Safety of elective abdominal and vascular surgery during the COVID-19 pandemic: a retrospective single-center study

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Abstract

Background: Patients with coronavirus disease 2019 (COVID-19) who undergo surgery have impaired postoperative outcomes and increased mortality. Consequently, elective and semi-urgent operations on the increasing number of patients severely affected by COVID-19 have been indefinitely postponed in many countries with unclear implications on disease progression and overall survival. The purpose of this study was to evaluate whether the establishment of a standardized screening program for acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is sufficient to ensure high-quality medical and surgical treatment of COVID-19 and non-COVID-19 patients while minimizing in-hospital SARS-CoV-2 transmission.

Methods: The screening program comprised polymerase chain reaction (PCR) testing of nasopharyngeal swabs and a standardized questionnaire about potential symptoms for SARS-CoV-2 infection. All elective and emergency patients admitted to the surgical department of a tertiary-care hospital center in Lower Franconia, Germany, between March and May 2020 were included and their characteristics were recorded.

Results: Out of the study population (n = 657), 509 patients (77.5%) had at least one risk factor for a potentially severe course of COVID-19 and 164 patients (25%) were active smokers. The average 7-day incidence in Lower Franconia was 24.0/100,000 during the observation period. Preoperative PCR testing revealed four asymptomatic positive patients out of the 657 tested patients. No postoperative SARS-CoV-2 infection or transmission could be detected.

Conclusion: The implementation of a standardized preoperative screening program to both COVID-19 and non-COVID-19 patients can ensure high-quality surgical care while minimizing infection risk for healthcare workers and potential in-hospital transmission.

Keywords: SARS-CoV-2, COVID-19, Elective surgery, Screening, PCR
SARS-CoV-2 infection have increased mortality [8–10]. Since the middle- to long-term consequences of postponing surgery in non-COVID-19 patients are presently unclear, specific containment and testing strategies are mandatory to ensure universally high-quality medical and surgical treatment while minimizing the risk of in-hospital-acquired infections [1, 11].

Presented with this problem, we introduced a number of precautionary measures including standardized preoperative SARS-CoV-2 testing, establishment of COVID-19 and non-COVID-19 areas (intensive care units, non-intensive care units, emergency rooms and operation rooms) and prioritization of operational interventions based on medical urgency and logistical resources (intensive care unit capacity for COVID-19 and non-COVID-19 patients, personnel and material capacities) [1]. The aim of this study was to show that by implementing these precautionary measures, emergency and elective surgeries are both feasible at a tertiary-care hospital center (university hospital) during the COVID-19 pandemic without increasing the risk for nosocomial transmission of SARS-CoV-2.

Methods
Study population
Patients admitted to the Department of Surgery I at the University Hospital Wuerzburg between March 26th and May 24th, 2020, had to answer a standardized COVID-19 questionnaire and were tested for SARS-CoV-2 infection by real-time reverse transcriptase polymerase chain reaction (RT-PCR) [12]. The standardized questionnaire enquired about clinical symptoms that are characteristic of symptomatic SARS-CoV-2 infection including coughing, shortness of breath, rhinorrhea, loss of smell and taste, sore throat, fever or diarrhea [13] as well as any potential contact the patient had with suspected or confirmed COVID-19 patients (Fig. 1). A nasopharyngeal swab for RT-PCR testing [14] was performed at our outpatient clinic by specially trained nursing staff within 48 h of elective surgery. In case of emergency, the questionnaire and PCR testing were conducted immediately prior to the operation. In such cases, anesthesia was performed by using personal protection equipment as generally recommended [1, 15]. Based on the outcome of the questionnaire, operations were performed in COVID-19 or non-COVID-19 operation areas.

Demographic variables included age, sex, body mass index (BMI), immunosuppression, and cardio-pulmonary risk factors. Operative variables included urgency of surgery, diagnosis, and surgical procedure. In parallel, the incidence of COVID-19 patients in the district of Lower Franconia was registered on a daily basis [16].

Statistical analysis
Descriptive data are presented as median with range, mean with standard deviation (SD) or total numbers with percentage. Statistical analysis was performed using SPSS statistics (Version 25, IBM, Armonk, NY, USA).

Results
During the observation period, 657 patients were admitted to our department with an average age of 59.93 ± 17.92 years and BMI of 26.82 ± 5.39 kg/m², of whom 101 patients underwent emergency surgery and 61 patients received urgent non-surgical treatment. One hundred and sixty-six patients were treated due to a cancer-related problem (Table 1). Almost 12% of patients (n = 78) had a medical history of pulmonary disease including bronchial asthma and chronic obstructive pulmonary disease (COPD), 25% (n = 164) were active smokers and more than three-quarters (77.5%, n = 509) had at least one risk factor for a potentially severe course of COVID-19 [17]. Operative procedures are listed in detail in Table 2, and were performed

| Questionnaire for SARS-CoV-2                                                                 | Answer |
|--------------------------------------------------------------------------------------------|--------|
| Has the patient any symptoms of a common cold (coughing, shortness of breath, rhinorrhea, loss of smell and taste, sore throat) or fever (≥38.0°C)? | Yes/no |
| Has the patient had contact to a person infected with SARS-CoV-2 or suffering from COVID-19 during the last 14 days? Has the patient visited an institution (hospital, outpatient clinic, retirement home, nurseries) with COVID-19 cases? | Yes/no |
| Has the patient visited an area or other country that is marked as risk region by the Robert Koch Institute? | Yes/no |

Fig. 1 Standardized questionnaire for SARS-CoV-2 infection
either using an open, laparoscopic or robotic-assisted approach. Vascular surgery included open and endovascular procedures.

The average 7-day incidence in Lower Franconia (1,317,000 residents) was 24.0/100,000 during the observation period [16]. Standardized RT-PCR testing of admitted patients revealed 4 SARS-CoV-2 positive cases— all of whom were asymptomatic. Treatment was delayed in one of these four patients. The other three patients were isolated and treated in dedicated COVID-19 areas (Fig. 2).

During the observation period, an average of 22 patients were hospitalized due to SARS-CoV-2 infection with a maximum of 22 patients in an ICU ward and 16 patients in a non-ICU ward on April 17th. Postoperative viral transmission and SARS-CoV-2 infection, respectively, were not detected and, thus, no COVID-19-related mortality occurred.

### Table 1  Baseline characteristics

| Variables                                           | All (n, %) | Emergency (n, %) |
|-----------------------------------------------------|------------|-----------------|
| Age (year) Mean (SD)                                | 59.93 (17.92) | 59.93 (17.92)   |
| Median (range)                                       | 62 (0–91)  | 62 (0–91)       |
| Sex (n, %)                                           | 302 (45.96) | 355 (54.04)     |
| Female                                              | 302 (45.96) | 355 (54.04)     |
| Male                                                | 355 (54.04) | 302 (45.96)     |
| Hypertonus (n, %)                                   | 377 (57.4)  | 137 (20.9)      |
| Diabetes (n, %)                                      | 137 (20.9)  | 377 (57.4)      |
| Coronary heart disease/peripheral artery occlusive disease (n, %) | 169 (25.7)  | 169 (25.7)      |
| COPD/asthma (n, %)                                  | 78 (11.9)   | 81 (12.3)       |
| Immunosuppression (n, %)                            | 81 (12.3)   | 164 (25.0)      |
| Active smoking (n, %)                               | 164 (25.0)  | 164 (25.0)      |
| Risk factors (n, %)                                 | 1509 (77.5) | 360 (54.8)      |
| = 1                                                  | 509 (77.5)  | 147 (22.4)      |
| > 1                                                  | 360 (54.8)  | 45 (6.8)        |
| > 2                                                  | 147 (22.4)  | 17 (2.7)        |
| > 3                                                  | 45 (6.8)    | 4 (0.6)         |
| Urgency (n, %)                                       | 164 (25.0)  | 493 (75.0)      |
| Emergency                                            | 164 (25.0)  | 493 (75.0)      |
| Elective                                            | 493 (75.0)  | 164 (25.0)      |
| Non-cancer/cancer (n, %)                            | 490 (74.6)/167 (25.4) | 490 (74.6)/167 (25.4) |
| Treatment procedure (n, %)                          | 514 (78.2)  | 143 (21.8)      |
| Operation                                            | 514 (78.2)  | 143 (21.8)      |
| Non-surgical treatment                               | 493 (75.0)  | 164 (25.0)      |

Risk factors include hypertonus, diabetes, coronary heart disease/peripheral artery occlusive disease, COPD/asthma, and immunosuppression

COPD chronic obstructive pulmonal disease, SD standard deviation

### Table 2  Type of surgical procedures

| Type of operation                                | All (n, %) | Emergency (n, %) |
|--------------------------------------------------|------------|-----------------|
| Appendectomy                                      | 13 (2.0)   | 12 (7.3)        |
| Colostomy formation                              | 1 (0.2)    | –               |
| Colostomy reversal                               | 3 (0.5)    | –               |
| Diagnostic laparoscopy                            | 18 (2.7)   | 2 (1.2)         |
| Diagnostic laparotomy                             | 21 (3.2)   | 14 (8.5)        |
| Drainage of hematoma                              | 4 (0.6)    | 4 (2.4)         |
| Feeding gastrostomy                               | 1 (0.2)    | –               |
| Ileostomy formation                              | 3 (0.5)    | –               |
| Ileostomy reversal                                | 1 (0.2)    | –               |
| Laparoscopic hernia repair                        | 7 (1.1)    | 2 (1.2)         |
| Open hernia repair                                | 21 (3.2)   | 3 (1.8)         |
| Left hemicolectomy                               | 19 (2.9)   | 4 (2.4)         |
| Right hemicolectomy                              | 8 (1.2)    | 2 (1.2)         |
| Low anterior rectum resection                     | 10 (1.5)   | –               |
| Ileocecal resection                               | 6 (0.9)    | –               |
| Small bowel resection                             | 1 (0.2)    | –               |
| Esophagectomy                                     | 11 (1.7)   | 2 (1.2)         |
| Esophageal procedure                              | 18 (2.7)   | –               |
| Repair of ulcer                                   | 3 (0.5)    | 3 (1.8)         |
| Laparoscopic fundoplication                       | 10 (1.5)   | –               |
| Subtotal colectomy                                | 3 (0.5)    | –               |
| Total colectomy                                   | 4 (0.6)    | –               |
| Gastrectomy                                       | 1 (0.2)    | –               |
| Abscess drainage                                  | 12 (1.8)   | 8 (4.9)         |
| Perineal abscess drainage                         | 11 (1.7)   | 8 (4.9)         |
| Wound exploration/revision                        | 18 (2.7)   | 7 (4.3)         |
| Thyroidectomy                                     | 38 (5.8)   | –               |
| Neck dissection                                   | 1 (0.2)    | –               |
| Cholecystectomy                                   | 26 (4.0)   | 4 (2.4)         |
| Partial pancreatectomy                            | 10 (1.5)   | –               |
| Total pancreatectomy                              | 2 (0.3)    | 1 (0.6)         |
| Resection of liver segment                        | 6 (0.9)    | –               |
| Hemi-hepatectomy                                  | 8 (1.2)    | –               |
| Other hepatopancreateal-biliary procedure/operation | 2 (0.3) | – |
| Lymph node dissection                             | 3 (0.5)    | –               |
| Central venous catheter implantation              | 34 (5.2)   | 1 (0.6)         |
| Multi visceral resection                           | 6 (0.9)    | –               |
| Femoral artery bypass                             | 15 (2.3)   | 6 (3.7)         |
| Embolectomy                                       | 2 (0.3)    | 2 (1.2)         |
| Femoral arterial endarterectomy                   | 10 (1.5)   | 1 (0.6)         |
| Arterio-venous fistula formation                  | 10 (1.5)   | 5 (3.0)         |
| Abdominal aorta repair                            | 10 (1.5)   | 2 (1.2)         |
| Femoral artery aneurysm repair                    | 3 (0.5)    | 1 (0.6)         |
| Percutaneous transluminal angioplasty             | 53 (8.1)   | 4 (2.4)         |
| Limb amputation                                   | 16 (2.4)   | 1 (0.6)         |
| Carotid endarterectomy                            | 8 (1.2)    | –               |
| Splenectomy                                       | 2 (0.3)    | 1 (0.6)         |
| Adrenalectomy                                     | 7 (1.1)    | 1 (0.6)         |
| Transplantation                                   | 1 (0.2)    | 1 (0.6)         |
Discussion
Recently published studies showing higher mortality rates after surgery in COVID-19 patients have concluded that the threshold for surgery during the COVID-19 pandemic should be higher [8–10]. This has had the implication that surgical procedures should be postponed and that non-operative therapies are promoted instead [8–10]. However, closer inspection of the data reveals that only 280 of the 1128 patients included in the study by D. Nepogodiev et al. [8] had an elective operation, of whom 250 had postoperative SARS-CoV-2 infection. Thus, in-hospital transmission of SARS-CoV-2 might be possible, since these data were collected during the beginning of the pandemic when health care systems were overwhelmed and there was a lack of sufficient personal protective equipment and test capacities. Given that asymptomatic undetected SARS-CoV-2-positive patients are a potential source of nosocomial transmission, effective screening and containment measures are mandatory to minimize the risk of in-hospital transmission of SARS-CoV-2. Our data show that under COVID-19 pandemic conditions, use of a standardized questionnaire and systematic RT-PCR testing are highly effective tools to identify preoperatively asymptomatic SARS-CoV-2 patients, and thus safely enable elective surgery. While our findings are supported by other studies [18–20], an international survey has shown that standardized screening programs are not yet established in surgical practice [21]. In our test strategy, we excluded the routine computed tomography (CT) of the chest, since its value has been questioned [20, 22], and may thus introduce unnecessary exposure to radiation.

It is well known that cardiovascular comorbidities and cancer are risk factors for a severe disease course of COVID-19 [17]. However, as shown by our analysis and other studies, the introduction of standardized screening programs and the establishment of dedicated COVID-19-free surgical pathways enable elective surgery in these high-risk patients during the COVID-19 pandemic without increasing the risk of postoperative SARS-CoV-2 infection and mortality [23–25].

Our study has some limitations including its retrospective character and the single-center design. However, as a tertiary-care hospital we were faced with the challenge of rapidly providing medical and surgical services to COVID-19 and non-COVID-19 patients at the same time. Thus, our data offer an important example of “real life” experiences in a rural area (Lower Franconia).

During the COVID-19 pandemic, a cost–benefit analysis for performing elective surgery is necessary to provide sufficient medical, personal and material resources for COVID-19 patients. While it is clear that elective operations in SARS-CoV-2-positive patients should be cancelled or postponed, their delay in non-COVID-19 patients suffering from cancer and other serious conditions can lead to disease progression and impact overall survival. Therefore, instead of recommending unconditional postponement of all “elective” operations, the establishment of COVID-19-free surgical pathways and standardized preoperative SARS-CoV-2 testing can ensure that universally high-quality medical and surgical treatment while minimizing the risk of in-hospital-acquired infections.

Conclusion
Despite initial studies recommending the postponement of elective surgeries during the COVID-19 pandemic and that non-surgical treatments should be considered for emergency cases, we show that the implementation of a standardized preoperative screening program ensures high-quality surgery for both COVID-19 and non-COVID-19 patients while minimizing infection risk for healthcare workers and potential in-hospital transmission.

Abbreviations
BMI: Body mass index; COVID-19: Coronavirus disease 2019; COPD: Chronic obstructive pulmonary disease; CT: Computer tomography; ICU: Intensive care unit; PCR: Polymerase chain reaction; RT-PCR: Real-time reverse transcriptase polymerase chain reaction; SARS-CoV-2: Severe acute respiratory syndrome coronavirus 2; SD: Standard deviation.

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Authors’ contributions
SF and AW designed and supervised the study. SK, MK and SF collected data. FA performed statistical analysis of the dataset. FA, MKH and SK prepared tables. SF and MKH wrote the manuscript. CTG, AW, and MK revised and edited the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials
Institutional database. Therefore, restrictions to availability apply due to data protection regulations. Anonymized data are, however, available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
The study was conducted according to the guidelines of the Declaration of Helsinki. Ethical review and approval were waived for this study (ethical committee of University of Wuerzburg, Germany), since this research study was conducted retrospectively from data obtained for clinical purposes with all the procedures being performed were part of the routine care. The informed consent was waived by the ethics committee of the University of Wuerzburg, Germany, since patients cannot be identified by anonymized data used for this study.

Consent for publication
Not applicable.

Competing interests
The authors declare no conflict of interest.

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