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Research Article

Retrospective registry-based nationwide analysis of the COVID-19 lockdown effect on the volume of general and visceral non-malignant surgical procedures

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ABSTRACT

Introduction: Coronavirus disease 2019 (COVID-19) is an acute virus infection, which was declared a pandemic by the World Health Organization. The Swiss government decreed a public lockdown to reduce and restrict further infections. The aim of this investigation was to analyze the impact of the first COVID-19 lockdown on the performance of general and visceral surgery procedures.

Materials and Methods: A retrospective study was performed on the basis of the surgical registry of the working group for quality assurance in surgery ("Arbeitsgemeinschaft für Qualitätssicherung in der Chirurgie" or AQC). All patients with specific surgical diagnoses (complicated gastric or duodenal ulcer, acute appendicitis, hernia, diverticular disease, gallstone disease, pilonidal sinus, cutaneous and perianal abscess) were analyzed during 2019 and the corresponding lockdown period of March 14 through April 26, 2020. Data regarding patients' characteristics, diagnoses, and treatments were analyzed.

Results: In total, 3,330 patients were analyzed, with 2,203 patients treated in 2019 and 1,127 patients treated in 2020. There was a reduction in the number of all investigated diagnoses during the pandemic period, with statistically significant differences in acute appendicitis, hernia, diverticular disease, gallstone disease, pilonidal sinus (all $p < 0.001$), and cutaneous abscess ($p = 0.01$). The proportion of complicated appendicitis ($p = 0.02$), complicated hernia ($p < 0.001$), and complicated gallstone disease (choledocholithiasis $p = 0.01$; inflammation, $p = 0.001$) was significantly higher during the lockdown period. The surgical urgency rate in all patients was higher during the lockdown period compared to the control period ($p < 0.001$).

Conclusions: The socioeconomic lockdown significantly impacted the number of general and visceral surgery procedures in Switzerland. The reasons for the reduction are multifactorial.

Introduction

Since the first reports about a viral infection of the respiratory tract in late 2019 caused by a coronavirus (severe acute respiratory syndrome (SARS)-CoV-2), coronavirus disease 2019 (COVID-19) was increasingly reported with mild and severe courses worldwide [1,2]. The massive extension of COVID-19 as an epidemic infection [3,4] led to the declaration of a pandemic by the World Health Organization on March 11, 2020. With further increases in the number of infections, COVID-19 became a worldwide public health emergency, and emergency departments and intensive care units suffered [5]. Consequently, the Swiss government declared a temporary public lockdown from March 14 to April 26, 2020, by limiting public and economic life [6].

At the peak of the pandemic, many governments restricted elective surgery to save resources [7–9] and redistribute the work force and hospital resources. In many countries, a decrease in elective and non-elective trauma and emergency cases was observed [6,10]. Furthermore, non-trauma admissions and surgical emergency procedures were reduced during the lockdown, probably caused by multifactorial issues [6,11-13].

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Limitations of public life and social distancing measures were implemented in many countries to reduce the spread of COVID-19, partly with national lockdowns. Non-urgent operations were postponed, preserving resources in hospitals [11]. These actions caused a slowdown of public life. Many hospitals noticed a decrease in medical emergencies such as strokes and cardiac events during the lockdown period, and they postulated that this decrease was caused by multiple factors. However, it was deemed to be occurring most likely because patients were avoiding hospitals due to fears of becoming infected with COVID-19 [14–16]. A decrease in surgical diseases such as acute appendicitis, acute cholecystitis, or non-complicated diverticulitis during the lockdown period has been recently reported [17–19]. By conducting a nationwide database analysis, we have been able to demonstrate that even trauma surgery decreased during lockdown, whereas mortality and complication rates remained stable compared to previous years [20].

COVID-19 had a serious impact on healthcare systems, creating workforce issues, problematizing procedural prioritization, and presenting a constant risk of viral transmission [21]. Many authors have identified issues to address regarding surgical practice to improve safety for patients and medical personnel [22–24].

The aim of this retrospective, nationwide, registry-based investigation was to analyze the impact of the COVID-19 lockdown on the performance of general and visceral surgery procedures in non-malignant diseases in Switzerland.

Materials and methods

A retrospective, nationwide registry study was performed using a prospectively led database of the AQC [25], a voluntary quality working group of surgical departments in Switzerland. Currently, more than 1.7 million cases are recorded in this database, including the data of more than 70 public (including regional, cantonal, and university hospitals) and private surgical departments nationwide. The patient and procedural data of each registered surgical department are entered in a centralized database. The analysis covered the years 2019 and 2020, with a primary interest in the governmental instituted lockdown period in Switzerland between March 14, 2020, and April 26, 2020, and the corresponding time period in 2019 as a control group. Overall, eight main diagnosis groups were included in this investigation: complicated gastric or duodenal ulcer, acute appendicitis, hernia, diverticular disease, gallstone disease, perianal abscess, cutaneous abscess, and pilonidal sinus. All of these non-malignant diseases have a certain necessity of urgent treatment, which was a precondition for treatment during the lockdown period, and they are not directly influenceable by the patient.

Data regarding the year and time point of surgery, patients' characteristics (age, gender, American Society of Anesthesiologists score), diagnosis group (complicated gastric or duodenal ulcer with bleeding and/or perforation, acute appendicitis, hernia, diverticular disease, gallstone disease, perianal abscess, cutaneous abscess, and pilonidal sinus), and urgency of surgical intervention (planned vs. urgent) were collected and compared between the two time periods.

Statistical analysis

Continuous variables were reported as mean and standard deviation or median and interquartile range as appropriate. Comparison of the groups was performed using Student's *t*-test. Categorical variables were reported as proportions and compared with the Chi square test. Statistical analysis of the data and graphics were completed with the GraphPad Prism 5.0 software package (GraphPad, San Diego, California, USA). A $p \leq 0.05$ was assumed to be statistically significant.

Ethical considerations

As the data were anonymized from the beginning of the analysis, an ethical committee approval was waived, but the data analysis was performed according to the guidelines of the local ethics committee and in strict adherence to the ethical guidelines for human research from the Swiss Academy of Medical Sciences. Due to the anonymity of the datasets, a specific informed consent for each patient in this investigation was not obtained, but in general all patients confirmed during their treatments that their personal and procedural data may be used for statistical analysis.

Results

In total, 31,497 patients were enrolled in this investigation, of which 17,147 patients were treated in 2019 and 14,350 patients were treated in 2020. Except during the months February and July, more patients were treated in 2019 than in 2020 (Fig. 1a), with an overall significant drop of 49% during the lockdown period in March and April 2020 compared to the corresponding time period in 2019 (Fig. 1b). Urgent operations were statistically significant more encountered in 2020 compared to 2019 (2019 $n = 1003$, 45.5% vs. 2020 $n = 769$, 68.2%, $p < 0.001$).

Except for perianal abscess (2019 $n = 73$ vs. 2020 $n = 70$; −4%, $p = 0.8$) and complicated gastric and duodenal ulcer (2019 $n = 15$ vs. 2020 $n = 8$; −46%, $p = 0.1$), the number of treated patients was significantly reduced during the COVID-19 lockdown: diverticular disease (2019 $n = 175$ vs. 2020 $n = 119$; −32%, $p < 0.001$), gallstone disease (2019 $n = 550$ vs. 2020 $n = 304$; −45%, $p < 0.001$), acute appendicitis (2019 $n = 418$ vs. 2020 $n = 319$; −24%, $p < 0.001$) with an increase only of complicated appendicitis (2019 $n = 81$, 19.4% vs. 2020 $n = 76$, 23.8%, $p = 0.02$), subcutaneous abscess (2019 $n = 98$ vs. 2020 $n = 66$; −33%, $p = 0.01$), pilonidal sinus (2019 $n = 73$ vs. 2020 $n = 34$; −54%, $p < 0.001$), and hernia (2019 $n = 802$ vs. 2020 $n = 207$; −74%, $p < 0.001$, Table 1). Apart from parastomal hernia, hernia surgery (inguinal, femoral, umbilical, ventral, incisional) was statistically significant decreased during the pandemic lockdown period in comparison to 2019 (Table 2).

Except for age in hernia repair and gallstone disease, there were no statistically significant differences between the groups regarding patients' characteristics (age, gender, and length of hospital stay, Tables 3 and 4). In cases of hernia repair, American Society of Anesthesiologists scores were statistically significant increased during the lockdown period in comparison to 2019 (2% vs 24%, $p < 0.001$, Table 3). Surgical treatments of hernia repair, cholecystectomy, diverticular disease, and pilonidal sinus were statistically significant more often performed as urgent procedures during the lockdown period (Table 5). For appendicitis, subcutaneous abscess, and perianal abscess, urgent procedures remained unchanged, and for gastric/duodenal ulcers, the rate of urgent procedures declined (Table 5). The rate of complicated diverticular disease (e.g. perforation, abscess) remained constant during the compared periods (2019 37% vs. 2020 34%, $p = 0.6$). The rate of obstructed hernia significantly increased (2019 17.2% vs. 2020 27.5%, $p < 0.001$), whereas the rate of gangrenous hernia was not significantly changed during the lockdown period (2019 and 2020 1.9%, $p = 0.9$). The lockdown period was associated with a statistically significant increased rate of complicated cholelithiasis (choledocholithiasis: 2019 $n = 48$, 8.7% vs. 2020 $n = 43$, 14.1%, $p = 0.01$; inflammation of the gallbladder: 2019 $n = 356$, 64% vs. 2020 $n = 229$, 75%, $p = 0.001$).

Discussion

This nationwide retrospective analysis showed a significant decrease in specific general and visceral surgery procedures in non-malignant diseases during the first COVID-19 lockdown in Switzerland. This effect was already seen in other medical specialties, especially in emergency surgery or medicine [6,13,15,26,27]. Most authors have assumed multifactorial causes, such avoidance and patient fears concerning possible COVID-19 infection in an overloaded emergency department, limited access to transportation, financial constraints, changes in

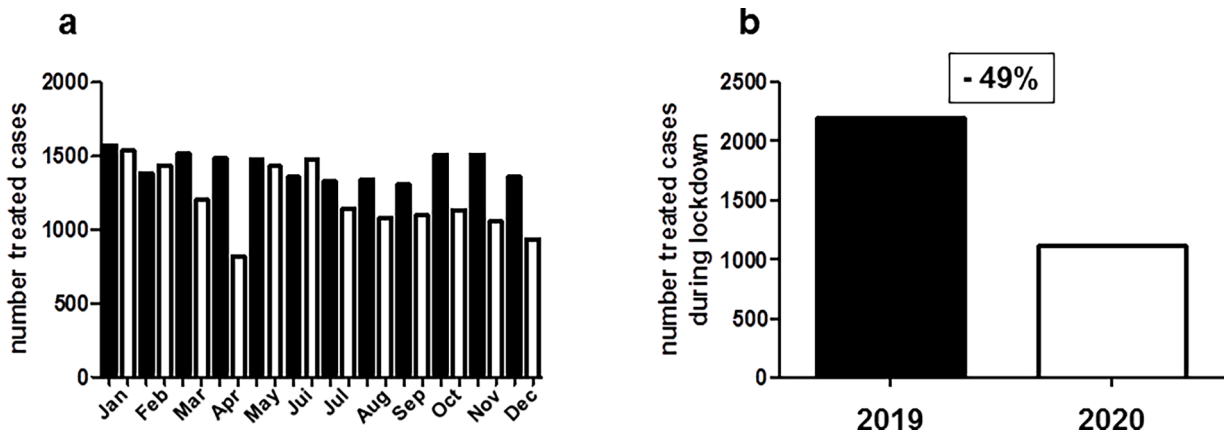

Fig. 1. a) Comparison of treated patients per month during 2019 (black bars) and 2020 (white bars), showing an obvious drop of treated patients during March and April 2020. b) Comparison of treated patients during the lockdown period and the corresponding time period in 2019.

Table 1
Incidence of specific non-malignant surgical procedures/diseases during lockdown period in comparison to 2019.

	2019 [n]	2020 [n]	p value*
Complicated gastric or duodenal ulcer	15	8	0.1
Acute appendicitis	418	319	<0.001
Rate of complicated appendicitis [%]	19.4	23.8	0.02
Hernia repair	802	207	<0.001
Diverticular disease	175	119	<0.001
Gallstone disease	550	304	<0.001
Perianal abscess	73	70	0.8
Cutaneous abscess	98	66	0.01
Pilonidal sinus	73	34	<0.001

* Analyzed with Chi square test; $p < 0.05$ statistically significant.

Table 2
Incidence of specific type of hernia during lockdown period in comparison to 2019.

	2019 [n]	2020 [n]	p value*
Hernia total	802	207	<0.001
Inguinal/femoral hernia	546	150	<0.001
Unilateral	344	102	<0.001
Bilateral	202	48	<0.001
Umbilical hernia	108	18	<0.001
Ventral abdominal hernia	90	22	<0.001
Incisional hernia	52	15	<0.001
Parastomal hernia	6	2	0.2

* Analyzed with Chi square test; $p < 0.05$ statistically significant.

lifestyle habits, or modifications to treatment strategies [11,28-30].

Overall, this pandemic affected the global medical community [31]. In a multinational survey among emergency surgeons from Europe, the United States of America, Asia, and Africa, it was shown that the COVID-19 pandemic substantially affected the daily lives of most of the surgeons via a decrease in surgical emergency patients [31]. On the other hand, an increase in disease severity, such as septic abdominal complications, was reported, which is comparable to our analysis [19, 31,32]. During the lockdown period, it was necessary to reshape clinical structures and processes to facilitate increased capacity in emergency departments, intensive care units, and medical wards to supply COVID-19 patients with the best medical care [13,33,34]. Therefore, the capacity of surgical wards and operation theaters was reduced, and elective surgery was postponed, decreasing the number of surgical procedures [13]. However, there are small studies showing that the care of COVID-19 patients and emergency or orthopedic surgery were possible due to changes in hospital structures and isolation measures [35,36].

Table 3
Comparison of age, male gender and American Society of Anesthesiologists (ASA) score in patients during lockdown period and 2019.

	Age [y]		Male Gender [n;%]		ASA [n]	
	2019	2020	2019	2020	2019	2020
Gastric / duodenal ulcer	69 ± 15	66 ± 22	9 (60%)	6 (75%)	ASA 1–2: 9 ASA >3: 6	ASA 1–2: 3 ASA >3: 5
Appendicitis	38 ± 19	40 ± 19	228 (55%)	177 (56%)	ASA 1–2: 392 ASA >3: 26	ASA 1–2: 306 ASA >3: 13
Hernia	60 ± 16	63 ± 17#	622 (78%)	158 (76%)	ASA 1–2: 788 ASA >3: 14	ASA 1–2: 158* ASA >3: 49
Diverticular disease	62 ± 13	64 ± 17	89 (51%)	62 (52%)	ASA 1–2: 150 ASA >3: 25	ASA 1–2: 93 ASA >3: 26
Gallstone disease	59 ± 16	56 ± 18##	241 (44%)	130 (43%)	ASA 1–2: 457 ASA >3: 93	ASA 1–2: 249 ASA >3: 55
Perianal abscess	47 ± 17	47 ± 16	46 (63%)	58 (83%)	ASA 1–2: 68 ASA >3: 5	ASA 1–2: 67 ASA >3: 3
Cutaneous abscess	47 ± 20	44 ± 17	58 (59%)	50 (76%)	ASA 1–2: 82 ASA >3: 16	ASA 1–2: 57 ASA >3: 9
Pilonidal sinus	30 ± 12	28 ± 11	60 (82%)	23 (68%)	ASA 1–2: 73 ASA >3: 0	ASA 1–2: 34 ASA >3: 0

Age given in mean and standard deviation.
Analyzed with *t*-test: # $p = 0.05$, ## $p = 0.04$.
Analyzed with Chi square test * $p < 0.001$.

The reduction in orthopedic and trauma patients might be explainable due to a decrease in work injuries, traffic accidents, leisure accidents, and violent crime incidences caused by social distancing and lockdown restrictions [37]. However, there is no obvious reason for the reduction of general and visceral surgery procedures such as acute

Table 4
Comparison of length of hospital stay in patients during lockdown period and 2019.

	Length of hospital stay [d]	
	2019	2020
Complicated gastric/duodenal ulcer	13.2 ± 8.8	8.25 ± 2.3
Appendicitis	4.3 ± 3.4	3.9 ± 2.0
Hernia	4.1 ± 4.3	4.6 ± 4.6
Diverticular disease	8.7 ± 7.3	8.0 ± 5.8
Gallstone disease	5.7 ± 16.7	5.1 ± 3.6
Perianal abscess	2.9 ± 1.3	3.4 ± 5.4
Cutaneous abscess	4.2 ± 3.7	3.2 ± 1.8
Pilonidal sinus	2.8 ± 1.1	2.4 ± 0.7

Data given in mean with standard deviation.
Analyzed with *t*-test, all $p > 0.05$.

Table 5
Proportion of urgent surgical procedures during lockdown in comparison to 2019.

	Urgent procedures		p value*
	2019	2020	
Complicated gastric/duodenal ulcer	15 (100%)	6 (75%)	<0.001
Appendicitis	399 (96%)	300 (94%)	0.3
Hernia	100 (13%)	158 (76%)	<0.001
Diverticular disease	59 (34%)	94 (79%)	<0.001
Gallstone disease	266 (41%)	197 (65%)	<0.001
Perianal abscess	59 (81%)	55 (79%)	0.7
Cutaneous abscess	82 (84%)	50 (76%)	0.2
Pilonidal sinus	20 (27%)	18 (53%)	0.01

* Analyzed with Chi square test; $p < 0.05$ statistically significant.

appendicitis, abscess, complicated cholecystitis and diverticulitis, or gastric and duodenal ulcers. One explanation for the reduction in surgical emergency patients might be the avoidance of many patients regarding overloaded emergency departments and potential COVID-19 infection [38]. The consequence of this avoidance was described by a multicenter study from Spain, which showed an increase of morbidity in patients undergoing acute care surgery [29].

Hernia repair, cholecystectomy, surgery for diverticulitis, and sinus pilonidalis were more often performed as urgent procedures in 2020 than in the control year. Whether this effect was only influenced by the fact that elective procedures were postponed cannot be determined due the nature of the database. However, a German study about the treatment of diverticulitis during the COVID-19 lockdown showed that 1/3 of postponed elective surgery patients needed urgent surgery due to deterioration and complicated diseases [17]. During the lockdown period in this investigation, the rate of obstructed hernia, a serious complication, increased by 10%, which may reflect the problem of postponed elective hernia surgery. In addition, a population-based analysis from Canada showed an increase of urgent cholecystectomies without effects on the outcomes of these procedures [39]. In contrast to these observations, an investigation from the United States of America reported that only 2% of patients with postponed elective surgery needed either emergency visits or urgent surgery [40]. Acute appendicitis and abscess surgeries are regularly performed as urgent surgeries, and the rate of urgent operations was not affected by the lockdown regularities.

In addition, the pandemic offers new perspectives regarding treatment of specific diseases, such as acute appendicitis. In the past, the conservative treatment of acute appendicitis has been intensively discussed, but the pandemic demonstrated that during the non-accessibility of operating rooms due to healthcare-dependent structural deficits, the non-surgical treatment of uncomplicated appendicitis is a debatable option [30]. In this investigation, only patients with surgical treatment of appendicitis were analyzed, so no statement is possible regarding a potential change toward more conservative treatment of appendicitis. McLean et al. showed, in a single-center cohort study from the United Kingdom, a shift in management strategies toward interventional treatment, less frequent use of laparoscopy, and significantly fewer procedures performed during the COVID-19 pandemic [28]. In contrast to their study, we did not observe a prolongation in length of hospital stay during the COVID-19 lockdown period, which is comparable to other studies performed in Germany and the United States of America [17,19,28,32].

Furthermore, the option of telehealth or video conferences offers new options for patient care in orthopedic patients and older adults with mild cognitive impairments or dementia [41–43]. This novel technology might help in the future to maintain patient care without the risk of infection. The main goal in future pandemic lockdown periods should be to sustain primary healthcare, including acute care surgery and telehealth, as a potential way to distinguish patients who require hospital admission and further surgical treatment. Furthermore, studies have shown that surgical care was assured with comparable results as in ordinary times in many hospitals around the world, and adequate triage systems will help address the specific needs of patients suffering from surgical diseases [17,18,40]. Distinct data is scarce about telemedicine and general and visceral surgery. One retrospective study was performed investigating the effect of telemedicine in the treatment of general and colorectal surgery during the COVID-19 pandemic [44]. This study analysed patients' perspectives and feedback using a simple questionnaire. Although a high percentage of patients were satisfied with the use of telemedicine, but a majority of patients would prefer a face-to-face consultation [44]. Another study dealing of patients with endocrine diseases and their endocrinologists showed that they would use telemedicine again but overall patients and physicians were unsatisfied and personal contact were preferred e.g. to discuss abnormal results [45]. Another survey including 1827 patients showed, that the majority of patients were satisfied with their telemedicine experience but only 33% would choose telemedicine again having an opportunity to in-person appointments with their physician [46]. One may speculate, but in the future telemedicine will become more naturally and therefore the acceptance will further improve in the future.

Another novel technology is artificial intelligence for patient information regarding diseases and their potential treatment. Comparable to telemedicine, data about the use and acceptance of artificial intelligence (AI) in surgical disciplines is even more scarce. An investigation of AI in plastic surgery concluded that this novel technology could serve as a helpful tool to give useful informations for patients prior to plastic breast operations [47]. But finally a surgeon in person is needed to give complete informations and advices regarding the planned procedure and consequences [47].

Ghanem et al. [48] even showed that the informations given by AI regarding acute appendicitis were too complex and beyond the general and public knowledge of this simple disease. A review investigating AI in thyroid diagnostics and surgery could demonstrate promising results, but on the basis of only a few studies dealing about AI and thyroid surgery further investigations are needed before a distinct opinion pro or contra AI is possible [49]. Chalhoub et al. even showed in a cohort of spine surgery, that AI revealed 30% misdiagnosis and in 53% mismanagement rates and concluded that AI (e.g. ChatGPT) should be used cautiously and only as a supplementary tool, as complex treatments and circumstances demand human judgement and interaction [50].

In conclusion, these novel technologies will probably help to inform and treat patients better in potential future pandemic lockdowns and help to provide sufficient medical health care without jeopardizing health care providers and patients.

The limitations of our large registry-based study are due to the nature of a registry database, which requires the independent diligence of the doctors and nurses submitting the data and entails an absence of opportunity to obtain further or missing data. In addition, the study investigated only basic patient characteristics and short-term outcomes,

not disease-specific features or laboratory parameters. However, despite these limitations, the data reflect a large, nationwide surgical patient cohort treated in all types of hospitals and institutes during the first lockdown period in Switzerland.

Conclusions

In conclusion, the first COVID-19 pandemic lockdown impacted the number of general and visceral surgery procedures in Switzerland. There was a trend toward more complicated and serious disease courses, but in this study there were no negative effects regarding length of hospital stay. Due to a restriction on elective surgery services, the rate of urgent procedures increased during the lockdown period. The main goal for future lockdown scenarios must be to sustain primary health care, including surgery, otherwise major concerns regarding the well-being of the population will remain. Whether these restrictions lead to increased mortality must be further investigated.

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Declaration of competing interest

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