing lower limb arthroplasty surgery during the initial surge of the COVID-19 pandemic in the UK at a single-speciality orthopaedic hospital

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Aims

The COVID-19 pandemic posed significant challenges to healthcare systems across the globe in 2020. There were concerns surrounding early reports of increased mortality among patients undergoing emergency or non-urgent surgery. We report the morbidity and mortality in patients who underwent arthroplasty procedures during the UK first stage of the pandemic.

Methods

Institutional review board approval was obtained for a review of prospectively collected data on consecutive patients who underwent arthroplasty procedures between March and May 2020 at a specialist orthopaedic centre in the UK. Data included diagnoses, comorbidities, BMI, American Society of Anesthesiologists grade, length of stay, and complications. The primary outcome was 30-day mortality and secondary outcomes were prevalence of SARS-CoV-2 infection, medical and surgical complications, and readmission within 30 days of discharge. The data collated were compared with series from the preceding three months.

Results

There were 167 elective procedures performed in the first three weeks of the study period, prior to the first national lockdown, and 57 emergency procedures thereafter. Three patients (1.3%) were readmitted within 30 days of discharge. There was one death (0.45%) due to SARS-CoV-2 infection after an emergency procedure. None of the patients developed complications of SARS-CoV-2 infection after elective arthroplasty. There was no observed spike in complications during in-hospital stay or in the early postoperative period. There was no statistically significant difference in survival between pre-COVID-19 and peri-COVID-19 groups ($p = 0.624$). We observed a higher number of emergency procedures performed during the pandemic within our institute.

Conclusion

An international cohort has reported 30-day mortality as 28.8% following orthopaedic procedures during the pandemic. There are currently no reports on clinical outcomes of patients treated with lower limb reconstructive surgery during the same period. While an effective vaccine is developed and widely accepted, it is very likely that SARS-CoV2 infection remains endemic. We believe that this report will help guide future restoration planning here in the UK and abroad.

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Introduction

During the COVID-19 pandemic in 2020, there were growing concerns about exposing

patients to an unknown risk of SARS-CoV-2 infection, and pulmonary complications with early reports of higher morbidity and

mortality among patients undergoing trauma, as well as non-urgent surgery in general.^{1,2} Consequently, within our unit all non-urgent orthopaedic procedures were suspended until further notice, while orthopaedic oncological procedures continued to be performed. Orthopaedic units across the UK and other countries had to undergo substantial restructuring to free up hospital bed capacity for patients presenting with respiratory problems, and to meet the projected increased requirement for ventilators. In some centres, orthopaedic surgeons were delegated to work in nonorthopaedic clinical roles, but our surgeons remained within their area of specialization to provide care to patients presenting with trauma and orthopaedic emergencies.

Despite the strict restrictions on public movement and activities, there was a steady number of patients presenting with general trauma and complications of arthroplasty such as instability, periprosthetic fractures, implant loosening with compromised function, impending fractures, or periprosthetic joint infection. These were treated at regionally designated centres as per the availability of facilities. After the spike of new cases and deaths from SARS-CoV-2 infection, healthcare facilities and surgical societies were keen to restore non-urgent surgical services. The COVIDSurg Collaborative reported high rates of pulmonary complications (44.3%) and 30-day mortality (28.8%) among orthopaedic patients who tested positive for COVID-19.³ The first report on clinical characteristics and outcomes of operative patients with SARS-CoV-2 infection suggests that surgery may accelerate and exacerbate progression to COVID-19.¹ At the time of this report, the orthopaedic community remains divided on the most appropriate restoration pathway as the risk of contracting SARS-CoV-2 infection is unknown. Our study reports the morbidity and mortality in patients undergoing lower limb arthroplasty procedures during the first stage of the UK pandemic at our unit. We believe that this report will help guide future planning here in the UK and abroad.

Methods

Study design. Institutional review board approval was obtained for a review of data prospectively collected on all consecutive patients who underwent a lower limb arthroplasty procedure for trauma or a complication of previous arthroplasty between 1 March and 31 May 2020 at a single speciality orthopaedic hospital in the UK. During this period, the hospitals in the region were receiving increasing numbers of cases with SARS-CoV-2 infection and on 19 March 2020, all nonurgent orthopaedic surgery except for orthopaedic oncology were cancelled at our institute, even before the national lockdown on 23 March 2020. Within a few days, our institute was the regional centre for treatment of most orthopaedic trauma and complications of arthroplasty from across the city

(population 900,000 people), usually served by three acute hospitals. Some cases with poly-trauma and significant hemodynamic instability were treated in the regional major trauma centre.

Patients. We included all consecutive patients who underwent urgent and elective lower limb arthroplasty surgery between 1 and 18 March 2020 as well as emergency and urgent arthroplasty surgery from 19 March to 31 May 2020. For the purpose of this report we have excluded patients with neck of femur fractures who were treated with any procedure other than a total hip arthroplasty and all orthopaedic oncology patients including revisions of previous joint reconstructive procedures performed for tumours. Patients were predominantly received from three acute hospitals in the region but also from a few surrounding acute hospitals that were unable to manage these cases due to lack of operating facilities at the peak of the pandemic. All patients were discussed at our daily multidisciplinary meeting and a proportion were performed with two surgeons operating in order to aid intraoperative shared decision-making, and as a backup in case the surgeon became ill before or during the procedure.

Patients were identified from the hospital electronic medical records and Healthcare Evaluation data for readmission to any NHS facility. Data collected included patient demographics, diagnosis, past medical history, BMI (kg/m²), Charlson Comorbidity Index (CCI), and American Society of Anesthesiologists (ASA)⁴ as surrogate marker of general health, anaesthetic history, operative details, length of stay, complication (if any), 30-day readmission, and 30-day mortality. Details were also recorded where available about SARS-CoV-2 testing on admission and during their stay or at discharge. In the early stages of the pandemic, patients were only tested if they had symptoms, whereas towards the end of the study period, all patients were tested prior to transfer and on arrival at our institute, irrespective of their symptoms. They were placed in a designated ward until the test results were available, and then transferred appropriately to COVID-19 clean or positive wards. The surgery was not delayed for the results unless the patient was symptomatic but adequate personal protective equipment, including N95 or powered air-purifying respirators, was used for all cases. Most orthopaedic procedures were classified as aerosol-generating due to the use of power tools, and spinal anaesthesia was used for the majority of the patients, as endotracheal intubation is also considered to be an aerosol-generating procedure. This was in keeping with the recommendations from Public Health England during the pandemic.⁵ Patients who tested positive for COVID-19 or were symptomatic were treated in a designated operating room away from the main hub of the operating department to minimize the risk to staff and other patients. In cases where endotracheal intubation

Table I. Summary of patient demographic data, comorbidities, surgery, and outcomes.

Parameter	Pre-COVID-19 (n = 827)	COVID-19 (n = 224)	p-value
Age, n (%)			0.032*
< 30 yrs	4 (0.5)	0 (0)	
31 to 50 yrs	63 (8)	8 (4)	
51 to 70 yrs	422 (51)	105 (47)	
> 70 yrs	338 (41)	111 (50)	
Mean age, yrs (range)	66.8 (17 to 96)	69.4 (35 to 91)	0.002†
Median age, yrs (IQR)	68 (60 to 75)	70 (63 to 76)	0.005‡
Sex, n (%)			0.001*
Females	464 (56)	154 (69)	
Males	363 (44)	70 (31)	
Diabetes, n (%)			0.900*
Non - Diabetic	706 (85)	192 (86)	
Non - Insulin dep	115 (14)	31 (14)	
Insulin dep	6 (1)	1 (0.4)	
BMI, kg/m², n (%)			0.004*
Underweight (< 18.5)	4 (0.5)	7 (3)	
Normal (18.5 to 24.9)	109 (13)	40 (18)	
Overweight (25 to 29.9)	286 (35)	66 (30)	
Class I Obese (30 to 34.9)	259 (31)	59 (26)	
Class II Obese (35 to 39.9)	111 (13)	30 (13)	
Class III Obese (> 40)	20 (2)	6 (3)	
Not available	38 (5)	16 (7)	
ASA grade n (%)			0.020*
1 to 2	714 (86)	178 (79)	
3 to 5	113 (14)	46 (20)	
Procedure urgency, n (%)			< 0.001*
Elective	803 (97)	167 (75)	
Non-elect emergency	24 (3)	57 (25)	
Anaesthetic type, n (%)			< 0.001*
General anaesthetic	790 (96)	182 (81)	
Spinal with/without sedation	8 (1)	31 (14)	
GA+ spinal	29 (3)	11 (5)	
CCI score, n (%)			0.077*
0 to 2	383 (46)	82 (37)	
3 to 4	329 (40)	105 (47)	
5 to 6	56 (7)	20 (9)	
> 6	59 (7)	17 (7)	
Length of stay, days, n (%)			0.062*
0 to 7	730 (88)	183 (82)	
8 to 14	66 (8)	29 (13)	
15 to 21	18 (2)	5 (2)	
22 to 28	4 (0)	4 (2)	
> 28	9 (1)	3 (1)	
Mean (range)	4.6 (0 to 76)	5.4 (1 to 72)	0.096†
Median	3	3	0.556‡
30-day readmissions, n (%)	10 (1.2)	3 (1.3)	0.809*
Mortality within 30 days, n (%)	2 (0.2)	1 (0.4)	0.512*
Mortality beyond 30 days, n (%)	3 (0.4)	1 (0.4)	0.616*
Complications n (%)			

Continued

Table I. Continued

Parameter	Pre-COVID-19 (n = 827)	COVID-19 (n = 224)	p-value
Deep infection	3 (0.4)	2 (0.9)	0.306*
Dislocations	5 (0.6)	1 (0.4)	0.780*
PE	1 (0.1)	0 (0.0)	N/A
Stroke	0 (0.0)	1 (0.4)	N/A
COVID-19 diagnosis, n (%)			N/A
Negative	N/A	41 (18)	
Positive postop	N/A	6 (3)	
Not tested	N/A	177 (79)	

*Pearson's chi-squared test or Fisher's exact test.

†Independent-samples *t*-test.

‡Mann-Whitney U test.

ASA, American Society of Anesthesiologists; CCI, Charlson Comorbidity Index; dep, dependent; IQR, interquartile range; N/A, not applicable; PE, pulmonary embolism.

was required, this was performed within the laminar air flow.

Outcomes. Our primary outcome was mortality from all causes within 30 days of surgery. Our secondary outcomes were the prevalence of SARS-CoV-2 infection among this group of patients, the incidence of a new diagnosis of SARS-CoV-2 infection during their inpatient stay, pulmonary and systemic complications, surgical complications, length of hospital stay, and readmission within 30 days from discharge. The data obtained were compared with data from a previous three-month period (1 November 2019 to 31 January 2020) for elective, urgent, and emergency arthroplasty procedures. The month of February was excluded to help avoid misrepresentation as it is believed that COVID-19 had already arrived in the UK by then.

Statistical analysis. The data were analyzed using the statistical and computing software R v3.6.3 (R Foundation for Statistical Computing, Austria) and Deducer software (USA). Continuous data were tested for distribution, and differences between groups were tested using the independent-samples *t*-test (means) and Mann-Whitney U test (medians). Pearson's chi-squared test and Fisher's exact tests were used for categorical data. Kaplan-Meier analysis was used for patient survival with Cox proportional hazard modelling to compare the survival distributions. A two-tailed probability (*p*) value < 0.05 was considered statistically significant.

Results

A total of 224 patients underwent lower limb arthroplasty procedures during the study period and 167 elective and 57 emergency procedures were performed. There were 70 males and 154 females. The median age was 70 years (IQR 63 to 76). The patient demographic data, diagnoses, BMI (kg/m²), Charlson Comorbidity Index (CCI), and American Society of Anesthesiologists (ASA),⁴ anaesthetic

Table II. Multivariate Cox regression analysis for overall mortality.

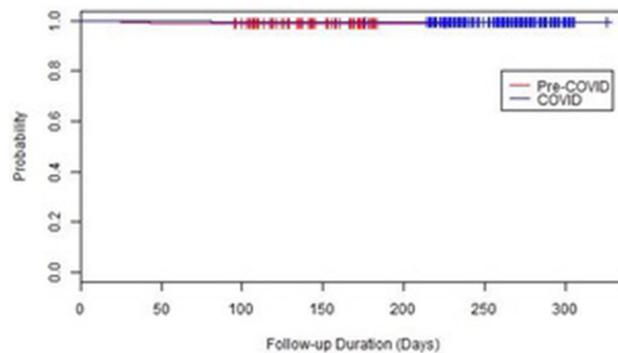
Parameter	Hazard ratio (95% CI)	p-value
Age, yrs		
< 30	0 (N/A)	0.999
31 to 50	0 (N/A)	0.993
51 to 70	0.562 (0.059 to 5.343)	0.616
> 70	Reference	
Sex		
Male	Reference	
Female	0.332 (0.061 to 1.796)	0.201
BMI, kg/m²		
Underweight (< 18.5)	0 (N/A)	0.997
Normal (18.5 to 24.9)	Reference	
Overweight (25 to 29.9)	1.134 (0.116 to 11.041)	0.914
Class I Obese (30 to 34.9)	0.119 (0.004 to 3.814)	0.229
Class II Obese (35 to 39.9)	0.282 (0.008 to 10.378)	0.491
Class III Obese (> 40)	0 (N/A)	0.994
N/A	0 (N/A)	0.988
Hypertension		
Present	Reference	
Absent	0.563 (0.117 to 2.714)	0.474
Obesity		
Present	Reference	
Absent	5.290 (0.597 to 46.873)	0.135
ASA grade		
1 to 2	Reference	
3 to 5	2.903 (0.578 to 14.575)	0.196
CCI score		
0 to 2	Reference	
3 to 4	2.143 (0.121 to 38.117)	0.604
5 to 6	0 (N/A)	0.992
> 6	5.297 (0.26 to 107.799)	0.278

ASA, American Society of Anesthesiologists; CCI, Charlson Comorbidity Index; CI, confidence interval; N/A, not applicable.

technique, operative procedure details, length of stay, and complications are summarized in Table I.

There was one death among this cohort within 30 days of their procedure (1/224, 0.4%). He was 73 years old with BMI of 39, hypertension, hypothyroidism, and a CCI of 3. He underwent an urgent first-stage revision right hip for sepsis due to *Staphylococcus lugdenensis* peri-prosthetic joint infection (PJI). He was making satisfactory progress and was due to be discharged the following day but on postoperative day 17, spiked a temperature overnight and tested positive for COVID-19. He died of multi-organ failure after four days of onset of his symptoms.

As stated previously, at the onset of the pandemic patients were only selectively tested based upon their symptoms. All patients referred from mid-April onwards were tested prior to transfer. In total, 47 patients were tested, of whom six tested positive (12.8%): four during their admission and two post-discharge, all in the postoperative period. We therefore report that the prevalence of COVID-19 infection in this group of patients was 12.8% but accept that this may be an under-representation as initially we had limited access to testing. The case fatality

**Fig. 1**

Kaplan-Meier survival analysis for patients in pre-COVID-19 and COVID-19 period.

rate for patients with a positive COVID-19 test was 16.7% (1/6). Two patients developed a surgical complication: there was one case of hip dislocation in a patient with a history of recurrent dislocation, and one PJI in a patient following a revision left hip arthroplasty. Both of these patients required further procedures: a manipulation for the recurrent dislocation and a first-stage revision for the patient with deep infection. In addition, a patient developed COVID-19 infection which required him to be transferred briefly to the regional teaching hospital for management of respiratory symptoms, before subsequent transfer back to our institute when recovered and from where he was discharged for offsite rehabilitation. Hence, the readmission rate within 30 days of discharge was 1.3% (3/224) of which two required a return to theatre within 30 days of their initial procedure 0.9% (2/224). The median length of hospital stay was three days (2, 12, and 25 days). One patient developed COVID-19 infection three weeks post-discharge after a revision knee arthroplasty prior to the national lockdown. They subsequently also developed a cerebrovascular event but have made a satisfactory recovery.

The above results were compared with data from a three-month period (1 November 2019 to 31 January 2020) during which 802 elective and 24 urgent and emergency arthroplasty procedures were performed at the same unit (Table I). The median age of the patients in this control cohort was 68 years with 362 male and 464 female patients. There were two deaths within 30 days of their procedure (0.24%) and ten readmissions within 30 days of their discharge (1.2%). The reasons for readmissions were: dislocation,⁶ PJI,³ pulmonary embolism,¹ severe back pain,¹ and eight patients among these required further procedures. A multivariate Cox regression analysis for overall mortality revealed no statistically significant differences (Table II), nor were there any statistically significant differences in survival between the pre-COVID-19 and peri-COVID-19 groups ($p = 0.624$) (Figure 1).

Table III. Summary of orthopaedic procedures performed according to the priority.

Priority level	Indication for procedures	Number of cases	Complications
1a - Emergency (within 24 hrs)	Dislocated joints Hip fractures PJI (DAIR)	Hips (10) Hips (20) Hips (3), Knees (4)	COVID-19 (1), Dislocation (1) COVID-19 (1)
1b Urgent (within 72 hrs)	Periprosthetic fractures	Hips (6) Knees (6)	
2 (Deferred up to 4 wks)	PJI (first-stage revision)	Hips (4) Knees (4)	COVID-19 (2), Death (1)
3 (Deferred for up to 3 mths)	AVN femoral head Revision surgery: ■ loosening ■ instability ■ second-stage revision ■ Adverse reaction to metal debris	Hips (2) Hips (7), Knees (4) Hips (2), Knees (2) Hips (1), Knees (0) Hips (2)	COVID-19 (1), PJI (1) COVID-19 (1)
4 (Deferred for > 3 mths)	Primary joint arthroplasty	Hips (75) Knees (72)	
Total		224	COVID-19 (6) Mortality (1, 0.4%)

AVN, avascular necrosis; DAIR, debridement, antibiotics and irrigation retention; PJI, periprosthetic joint infection.

Discussion

COVID-19 is believed to have arrived in the UK on 31 January 2020 and at the time of closure of the study period (31 May 2020), 257,539 people had tested positive for the disease and 37,527 people had confirmed infection at the time of their death in the UK.⁶ These were unprecedented times and warranted unprecedented arrangements regionally and nationally. Early reports from other centres in the epicentre of the pandemic reported mortality of 35% among patients undergoing urgent and nonurgent surgical procedures, which was deeply concerning.¹ Another report of patients treated with fracture neck of femur at multiple sites within Spanish territory early on in the pandemic showed a similar trend with higher mortality (30.4%) within 14 days from surgery in patients who contracted COVID-19, compared to 10.3% who tested negative despite displaying some of the symptoms.² This supported the decision to suspend all nonurgent surgical procedures at the onset of the pandemic understandably to protect patients, increase hospital capacity to care for patients with respiratory illnesses, and conserve personal protective equipment. Most recently, an international collaborative has reported a high overall 30-day mortality at 23.8% from an international cohort of 1,128 patients with COVID-19 among patients who underwent all types of surgery. The mortality among patients undergoing orthopaedic procedures was also high at 28.8%.³ There are currently no reports on the clinical outcomes of patients treated with arthroplasty surgery for lower limb trauma and for the complications of previous arthroplasty surgery.

This report shows that among the 167 patients who underwent elective joint reconstructive procedures during the study period, one patient contracted COVID-19 in the early postoperative period and recovered satisfactorily from her infection. There was no increase in 30-day

mortality, readmission, or return to theatre within 30 days of the procedure. This is also comparable to data over three months from the same institution prior to the pandemic. This is reassuring as there is significant anxiety among healthcare systems about resuming elective surgery (Tables I and II).

With regards to the urgent and emergency arthroplasty procedures performed during the study period, we had six patient who tested positive during their admission, all in their postoperative period. There was one death in a patient who had tested positive for COVID-19 at the time of their death. There are also reports on increased morbidity and mortality among patients aged > 70 years.³ Among the patients who tested positive for COVID-19, the case fatality rate was 16.7%. This is in keeping with the report from the international collaborative study highlighting that the patients aged 70 years or older, males, patients with comorbidities (ASA grades 3 to 5), and those needing emergency or major surgery are reportedly the most vulnerable to adverse outcomes with COVID-19.³ In patients who did not contract the virus, we did not find an increase in 30-day readmission or mortality (Tables I and II).

A recent publication from our institute evaluating the impact of the pandemic in 100 consecutive patients who underwent orthopaedic oncological procedures reported that three patients tested positive for COVID-19 during their admission and two patients tested positive on day 4 and 14 after discharge.⁷ There was one postoperative death among these five patients, leading to an overall mortality of 1% (1/100 patients) but 20% (1/5 patients) among those who tested positive for COVID-19. The annual mortality for comparable patients from our institute in the preceding year was 0.6%. The study concludes that it was safe to proceed with performing orthopaedic oncological procedures within managed pathways at a

single speciality orthopaedic hospital for these high-risk patients.⁷ The results of this report, combined with the current study, reassures the orthopaedic community that although the case fatality is high if patients tested positive for COVID-19 during their in-hospital stay, the likelihood of contracting the virus was low in our hospital.

With the reducing number of new cases regionally and nationally, orthopaedic trauma services had resumed at the referring hospitals with some orthopaedic services by the end of the study period. After a brief period to allow for decontamination, our unit cautiously resumed performing arthroplasty procedures. All patients undergoing orthopaedic surgery procedures are screened for symptoms such as fever, cough, shortness of breath, respiratory disturbances, pneumonia of uncertain cause, and contact with a person who tested positive for COVID-19 over the past 14 days at the time of listing as per the guidance issued by the WHO.^{8,9} Patients are advised to self-isolate for 14 days prior to surgery and have swab tests performed at 48 and 96 hours prior to their surgery. All entrants to the hospitals are required to wear masks and sanitize their hands frequently and before and after entering clinic areas. Staff members are required to follow local and national guidance on self-isolation upon developing symptoms or return from foreign travel.

A considerable amount of effort is currently going into the recovery and restoration of orthopaedic services across the country. NHS England, in partnership with the Royal Colleges of Surgeons in the UK, produced a document to guide surgeons to prioritize patients awaiting surgery and Trauma and Orthopaedics, categorizing them as Categories 1 to 4 (Table III).¹⁰ Unfortunately, it quickly became evident that often the patients believed to be the most urgent were also medically the most challenged and most at risk of developing pulmonary and complications if they were to contract COVID-19. We started with Category 1 and 2 patients who were medically suitable to proceed with, and Category 3 and 4 patients who were < 60 years followed by patients < 70 years who were otherwise in good health. All cases were discussed at our weekly multidisciplinary team meeting. We have not encountered any COVID-19-related complications among these patients so far. The orthopaedic community remains anxious and continues to work with local systems and regional teams to make COVID-19 safe sites to restore elective arthroplasty surgery. This is understandably challenging for centres that also receive acute admissions.

One of the most challenging aspects of restoration of elective orthopaedic surgery has been informing patients of the additional, but unknown, risks of undergoing a major orthopaedic procedure during the pandemic and obtaining informed consent. From the published literature it is understood that the risk of morbidity and mortality is considerably high if patients were to contract

COVID-19, however the risk of contracting such an infection is currently unknown.¹⁻³ It does therefore seem logical that major surgical procedures are performed within “COVID safe” or “managed” pathways to minimize the risk of exposure for the patients. There are guidelines and recommendation from NHS England, the Royal College of Surgeons in the UK, the Royal College of Anaesthesia, the British Orthopaedic Association in conjunction with other specialist societies,^{11,12} and most recently from the British Hip Society about prioritizing these patients.¹³ This study will provide some evidence on outcomes to guide patients and surgeons offering lower limb joint arthroplasty surgery.

COVID-19 was in circulation for nearly three weeks before we appreciated its full impact. Patients were not tested in the early stages of the study period – we are therefore unable to comment on the true incidence of COVID-19 among this group. Patients in the postoperative period were only selectively tested when clinically indicated, and hence their risk of contracting during their hospital stay or at home in the early postoperative period could not be established. For an outcome measure with a low reported rate, such as our reported death rate, it would be ideal to have a larger study population. However, this would require multicentre collaboration or a registry-based study which would then be complicated by variations in local protocols. Accepting the limitations of our study’s size, we feel the results add usefully to the understanding of the risks of surgery in the potential presence of COVID-19.

While an effective vaccine is developed and widely accepted, it is very likely that COVID-19 remains endemic. Despite appropriate screening and testing, patients will continue to be at risk of contracting infection during their hospital stay or in the postoperative period after discharge. We recommend that all precautions are taken to prevent patients contracting COVID-19 and developing pulmonary and systemic complications.

In conclusion, this study did not observe a significant rise in the morbidity due to COVID-19 among the elective or emergency lower limb arthroplasty procedures. The risk of mortality was high in the patients who contracted COVID-19 but such a risk appears to be low in managed pathways.



Take home message

- This study did not observe a significant rise in the morbidity due to COVID-19 among the elective or emergency lower limb arthroplasty procedures.

- The risk of mortality was high in the patients who contracted SARS-CoV-2 infection but such a risk appears to be low in managed pathways.

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References

1. **Lei S, Jiang F, Su W, et al.** Clinical characteristics and outcomes of patients undergoing surgeries during the incubation period of COVID-19 infection. *E Clin Med.* 2020;23:100331–100386.
2. **Muñoz Vives JM, Jornet-Gibert M, Cámara-Cabrera J.** Mortality rates of patients with proximal femoral fracture in a worldwide pandemic. *J Bone Joint Surg Am.* 2020;102-A(13).
3. **COVIDSurg Collaborative.** Mortality and pulmonary complications in patients undergoing surgery with perioperative SARS-CoV-2 infection: an international cohort study. *Lancet.* 2020;396(10243):27–38.
4. **Saklad M.** Grading of patients for surgical procedures. *Anesthesiol.* 1941;2(5):281–284.
5. **NHS England.** Clinical guide for the management of trauma and orthopaedic patients during coronavirus pandemic. 2020. <https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/C0274-Specialty-guide-Orthopaedic-trauma-v2-14-April.pdf> (date last accessed 14 June 2020).
6. **Worldometer.** Total coronavirus cases in the United Kingdom. 2020. <https://www.worldometers.info/coronavirus/country/uk/> (date last accessed 6 June 2020).
7. **Stevenson JD, Evans S, Morris G, et al.** Mortality of high-risk orthopaedic oncology patients during the COVID-19 pandemic: a prospective cohort study. *J Surg Oncol.* 2020;122(6):1027–1030.
8. **World Health Organization.** Infection prevention and control during health care when novel coronavirus (NCOV) infection is suspected. 2020. [https://www.who.int/publications-detail/infection-prevention-and-control-during-health-care-when-novel-coronavirus-\(ncov\)-infection-is-suspected-20200125](https://www.who.int/publications-detail/infection-prevention-and-control-during-health-care-when-novel-coronavirus-(ncov)-infection-is-suspected-20200125) (date last accessed 4 June 2020).
9. **World Health Organization.** Coronavirus disease (COVID-19) technical guidance: Surveillance and case definitions. 2020. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/surveillanceand-case-definitions> (date last accessed 2 April 2020).
10. **Cascella M, Rajnik M, Cuomo A, Dulebohn SC, Di Napoli R.** *Features, evaluation and treatment coronavirus COVID-19.* Treasure Island: Stat Pearls Publishing, 2020.
11. **NHS England.** Clinical Guide to surgical prioritisation during the coronavirus pandemic. 2020. <https://www.england.nhs.uk/coronavirus/wp-content/uploads/sites/52/2020/03/C0221-specialty-guide-surgical-prioritisation-v1.pdf> (date last accessed 2020).
12. **British Orthopaedic Association.** Re-starting non-urgent trauma and orthopaedic care: full guidance. 2020. <https://www.boa.ac.uk/uploads/assets/9383a53f-36d8-4782-8fe264c691b39b15/BOA-Guidance-for-restart-full-doc-final2-v11.pdf> (date last accessed May 2020).
13. **British Hip Society.** British hip society guidelines for prioritisation in hip surgery. 2020. <https://britishhipsociety.com/wp-content/uploads/2020/12/2020-Sept-Surgical-Prioritisation.pdf> (date last accessed 7 May 2021).

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- Y. Agrawal: Conceptualized the study, Collected and analyzed the data, Prepared the manuscript.
- A. Vasudev: Collected and analyzed the data, Prepared the manuscript.
- A. Sharma: Reviewed the manuscript.
- G. Cooper: Reviewed the manuscript.
- J. Stevenson: Analyzed the data, Prepared the manuscript.
- M. C. Parry: Reviewed the manuscript.
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