

Understanding the Effect of COVID-19 Pandemic on Emergency Surgical Care Delivery in India: A Multicenter Cross-sectional Study

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Short title: A clinical audit of surgical services during COVID -19 pandemic.

Key words: India; COVID-19 pandemic; Cancellation of surgeries, Global lockdown; Low- and Middle-income country; Emergency surgeries

Word Count (Abstract): 265 words

Word Count (Manuscript): 2620 words

Title

Understanding the Effect of COVID-19 Pandemic on Emergency Surgical Care Delivery in India: A Multicenter Cross-sectional Study

Abstract

Background

The ongoing COVID-19 pandemic and subsequent lockdown have adversely affected global health care services to varying extent. Emergency Services were also affected along with elective surgeries, which were deferred to accommodate the added burden of COVID 19 affected patients, on the healthcare systems. We aimed to assess the change in delivery of essential and emergency surgeries due to the pandemic.

Methodology

A research consortium led by WHO Collaboration Centre (WHOCC) for Research in Surgical Care Delivery in Low- and Middle-Income countries (LMIC), India, conducted this retrospective cross-sectional study with 12 recruited centers. All surgeries performed during the months of April 2020 were compared with those performed in April 2019. These surgeries were stratified into emergency and elective, and further categorized based on NHS surgery prioritization documents.

Results

A total of 4396 surgeries were performed at these centers in April 2019 and 1216 surgeries were performed in same month during 2020, yielding a fall of 72.3% (1216 /4396). We found a 54% reduction in emergency surgeries and a 91% reduction in the elective surgeries. Number of cesarean sections reduced by 29.7% and fracture surgeries declined by 85.3% Laparotomies and surgeries for local soft tissue infections with necrotic tissue reduced by 71.7% and 69.5% respectively.

Conclusion

Our study quantifies the effects of COVID 19 pandemic on surgical care delivery in India and documents that the overall surgical volume reduced by three fourths in the pandemic period. Emergency surgeries reduced to half when compared with pre-pandemic period. Cesarean section surgeries were affected the least by pandemic, whereas the fracture surgeries and laparotomies were affected the most.

Introduction

COVID-19 pandemic and the resultant world-wide lockdowns have led to a drop in surgical volumes globally. There was a global call for deferment of all elective surgeries to reorganize the healthcare facilities, infrastructures and workforce for providing care to the COVID-19 affected patients. In reality, the pandemic and reduction in services affected not just the elective but many emergency surgeries as well.[1-4] Some of these emergency surgeries are categorized as 'essential surgeries' by the World Bank in 'Disease Control Priorities-3'(DCP3), indicating these need to be performed to avert 1.5 million deaths, globally per year.[5] Among these emergency surgeries, caesarean births, exploratory laparotomy and fracture fixation surgeries are considered bellwether procedures which indicate the capacity of healthcare system to perform essential and emergency surgeries. In this ongoing pandemic, approximately 70-80% of the healthcare services have been affected world-wide as many of the facilities shut down completely or partially for non-COVID-19 affected patients. Even emergency surgeries and bellwether procedures reduced as an effect of the pandemic and subsequent lockdown.[6] The intensive care facilities are being either used or reserved for COVID-19 patients and healthcare workers have been reassigned towards care of COVID-19 patients. The healthcare facilities have encouraged the healthcare workers to work in rotational duties to minimise contacting COVID-19 infection as an occupational risk and maintain a healthy workforce.[7] Healthcare workers worked in teams with rotational duties to minimise COVID-19 infection among the healthcare workers.[8] As the occupational risk has increased, the providers are having to deal with ethical dilemmas, regarding their own safety, patients' condition and judicious use of the available resources. As a consequence, a natural selection of surgeries has been observed, despite all previous priority-settings and protocols. An extensive body of literature has dealt with practice guidelines, prioritisation and resource managements in pandemic in subspecialties like surgical oncology, urology, minimal

access surgery, otolaryngology, neurosurgery amongst others. [4,6,9,10,11] Few studies have quantified the effect of COVID-19 pandemic on the emergency surgeries. Hence, we aimed to quantify the reduction in the emergency surgeries and bellwether procedures as an effect of COVID-19 pandemic and subsequent lockdown, across many hospitals in India.

Methodology

Research Collaboration

A research consortium led by WHO Collaboration Centre (WHOCC) for Research in Surgical Care Delivery in Low- and Middle-Income countries (LMIC), India, conducted this retrospective cross-sectional study. The healthcare centers with the capacity to provide all the 'essential surgeries', including all the bellwether procedures of caesarean sections, surgery for fractures and exploratory laparotomies, were included.[5,12] We recruited public, private and charitable hospitals which provided emergency and planned/elective surgical services in the departments of General Surgery, Orthopedics and Obstetrics-Gynecology. The total and emergency surgical volumes in the month of April 2020 were analysed and compared with surgeries in the month of April 2019 as a pre-pandemic comparator to minimise seasonal variations. The month of April 2020 was selected to capture the initial impact of pandemic and lockdown on surgical services, as the nation-wide lockdown in India started on March 24th, 2020. During this period many healthcare facilities were converted to dedicated COVID-19 facilities. Many healthcare facilities shut down temporarily for non COVID patients and the elective surgeries were cancelled all over the country.

We invited several hospitals across the country via emails and telephone calls, based on convenience, out of which 12 hospitals agreed to participate in the study. There were seven government teaching hospitals namely Maulana Azad Medical College (MAMC) and Lok Nayak Hospital, New Delhi; All India Institute of Medical Sciences, Jodhpur (AIIMS-J); AIIMS-Rishikesh (AIIMS-R); Seth G.S. Medical College & King Edward Memorial Hospital Mumbai (SGSMC & KEMH), Mumbai; Baroda Medical College(BMC), Vadodara; Command Hospital (CH), Pune and Bhabha Atomic Research

center Hospital (BARC), Mumbai; one private teaching institute namely Terna medical college (Terna), one private hospital namely Manipal Hospital, Delhi; and three district hospitals (DH) at Gopalganj, Vaishali and Purnea in Bihar. The centers exercised the choice to share data of any or all the selected departments performing essential surgeries.

Data collection

The investigator team at each institute collected the data either from the electronic medical records of the hospitals or captured the snapshots of the Operation Theatre registers where details of the surgeries were entered manually. Details of both elective and emergency surgeries were collected. Data variables collected from the centers were department names, patient unique identification number, age, sex, date of the surgery, and whether surgery was elective or emergency.

Data categorization

The patient identification was masked and the hospital names were coded. Data analysis team collated and standardized the names of the surgeries. The names of the surgeries were finalised by discussion between the members in the team for uniformity. Any differences or discrepancies were resolved with mutual discussion between the team members over periodic telephonic meetings. The standardized names were then grouped as emergency and elective surgeries. Ambiguous/ illegible surgery names were excluded from the analysis (Fig1). The surgeries were further classified as per the 'National Health Service (NHS) list for prioritisation of surgeries in COVID-19 pandemic document'. For this categorisation, we used the two separate lists, one published for Obstetrics-Gynecology and another one for subspecialties of surgery.[10,13] NHS surgery prioritisation lists describe various surgical procedures as per the urgency of carrying them out without risk to life. Category 1a includes high priority surgeries that cannot be postponed beyond 24 hours, like laparotomy for perforated hollow viscus or caesarean sections. Category 1b includes procedures that cannot be postponed beyond 72 hours. Similarly, category 2, 3 and 4 include procedures that cannot be postponed beyond one month,

can be postponed only up to three months and beyond three months, respectively. We combined category 1a and 1b for ease of analysis.

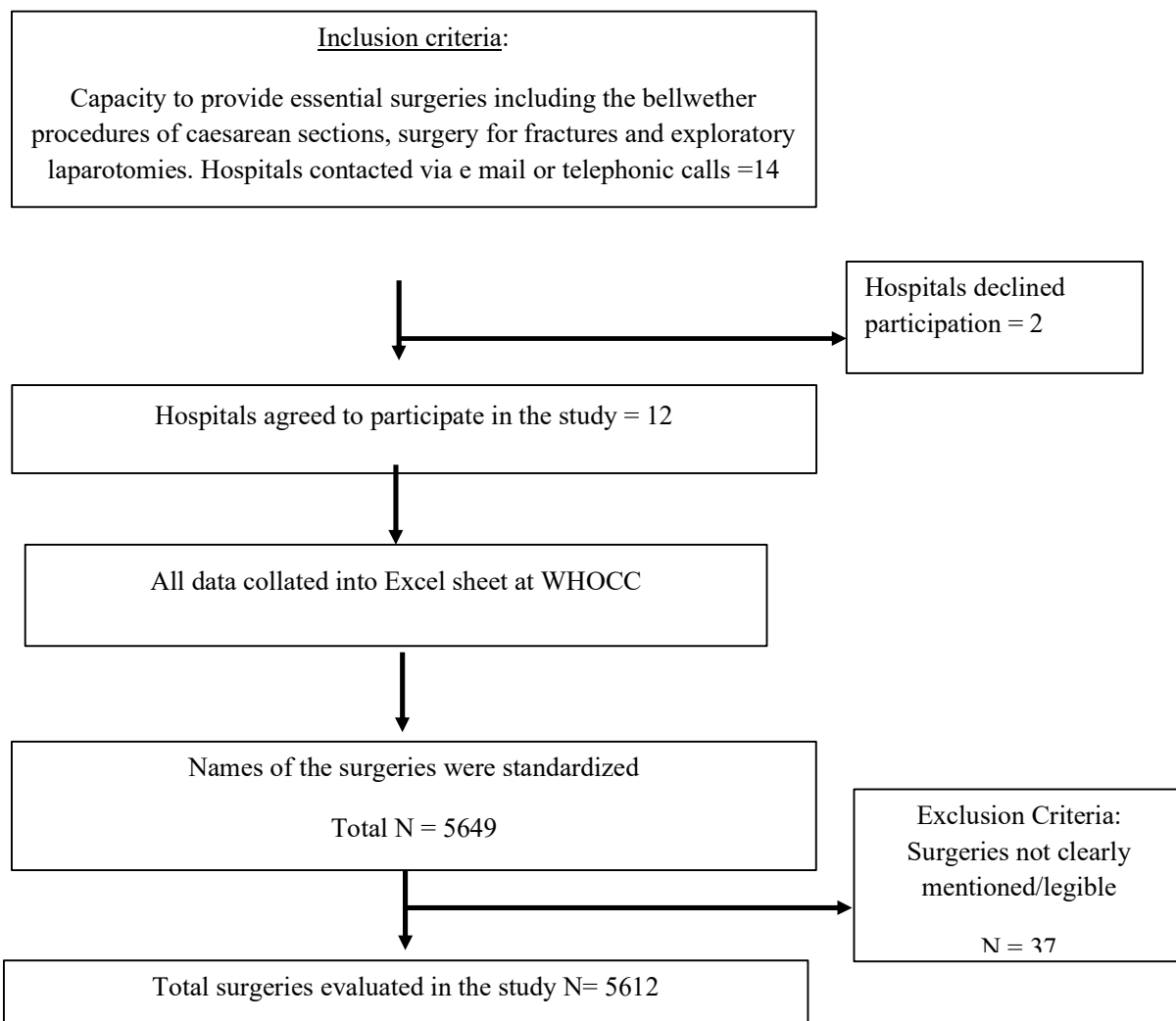
Data analysis

Microsoft Excel 2019 was used for the analysis. Frequency of surgeries performed during both the months (Pandemic period April 2020 and pre-pandemic period April 2019) was estimated, number of surgeries were calculated across age group, sex, specialty and participating centers. Difference in emergency and elective surgeries and differences across NHS categories one to four were also calculated. For ethical reasons we did not compare the surgeries and reductions in numbers between various hospitals. Our outcome measure was to calculate the change in the total number of emergency surgeries performed in April 2020 compared to April 2019 and document the change in bellwether procedures of caesarean section, fracture fixation and exploratory laparotomies.

Results

Figure 1 shows the recruitment algorithm and exclusion criteria for surgeries. 32 surgical departments from 12 hospitals across Indian cities participated in the study. We analysed records of 5612 surgeries from these centers. The mean age of the patients was 37.3 (SD-17.7; range 0-95 years). It was slightly lower in 2019 (mean 38.2, SD-18.1; range 0-95 years). 60.7% (n=3420) were females and 39.3% were males. The percentage reduction of surgeries amongst females was less (66.9%) compared to males (85.7%). Surgeries in age groups 21-30 years and 31-40 years experienced least reduction when compared to other age groups.

Figure 1: Recruitment Algorithm



Characteristics of participants:

Table 1 describes the characteristics of the participants. A total of 4396 surgeries were performed at these centers in April 2019 and 1216 surgeries were performed in same month during 2020. The total number of surgeries reduced by 72.3%(1216 /4396) in April 2020, compared to 2019.

Figure 2 depicts the reduction in the number of surgeries in each of the centers. Four hospitals provided data from Obstetrics-Gynecology departments only (center number: 6,10,11,12), whereas other eight hospitals provided data from all the three departments; Orthopedics, Obstetrics-Gynecology and General surgery.

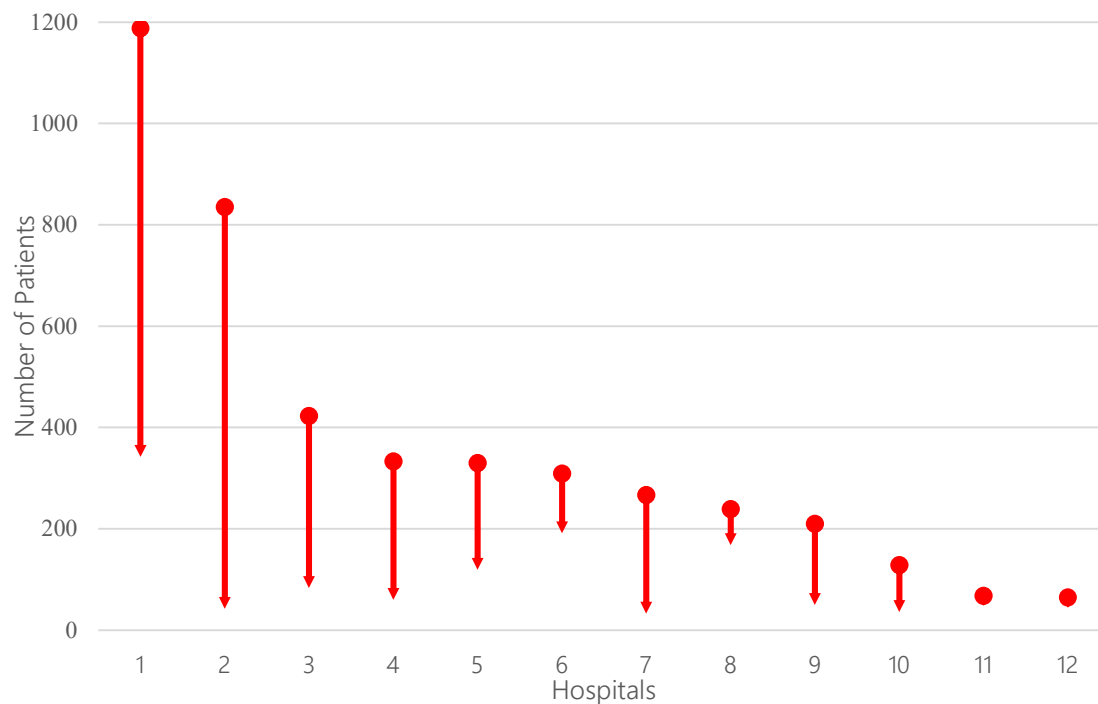
Table 1: Characteristics of the Participants

	Number of surgeries in April 2019	Number of surgeries in April 2020	% Reduction
Sex*			
Female	2569	851	66.9
Male	1719	245	85.7
Age Group**			
<10	116	17	85.3
10-20	266	35	86.8
20-30	1251	428	65.8
30-40	756	217	71.3
40-50	542	62	88.6
50-60	445	50	88.8
60-70	412	52	87.4
70-80	265	36	86.4

* Missing data for Sex of the patient: 228

** Missing data for age of the patient: 662

Figure2: Decrease in The Number of Surgeries at Individual Centres between April 2019 and April 2020



Reduction in the number of surgeries

Table 2 depicts the distribution of surgeries in both the reported periods. The total number of emergency surgeries reduced by 54.5% and the elective surgeries reduced by 91.1% but, the proportion of emergency surgeries to the total number of surgeries increased from 51.2%(2248/4396) to 84.2%(1024/1216) from 2019 to 2020.

Table 2 Comparison of number of surgeries between April 2019 and April 2020

	Number of surgeries in April 2019	Number of surgeries in April 2020	% Reduction

Number of Surgeries		4396	1216	72.3
Emergency	Emergency	2248	1024	54.50
	Elective	2148	192	91.10
NHS prioritization category				
	1 (within 72 hours)	2224	1033	53.5
	2 (within 1 month)	325	30	90.7
	3 (within 3 months)	32	5	84.3
	4 (beyond 3 months)	1658	110	93.3
	NHS categories not available	157	38	75.8

Comparison of emergency procedures:

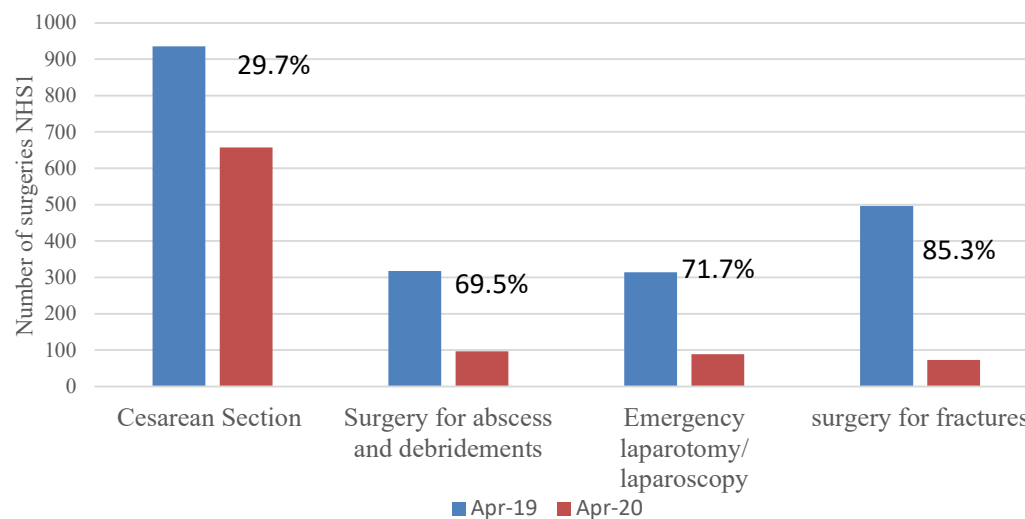
Table 3 shows the comparison of specific surgical procedures between the two study periods. All emergency procedures reduced with maximum reduction in management of fractures and minimum reduction in caesarean sections.

Table 3: Comparison of procedures between April 2019 and April 2020

Name of the surgery	NHS category	Number of surgeries in April 2019	Number of surgeries in April 2020	% Reduction
Caesarean Birth	1	935	657	29.7
Surgery for Fracture	1	496	73	85.3
Drainage of Abscess/Debridement/Amputation	1	318	97	69.5
Emergency Laparoscopy/Laparotomy	1	314	89	71.7
Dilatation and Curettage	1	162	54	66.7
Burr Hole	1	25	14	44.0
Gall Bladder Surgery	2	242	12	95.0
Uncomplicated Hernia	4	227	10	95.6
Others		1677	210	87.5
Total		4396	1216	72.3

Figure 3 highlights the reduction in emergency surgeries included in NHS category 1 procedures during pandemic period. Minimum drop was seen in the number of Caesarean sections (29.7%) and maximum reduction was seen in fracture surgeries (85.3%). Laparotomies and surgeries for local soft tissue infections with necrotic tissue reduced by 71.7% and 69.5% respectively.

Fig 3. Reduction in the NHS1 category surgeries during COVID pandemic period.



Discussion

Our study documented a 72.3% overall reduction in surgical volumes across various levels of healthcare facilities. The COVID-19 pandemic has affected the pre-existing frail surgical care delivery system in LMIC like India where workforce as well as infrastructure resources are limited.[12] The reduced access to hospitals due to national lockdown and subsequently reduced admissions and footfalls further affected the number of surgeries being performed.[3,14] In our study, the reduction by three fourths is significant, considering large teaching hospitals as well as

secondary care (district) hospitals are represented. These referral hospitals were the only functioning healthcare facilities in the initial month after lockdown and the smaller hospitals and private nursing homes had shut down.[3,6] ‘COVID Surge Collaborative’ in its prediction of effect of pandemic on cancellations of surgeries, estimated that 72% of the total surgeries would be cancelled due to pandemic and cancellation of elective surgeries for a 12-week period was estimated to be at 80%.[2] Similar 79% drop in the neurosurgeries was documented in a global survey. This survey documented 81% reduction in neurosurgical services in India.[4] An Italian study documented a drop-in emergency surgery by 86% in the first month after nation-wide lockdown. This drop was in spite of reserving a center specially for emergency medical and surgical care in patients, other than COVID-19 infected patients.[3] Our study period, similarly corresponds to the first month after a lockdown was announced for the pandemic. None of the studies have documented the effect on emergency surgeries other than those for sub specialties. [1,6,10,12] Similar 70% drop in surgical admissions and 50% drop in major surgeries was documented in the Ebola pandemic from Sierra Leone.[15]

We found a 54% reduction in emergency surgeries and a 91% reduction in the elective surgeries. The reduction in the emergency surgeries may be attributed to resource diversion to the care of COVID-19 patients, as well as lockdowns leading to poor access to healthcare. Omission of these emergency surgeries, which include essential surgeries, would lead to a huge disease burden and consequently a larger number of Disease Adjusted Life Years (DALYs).[5] As the number of total surgeries reduced, the proportion of emergency surgeries increased from 51 to 84%. The proportion of emergency surgeries within total surgical volumes is a measure of how advanced the surgical systems are.[16,17,18] The proportion of emergency surgeries is higher in the less advanced health systems as these systems are not prepared to handle advanced and elective

procedures. The enumeration of surgeries in low income countries like Sierra Leone and Ghana in non-pandemic times, showed that 60-70% of the surgeries are emergency surgeries among the total volumes.[19] The pandemic situation has brought down the surgical systems all over the world to 'limited resource environments', where predominantly emergency surgeries are being performed and there are limited or no resources allotted for advanced and elective surgeries. This has led to expected subsequent rise in the proportion of emergency surgeries as we have documented in this study.

We documented a 54% reduction in the NHS category 1 surgeries. Provision of these surgeries would avert 6-7% of avertable deaths in LMICs. Hence quantifying this gap in the delivery of emergency surgeries is necessary for making provisions for them. There are no Indian studies to compare or externally validate our observations about overall reduction in emergency surgeries. Similar studies during Ebola epidemic in Africa had showed a similar reduction in the surgical volume.[15] Studies from Italy documented similar 70-78% reduction in elective urological and oncological surgeries, our study has documented an effect of similar magnitude (91%) on elective surgeries as documented from Italy.[11,20]

Caesarean sections were affected the least of all emergency surgeries (29.7%) as shown in figure 3, documenting that redistribution of priorities happened even within the emergency surgery category. Similar studies measuring impact on obstetric services and caesarean sections in the COVID pandemic were not available for comparison. The Sierra Leonean study documented a similar 20-40% reduction in Caesarean surgeries during initial period of Ebola epidemic within first 21 weeks from the onset of pandemic.[21] It is possible that Caesarean sections were prioritized by the healthcare workers and the risk-taking ability of the healthcare workers for the caesareans were higher compared to that for other surgeries. This was documented by healthcare

workers' narratives in another study documenting Ebola pandemic. [22] The number of caesareans picked up and even increased within six months in the Ebola epidemic. We will need longer follow up period to assess the trends.

The higher number of reductions in surgeries for fractures and trauma could be due to reduced numbers of vehicular accidents and road traffic restrictions enforced due to lockdown. We did not have documentation of the mechanism of injuries in these 'surgeries for fractures. We could, thus, not confirm whether the fractures operated during the pandemic period were caused by road traffic accidents or any other mechanisms. The orthopedic study considering femur fractures documented reduced femur fracture rates by 25%. [23] A definite change of indications for operations was documented in the global neurosurgery survey and also in a study from Spain, where threshold for surgery was higher than pre-pandemic period. [4,24] The Spanish study documenting abdominal emergency surgeries, attributed the reduction partly to changed indications for surgeries. Appendicitis, cholecystitis and some of the abdominal conditions may have been treated conservatively with higher threshold for surgery. [24] This may explain similar decline in laparotomies and surgeries for fractures in our study. Reduced access to hospitals and subsequent reduced footfalls and admissions, still remain the most likely reason for reduction in all the surgeries.

The strength of our study is that this is the first Indian study looking at the immediate impact of ongoing pandemic and lockdown on delivery of surgical services. This may be used as a benchmark for identifying areas of potential strengthening of emergency surgical care delivery in India. Assessing workload and patient population has been recommended as a strategy while considering reopening and reorganisation of services by the guidelines published by Royal college of Surgeons. [25] Reserving dedicated healthcare facilities or dedicated teams within the existing

facilities for emergency surgical and medical care was also documented in various studies.[7,8] In a limited resource country like India, some health care facilities initially were reserved as dedicated COVID-19 facilities, however, this may not be sustainable solution. Strengthening government healthcare facilities to take the additional disease burden of COVID affected patients, reserving different teams for continuing the emergency surgical services in patients affected with COVID as well as other patients, could be explored.

The limitations of our study are relatively lesser number of representative health care institutions, compared to the size of our country. There is also a possibility of selection bias, as there are fewer private institutions in our study population. This being said, our study included hospitals from different cities, and may partly overcome the said limitations

Conclusion

To conclude, our study quantified the effects of COVID 19 pandemic on surgical care delivery and documents that the overall surgical volume reduced by three fourths in the pandemic period. Emergency surgeries reduced to half, whereas elective surgeries reduced by ninety percent. Caesarean sections were affected the least, whereas the fracture surgeries and laparotomies were affected the most.

Declarations

Ethics Approval: Institutional review board concurrence was obtained by respective participating center (TMCHRC/SURG/2020/IEC/28/58; CT/HCMCT/IEC/Gen Surg/2020-21)

Consent: Not applicable as this is an audit of surgical procedures during COVID 19 pandemic in India.

Consent for Publication: All the authors of the manuscript have provided their consent for publication

Availability of Data & Materials: The data and material used in this research is available with the corresponding author and will be provided on request

Competing interests: None of the authors of the manuscript have financial or non-financial competing interests to disclose

Funding: No funding was received for this study

Authors' contributions: AG, NR, GB, MK, BS, DKV, PB, MM, PS: Conceived the study, refined the aims and methodology, recruitment of the study centers, data collection, standardization and analysis of the data and contributed to the writing and revision of the manuscript

LB, AR: Refined the methodology, helped in the data collection, contributed in revising and improving the manuscript

DB, AM, RP, SKS, PK, AG, HJ, RW, RK, NS, DB, SA, RRS, NMM: Contributed to data compilation and revising the manuscript with valuable inputs and suggestions.

Acknowledgements: We would like to acknowledge the contribution of Jyoti Kamble and Sakshi Shimpi who helped in data documentation and standardisation

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