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ORIGINAL PAPER

The impact of COVID-19 pandemic on the mortality and morbidity of patients undergoing trauma surgery: a report from the UK Corona TRAUMA Surge (UKCoTS) study

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Abstract

Purpose To assess the impact of the COVID-19 pandemic on the outcomes of the patients who underwent trauma surgery during the peak of the pandemic.

Methods The UKCoTS collected the postoperative outcomes of consecutive patients who underwent trauma surgery across 50 centres during the peak of the pandemic (April 2020) and during April 2019.

Results Patients who were operated on during 2020 were less likely to be followed up within a 30-day postoperative period (57.5% versus 75.6% p <0.001). The 30-day mortality rate was significantly higher during 2020 (7.4% versus 3.7%, p <0.001). Likewise, the 60-day mortality rate was significantly higher in 2020 than in 2019 (p <0.001). Patients who were operated on during 2020 had lower rates of 30-day postoperative complications (20.7% versus 26.4%, p <0.001).

Conclusions Postoperative mortality was higher during the first wave of the COVID-19 pandemic compared to the same period in 2019, but with lower rates of postoperative complications and reoperation.

Keywords COVID-19 · Surgical outcomes · UK · Surgical services

Introduction

Since the World Health Organization (WHO) announced Coronavirus Disease 2019 (COVID-19) as a global pandemic in March 2020, the outbreak has spread worldwide and affected several sectors, leading to substantial socio-economic implications [1]. As of December 2021, nearly 289 million cases were affected by COVID-19, and over 5.4 million deaths were recorded globally [2]. The high replication rate (R0) of the severe acute respiratory syndrome coronavirus-type 2 (SARS-CoV-2) (R0 =2–3)—alongside the high proportion of asymptomatic patients—has led to constant growth in the active cases rate and increased healthcare services demands [3], which exceeded by far the healthcare system preparedness and capacity across the globe [4, 5]. Owing to such an unprecedented challenge, healthcare policymakers and stakeholders implemented several adaptations and response plans to prioritise provided services towards the high volume of COVID-19 patients, face the shortage in emergency healthcare capacity and staff, and limit the spread of COVID-19 amongst healthcare workers [6]. Surgical practices were amongst the early affected

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sectors. Many centres decided to postpone elective procedures, decrease the number of surgical staff, minimise face-to-face staff meetings, enhance self-prevention measures, mandate SARS-CoV-2 screening for patients before surgery, activate surgical pathways for infected cases, and limit visitors' time [7–10].

Nonetheless, a growing body of evidence hypothesised that the COVID-19 impact on surgical practices might affect the outcomes of patients undergoing emergency or elective surgeries [11–14]. For example, many centres mandate preoperative SARS-CoV-2 screening, which may limit timely management and compromise the postoperative outcomes of the patients [15]. The direction of the workforce towards intensive care units may result in a shortage of available anaesthesiologists for surgeries. Besides, previous reports indicate that COVID-19-infected patients had poor postoperative outcomes and a high in-hospital mortality rate, putting a further burden on the surgical procedures performed during the pandemic [16, 17]. However, the impact of the COVID-19 pandemic on postoperative outcomes is inconsistent in the published literature. In the PREDICT study, the peak months of the first wave of the pandemic witnessed a notable increase in postoperative mortality [18]. On the contrary, other studies highlighted no difference in postoperative mortality and morbidity between the peak months of the pandemic and the corresponding period before the pandemic [19].

In April 2020, the United Kingdom (UK) witnessed a dramatic increase in the number of COVID-19-infected individuals and a mortality rate of nearly 1000 cases per day, coupled with a shortage in an intensive care capacity. In return, several recommendations were implemented to mitigate the COVID-19 impact, including prioritising emergency services, cancellations of elective surgeries, redeploying surgical staff, mandatory SARS-CoV-2 testing for emergency surgery cases, minimising the operating team to essential members only, and measures for reducing the pre and intraoperative risk of infection [7]. The UK Corona TRAUMA Surge (UKCoTS) is a nationwide retrospective study that aimed to assess the impact of the COVID-19 pandemic on the postoperative mortality and morbidity of the patients who underwent trauma (bony or soft tissue procedure) surgery during the peak of the pandemic (April 2020).

Patients and methods

The present study was approved by the ethics and audit committee of all participating centres. The need for written informed consent was waived due to the retrospective nature of the study. The present manuscript was prepared in concordance with the STROBE guideline [20].

Design and patients

The UKCoTS, a part of the COVID Research group of the Royal College of Surgeons in England, was a retrospective multi-centre study that retrieved the data of patients who underwent trauma surgery across 50 centres in England, Wales, Scotland, and Ireland during the peak of the pandemic (April 2020). Investigators from the participating hospitals were invited to participate in the UKCoTS study during the Royal College of Surgeons (London) COVID-19 research team meeting. Sites' investigators were required to retrieve both electronic and paper records of all patients who underwent trauma surgery, regardless of its type, from April 1 to April 30, 2020 (the peak of the pandemic) and 2019 (to serve as a control group). There were no restrictions regarding age, sex, or type of anaesthesia. The urgency of surgery was defined as immediate, urgent, expedited, or elective, according to National Confidential Enquiry into Patient Outcome and Death (NCEPOD) guidelines.

Data collection

The data were collected remotely using a standardised Excel spreadsheet at each participating site. The collected data included demographic characteristics of the patients, comorbidities, nature of the procedure and its indication, procedure-related characteristics, time to surgery, pre and postoperative COVID-19 status, hospital stay, type of follow-up, 30-day postoperative complication, needs for reoperation, 30-day mortality, causes of death, and 60-day morbidity and mortality.

Statistical analysis

According to the procedure date (April 2020 versus April 2019), retrieved data were categorised into two groups. The data were summarised using a median with interquartile range (IQR) for continuous variables and numbers with percentages for categorical variables. The association between the date of procedure and continuous variables was tested using the Mann-Whitney *U* test, while categorical variables were compared using the chi-square or Fisher's exact test. A two-tailed *p*-value was considered statistically significant at <0.05.

Results

A total of 2595 patients were operated on during April 2020, compared to 4426 patients during the same period in 2019. Patients operated on during April 2020 were significantly

younger (p <0.001) and less likely to be males (p <0.001). Concerning comorbidities, patients operated on during 2020 were more likely to have cardiovascular diseases, pulmonary diseases, diabetes, and renal diseases (p <0.001). Besides, patients who were operated on in 2020 were more likely to have a higher American Society of Anaesthesiologists (ASA) status than patients operated on in 2019 (ASA us th=42% versus 30.6%, respectively, p <0.001). Regarding the urgency of surgery, more than two-thirds of 2020 surgeries were urgent, which was significantly higher than the percentage of urgent surgeries during 2019 (p <0.001). The median time to surgery was significantly shorter during 2020 compared to 2019 (1 (1–2) versus 1 (1–4) days, respectively, p <0.001). The contribution of trauma surgery to the overall surgery indications was significantly higher in 2020 than in 2019 (87.1% versus 80.2%, respectively, p <0.001). Notably, surgeries were less likely to be performed by registrars during 2020 than in 2019 (36.6% versus 44.8%, respectively, p <0.001), while surgeries were more likely to be performed under general anaesthesia during 2020 (p <0.001) (Table 1).

Association between the year of surgery and postoperative outcomes

Patients in 2020 were less likely to be followed up within a 30-day postoperative period than patients in 2019 (57.5% versus 75.6%, respectively, p <0.001). Out of the followed-up cohort, remote follow-up was more common in 2020 (Table 2).

The postoperative 30-day and 60-day mortality rates for the whole cohort were 6.3% and 14.5%, respectively. The 30-day mortality rate was significantly higher in 2020 than in 2019 (7.4% versus 3.7%, respectively, p <0.001). Patients who were operated on during 2020 were more likely to die within the 30-day postoperative period or alive in rehabilitation centres/hospitals than patients who were operated on during 2019 (p =0.028). Likewise, the 60-day mortality rate was significantly higher in 2020 than in 2019 (15.8% versus 13.7%, respectively, p <0.001; Table 2).

The overall 30-day rate of the study cohort was 24.2%. Surprisingly, patients who were operated on during 2020 were less likely to experience 30-day postoperative complications than those who were operated on during 2019 (20.7% versus 26.4%, respectively, p <0.001). The reoperation rate was lower amongst patients in 2020 (5.2% versus 9.2%, respectively, p <0.001). A similar trend was observed concerning the 60-day complication rate (Table 2).

Association between patients' characteristics and outcomes and the preoperative COVID-19 test result (Table 3)

Nearly 6% of patients had been identified with COVID-19 symptoms and had a positive preoperative swab test. All three (COVID-19 negative, COVID-19 positive, and patients with unknown COVID-19 status) groups had similar age and gender distributions. Most patients with either negative (43.2%) or positive (49%) test results were ASA grade III. Urgent surgeries predominated in all groups, with a small percentage of polytrauma patients. Trauma was the most common indication for surgery in all groups, followed by infection (p <0.05). Most surgeries were performed by consultants regardless of the test result. General anaesthesia was applied more in patients with positive or unknown preoperative COVID-19 status, whereas regional anaesthesia was used more in patients with negative tests (p <0.001). Patients with positive preoperative tests had significantly higher diabetes and cardiovascular, renal, pulmonary, and cognitive diseases (p <0.001). Preoperative COVID-19 symptoms were more evident amongst patients with positive preoperative tests with higher overall 30-day complications and mortality rates (p <0.001).

Discussion

The COVID-19 pandemic has exerted substantial healthcare, economic, and social burdens, which extended to affect surgical practice, particularly during the early waves of the pandemic. In the UK, surgical practices changed to accommodate the large number of COVID-19 patients needing hospitalisation; little is known about how such changes impacted the outcomes of patients undergoing surgery. The present nationwide study aimed to assess the impact of the COVID-19 pandemic on the postoperative mortality and morbidity of the patients who underwent trauma (bony or soft tissue procedure) surgery during the peak of the pandemic (April 2020). Our results highlighted that the surgical outcomes during the pandemic's peak were inferior to those during the same period before the pandemic, reflecting a substantial impact of the changes in the surgical practices implemented during the early wave of the pandemic on patients' outcomes.

As previously mentioned, several measures were implemented in the UK during the early wave of the pandemic, which might have extended to affect even emergency services. For example, several centres redeployed surgical staff to increase the readiness of intensive care services against the sheer volume of COVID-19 cases [21]. Besides, preventive measures towards the risk of intraoperative infection were employed, including minimising the operating team and preoperative COVID-19 screening [7]. While these measures aimed primarily to reduce the risk of in-hospital infection and increase the healthcare system's capacity, several researchers proposed that these measures negatively affected surgical outcomes [22–24]. Despite the increased mortality rate, our study highlighted a reduced

Table 1 Comparison of pre- and intraoperative characteristics of the study population according to the year of operation

Variables		Year 2020 (n =2595)	Year 2019 (n =4426)	p-value
Age in years	*n*	2563	4394	<0.001
	Median (IQR)	44 (71–85)	61 (32.8–80)	
Sex	*n*	2595	4412	<0.001
	Male (%)	1087 (41.9)	2130 (48.1)	
ASA grade (%)	*n*	2508	4265	<0.001
	I	685 (26.4)	1578 (35.7)	
	II	732 (28.2)	1325 (29.9)	
	III	901 (34.7)	1111 (25.1)	
	≥11	190 (7.3)	244 (5.5)	
Urgency of surgery (%)	*n*	2591	4419	<0.001
	Elective	55 (2.1)	434 (9.8)	
	Expedited	679 (26.2)	1371 (31.0)	
	Immediate	36 (1.4)	52 (1.2)	
	Urgent	1821 (70.3)	2562 (58.0)	
Polytrauma	*n*	2590	4416	0.91
	Yes (%)	77 (3.0)	126 (2.8)	
Time to surgery in days	*n*	2546	4308	<0.001
	Median (IQR)	1 (1–2)	1 (1–4)	
Indication for surgery (%)	*n*	2595	4358	<0.001
	Cancer	9 (0.3)	12 (0.3)	
	Infection	184 (7.1)	289 (6.5)	
	Invasive soft tissue procedure	82 (3.2)	266 (6)	
	Non-invasive soft tissue procedure	23 (0.9)	37 (0.8)	
	Others	27 (1.0)	180 (4.1)	
	Spine	11 (0.4)	23 (0.5)	
	Trauma	2259 (87.1)	3551 (80.2)	
Grade Of surgeon (%)	*n*	2415	4398	<0.001
	Consultant	1236 (47.6)	1944 (43.9)	
	CT/SHO	29 (1.1)	86 (1.9)	
	Fellow	200 (7.7)	385 (8.7)	
	Registrar	950 (36.6)	1983 (44.8)	
Type Of anaesthesia (%)	*n*	2576	4310	<0.001
	General	1371 (52.8)	3024 (68.3)	
	General and regional	269 (10.4)	491 (11.1)	
	Local	85 (3.3)	116 (2.6)	
	Regional	851 (32.8)	679 (15.3)	
Tourniquet use (%)	*n*	2558	4234	<0.001
	No	762 (29.4)	1364 (30.8)	
	Not applicable	1133 (43.7)	1334 (30.1)	
	Yes	663 (25.5)	1536 (34.7)	
Cardiovascular disease	*n*	2588	4410	<0.001
	Yes (%)	1072 (41.3)	1390 (31.4)	
Pulmonary disease	n	2591	4408	0.015
	Yes (%)	428 (16.5)	640 (14.5)	
Dementia	*n*	2592	4407	<0.001
	Yes (%)	371 (14.3)	318 (7.2)	
Diabetes mellitus	*n*	2592	4409	0.008
	Yes (%)	285 (11.0)	408 (9.2)	

Table 1 (continued)

Variables		Year 2020 (n =2595)	Year 2019 (n =4426)	p-value
Renal disease	n	2592	4407	<0.001
	Yes (%)	263 (10.1)	388 (6.5)	

Table 2 Comparison of postoperative outcomes of the study population according to the year of operation

Variables		Year 2020 (n =2595)	Year 2019 (n =4426)	p-value
Follow-up within 30 days	n	2551	4384	<0.001
	No follow-up	1085 (42.5)	1069 (24.4)	
	Remote surgical team	180 (7.1)	12 (0.3)	
	Remote therapy	24 (0.9)	1 (0.01)	
	Face-to-face surgical team	1168 (45.8)	3093 (69.9)	
	Face-to-face therapy	36 (1.4)	75 (1.7)	
	Face-to-face community	58 (2.2)	134 (3)	
30-day outcome	n	1481	819	0.028
	Died on table	2 (0.1)	1 (0.1)	
	Died day 0 to 7	28 (1.9)	7 (0.9)	
	Died day 8 to 30	80 (5.4)	22 (2.7)	
	Alive and still in the hospital	84 (5.7)	44 (5.4)	
	Alive and in another hospital	23 (1.6)	16 (2)	
	Alive and in a rehab unit	116 (7.8)	62 (7.6)	
	Alive and at home	1148 (77.5)	667 (81.4)	
Complications within 30 days	n	2586	4150	<0.001
	Yes (%)	536 (20.7)	1097 (26.4)	
Reoperation within 30 days	n	2585	4185	<0.001
	Yes (%)	135 (5.2)	384 (9.2)	
Morbidity within 60 days	n			<0.001
	Yes (%)	411 (15.8)	607 (13.7)	

Table 3 Comparison of patients by COVID-19 test result

	COVID-19 negative	COVID-19 positive	COVID-19 unknown	p-value
Number	658	151	1716	
Preoperative COVID-19 symptoms = true (%)	84 (12.8)	58 (38.4)	14 (0.8)	< 0.001
Complication 30 days = yes (%)	116 (17.6)	78 (51.7)	199 (11.6)	< 0.001
Mortality 30 days = yes (%)	47 (7.1)	15 (9.9)	64 (3.7)	< 0.001
Composite outcome 30 days = yes (%)	135 (20.5)	80 (53.0)	218 (12.7)	< 0.001

morbidity rate in form of lower complications and reoperations, which may emphasise the role of implementing preventive measures. To the best of our knowledge, this is the first nationwide study assessing the difference in postoperative outcomes between the peak months of the pandemic and the same period from the previous year. In a single-centre study from Turkey, the rate of in-hospital mortality amongst patients undergoing emergency surgery was higher during the pandemic peak (March to May 2020) than during the same period in the previous year [25]. In a multi-centre report from Germany, in-hospital mortality was higher in 2020 than in the previous two years amongst patients who underwent surgical treatment [26]. Similarly, the international PREDICT study reported an increase in in-hospital mortality amongst surgical patients presented during the first wave of the COVID-19 pandemic [22]. The increase in the mortality rate during the pandemic may be attributed to delayed presentation of the patients due to fear of COVID-19 infection leading to more severe status at presentation, as well as the changes in in-hospital

logistics leading to delayed diagnosis and intensive care capacities [27].

On the other hand, we found that the rate of postoperative complications was lower during the peak of the pandemic than in the same period from the previous year. Such findings run in line with previous reports showing either positive or no impact of the COVID-19 pandemic on postoperative complications [26, 28, 29].

During the COVID-19 pandemic, the focus of healthcare centres was directed towards the urgent surgeries rather than elective surgeries, in order to preserve human resources and infrastructure, which resulted in reducing the number of major elective surgery procedures performed. Some investigators believe that this change in the surgical practice, performing more urgent surgeries, may contribute to the high mortality rates, regardless of the direct effect of COVID-19. Minto et al. compared elective and emergency surgeries in terms of postoperative mortality and morbidity during the COVID-19 pandemic. Their findings showed that the overall all-cause 30-day mortality was 3.6% in the emergency setting compared to 0.79% in the elective setting. Moreover, mortality was higher in patients with positive COVID-19 compared to those with negative COVID-19 (14.6% vs 1.4%, $p<0.001$), respectively. The logistic regression analysis demonstrated a significant association between mortality and COVID-19-positive status (OR= 5.25, $p<0.001$) and emergency surgery (OR= 3.91, $p<0.001$) [30]. These findings highlighted that both COVID-19 status and emergency surgery may augment the risk of postoperative mortality; therefore, emergency and elective surgeries should be treated differently and should be separated in all studies to avoid the risk of bias. Based on our experience, we believe that the COVID-19 pandemic has a major effect on the mortality rate, regardless of the type of surgery; thus, we recommend treating both emergency and elective surgeries with the same degree of caution and implementing all preventive measures in both types of surgery. A Chinese series that included 34 patients with a perioperative diagnosis of COVID-19 infection undergoing elective surgery reports a mortality rate of 20.5%, requiring ICU management for respiratory failure in 44.1% of patients [31]. This rate of mortality resembles the rates reported from emergency surgeries, which supports our hypothesis.

We acknowledge that the present study has some limitations. The retrospective nature of the study can increase the risk of misclassification bias and impact the generalizability of the study. Besides, recall bias might have been presented during data collection, affecting its reliability.

In conclusion, the present study shows that postoperative mortality was higher during the first wave of the COVID-19 pandemic, compared to the same period in 2019, but with lower rates of postoperative complications. The harmful impact of COVID-19 on postoperative mortality can be explained by the tendency to perform urgent surgeries only during the peak of the pandemic and the delayed presentation of the patients due to fear of COVID-19 infection. However, the favourable postoperative complication rates during the pandemic reflect that trauma surgery can be safely performed during COVID-19 and similar pandemics. Hence, a risk assessment tool should be developed for surgical emergency services during pandemics.

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performed by Ahmed Elgebaly, Rawad Hassan, and Hassan Abdalla. The first draft of the manuscript was written by Mohamed Imam and Ahmed Elgebaly, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Declarations

Ethics approval This study was performed in line with the principles of the Declaration of Helsinki. The present study was approved by the ethics and audit committee of all participating centres.

Consent to participate The need for written informed consent was waived due to the retrospective nature of the study.

Consent for publication Not applicable

Competing interests The authors declare no competing interests.

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