Review

The impact of the COVID-19 pandemic on surgical education: A survey and narrative review

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ABSTRACT

Background: Since the emergence of the COVID-19 pandemic, medical education has been a concerning issue, especially in surgical fields. Due to the postponement of many elective surgeries and even alternations in the pattern of emergent surgeries, concerns have been raised about whether residents of surgical disciplines are experienced enough after graduation or not. We aimed to describe the impact of the COVID-19 pandemic on surgical residency training in different fields.

Materials and methods: We conducted a cross-sectional study with a 20-item questionnaire on residents of surgical disciplines from three different educational hospitals of Tehran University of Medical Sciences, Iran in 2020. In addition, we reviewed the current literature regarding the impact of COVID-19 pandemic on surgical education worldwide.

Results: Our survey, with a response rate of 56.8% demonstrated significant reduction in the time spent in elective surgeries, surgical clinics and even in emergent surgeries for residents. Besides, it has reported that significant time has been spent in COVID 19 wards which resulted in decreased satisfaction of educational activities.

Conclusions: The impacts of COVID 19 pandemic on surgical education are significant and inevitable. Thus, we must integrate novel educational methods in surgical curriculum to optimize training and minimize the adverse effects of the pandemic on surgical education.

Introduction

The coronavirus disease (COVID-19), first recognized in Wuhan, China has spread throughout the world at an unprecedented rate [1]. COVID-19 has been a serious health concern in the world and Iran, with this nation having the 11th highest national death toll in the world [2]. Due to the unparalleled number of patients resultant from the pandemic, the healthcare system in Iran, as well as many others, was overcrowded by the shortage of adequate resources [3]. Thus, guidelines were put in place to prioritize the care for COVID-19 patients and most non-urgent outpatient visits and elective surgeries were postponed [4]. Likewise, a dramatic reduction in educational opportunities and hands-on experience in surgical specialties resulted and raised the question of whether the surgical residents would have gained adequate experience for high-quality patient care upon the completion of residency program [5, 6].

A better understanding of the impacts of the COVID-19 pandemic on surgical education is essential for improvements in educational curricula. We aimed to evaluate the impact of COVID-19 on surgical disciplines in educational hospitals associated to Tehran University of Medical Sciences (TUMS). Therefore, a questionnaire with a focus on surgical education was designed and it was filled out by residents of different surgical disciplines. Moreover, we reviewed the previously published experiences of other countries and we made suggestions on how to turn this challenge into opportunity.
Methods

This was a cross-sectional and survey-based study held in Imam Khomeini Hospital Complex (IKHC), Sina Hospital and Shariati Hospital, TUMS with the aim of investigating the effects of the COVID-19 pandemic on the quality of surgical education. Thus, the study population was surgical residents of different disciplines, including general surgery, orthopedics, urology, obstetrics and gynecology (OB/GYN), and neurosurgery in all three hospitals. Ethical approval was obtained from the ethics committee of TUMS. To formulate a valid and accurate questionnaire, possible factors associated with the quality of residents’ education were determined based on several focus group discussions (FGD). Successively, an online questionnaire based on Google Forms was created using the FGD findings. This questionnaire was divided into three sections including questions about the demographics of the resident, reported degree of satisfaction with the current training system, and the mean working and resting hours during the COVID-19 pandemic.

In order to review the current literature on the impact of COVID-19 on surgical education, we searched the PubMed (National Center for Biotechnology Information) database and used the Google Scholar to shape our narrative review. The search was conducted on English-language articles available in peer-reviewed journals. There were no limitations regarding publication time. We focused on residents of different surgical disciplines as our population of interest. As a result, we conducted title and abstract searches using the following keywords for participants: residents, trainees, fellows, COVID-19, coronavirus, and pandemic. Eligible articles were ones in which participants were residents or fellows and reported the impacts of the COVID-19 pandemic on the defined subjects. Studies were excluded when the term “residents” referred to disciplines other than medicine.

The degree of the normality of the distribution of quantitative data was deliberated using the Kolmogorov-Smirnov test and the Q-Q graphical method. Additionally, quantitative variables were described as mean (standard deviation) or median (first quartile-third quartile) as best suited based on these tests, and qualitative variables were described as the percentage of respondents. To compare quantitative variables between groups, t-test (Mann-Whitney test) and analysis of variance (Kruskal-Wallis’s test) were used. Paired t-test was used to compare quantitative variables before and after the pandemic. All statistical analyses were performed using SPSS software version 24. The level of statistical significance was less than 0.05, and the marginal statistical significance was between 0.05 and 0.1.

Results

The questionnaire was sent to all residents of different surgical specialties. A total of 104 out of 183 residents (general surgery (62/69), orthopedics (9/36), urology (7/15), OB/GYN (20/38), and neurosurgery (6/25)) completed the questionnaire (Response rate, 56.8%).

1. How has COVID-19 pandemic affected surgical residents’ schedules? a. Visit of COVID-19 Patients; An Extra Duty

Due to the limited resources during a pandemic, surgical trainees were reallocated to participate in the management of COVID-19 patients or attend COVID-19 wards, which interrupted their surgical training [8-10]. A survey on surgical residency programs in Italy demonstrated that 14.8% of participants have been reallocated to a nonsurgical unit or have voluntarily interrupted their training to attend a COVID-19 unit [7]. According to another study conducted at the US surge of the pandemic, 14% of otolaryngology residents were transferred to other departments, mostly ICUs or COVID-19 wards. These trainees were significantly more concerned in terms of anxiety and burnout, and experienced lower levels of wellbeing. They also experienced higher levels of concern for getting ill and transmitting COVID-19, but this did not reach statistical significance [8]. A global survey on the impact of the COVID-19 pandemic on surgical training revealed that COVID-19-associated emergency care, reallocation to other specialties or alterations in duties within the same specialties have led to disruption and fewer opportunities for surgical trainees [9].

According to our survey, the surgical trainees spent a median of 5.5 h weekly in the COVID-19 wards. Remarkably, this value was higher for female trainees when compared to their male counterparts (8 vs. 2 h in a week, respectively). However, the mean time spent at the COVID-19 wards did not significantly differ between the IKHC, as the main referral hospital for COVID-19 patients, and the other surveyed hospitals ($P = 0.24$).

b. Emergency Surgeries

A disruption in surgical training, in part due to social distancing, was observed in numerous previous studies due to the decreased trauma admissions and emergency department visits [10-21]. In our survey, 53.9% of residents experienced less than 50% decrease in emergency operating room attendance, while 29.8% of them reported a reduction of more than 50% in their attendance. Moreover, 64.5% of residents reported a less than 50% decrease in the number of surgeries in the emergency operating room, while 25% of them experienced a reduction of more than 50% in the number of emergency surgeries (Table 1).

c. Elective Services

Surgical fields were one of the first and most disrupted trainings due to canceled or deferred elective surgeries and decreased surgical services during the pandemic. Thus, surgical residents of various specialties have been adversely affected in terms of less hands-on opportunities and operative experience [22-26]. In our survey, 94.2% of residents expressed a decrease in the number of elective surgeries while 44.3% of them stated that their presence in the elective operating room had decreased more than 50% due to the pandemic. Overall, 74% of the residents reported that their time in the surgical clinic was also reduced (Table 1).

2. How has the COVID-19 pandemic affected didactics in surgical training?

A scoping review on the impact of COVID-19 on surgical training in the United States, United Kingdom, Canada, Australia, and New Zealand has demonstrated that during the pandemic, face-to-face courses and conferences have been deferred, and curricular trainings were provided through webinars, virtual platforms, and open access virtual resources [27]. A survey of general surgery residency programs in the United

| Table 1 | The reported change (%) in the number of surgeries, time spent in emergency and elective operating rooms, and attendance at the surgical clinic. |
|---------|--------------------------------------------------------------------------------------------------|
| Reported Decrease (%) | Time Spent in Emergency Operating Room | Number of Emergency Surgeries | Time Spent in Elective Operating Room | Number Elective Surgeries | Time Spent in Surgical Clinic |
| 0-25 | 27 (26.0%) | 35 (33.7%) | 20 (19.2%) | 22 (21.2%) | 35 (33.7%) |
| 25-50 | 29 (27.9%) | 32 (30.8%) | 30 (28.8%) | 32 (30.8%) | 24 (23.1%) |
| 50-75 | 17 (16.3%) | 22 (21.2%) | 22 (21.2%) | 24 (23.1%) | 12 (11.5%) |
| 75-100 | 14 (13.5%) | 4 (3.8%) | 24 (23.1%) | 6 (5.8%) | 27 (26.0%) |
| No Change | 17 (16.3%) | 11 (10.6%) | 8 (7.7%) | 6 (5.8%) | 27 (26.0%) |

- Data are presented as number of participants (percentage %).
States have revealed similar results with decreased in-person education time, and increased virtual didactics [28]. In a study conducted in Italy, 29.5% of residents allocated to COVID-19 emergency units postponed surgical didactic activities, while 19.6% increased their activities [7]. Similarly, an online survey of general surgery residents across the United States has demonstrated that while didactics were moved towards virtual platforms, the majority of trainees spent more time on educational didactics than before the pandemic [29].

Another study on orthopedic and trauma surgery trainees in Europe has indicated that the teaching duties of residents, in terms of didactic education have decreased, and the traditional modalities of faculty-led and bedside education were limited as well. However, most participants stated that remote learning increased and academic education in virtual research was similar or even higher [30]. In a qualitative study, surgical trainees perceived the pandemic as an unexpected opportunity and reported more reading time, increased time for self-study, and didactics. In addition, more online resources had helped to fill in the previous gap in education [31].

In line with the previous studies, our data demonstrate that during the pandemic, the resting time, time for self-study, and virtual education have increased 82.8%, 70.2%, and 76.9%, respectively. Furthermore, 82.7% of trainees reported that their face-to-face education time was reduced (Table 2). Based on our survey, 18.3%, 41.3%, and 40.4% of trainees reported improved, no changes, and a reduction in the quality of education during the pandemic, respectively.

### 3. How has the COVID-19 pandemic impacted surgical trainees’ satisfaction?

A study on the perception of neurosurgery residents on online webinars during the COVID-19 pandemic revealed that 89% of residents were satisfied with online webinars, while 75% of them found online lectures more useful than traditional lectures [32]. Another study on the perception of E-learning during the pandemic demonstrated that trainees had higher satisfaction in comparison to in-person learning, with 51.4% of them supporting E-learning [33]. In a study of otolaryngology trainees at the US COVID-19 surge, 75% of trainees were satisfied with the departments’ response to COVID-19 and 75% were comfortable expressing their concerns to the attending faculty. Their level of satisfaction was associated with the comfort in communicating their concerns [8].

According to our survey, 48.1% of residents have reported worsened satisfaction with clinical classes, while 12.5% reported no changes in satisfaction. Overall, the mean difference in the satisfaction score with the clinical classes after COVID-19 decreased by 1.65 (1.15–1.16) units, which was statistically significant (P < 0.001). The decrease in satisfaction with clinical classes was significantly greater in older (P = 0.02), female trainees (P = 0.04). Moreover, senior trainees experienced smaller drops in satisfaction when compared to junior trainees (P = 0.02) (Tables 3 and 4). The same trend was observed when non-general surgery residents were compared to general surgery trainees (P = 0.05), and junior residents were compared to the seniors (P = 0.01). Moreover, trainees who allocated more visiting hours for COVID-19 patients reported a higher rate of dissatisfaction.

**Table 2**

| Reported Change (%) | Increase in Resting Time | Increase in Study Time | Reduction in Face-to-Face Class Time | Increase in Virtual Class Time |
|---------------------|--------------------------|------------------------|-------------------------------------|-------------------------------|
| 0–25                | 42 (41.3%)               | 37 (35.6%)             | 36 (34.6%)                          | 32 (30.8%)                    |
| 25–50               | 33 (31.7%)               | 21 (20.2%)             | 16 (15.4%)                          | 24 (25%)                      |
| 50–75               | 6 (5.8%)                 | 8 (7.7%)               | 16 (15.4%)                          | 10 (9.6%)                     |
| 75–100              | 4 (3.8%)                 | 7 (6.5%)               | 18 (17.3%)                          | 13 (12.5%)                    |
| No Change           | 18 (17.3%)               | 31 (29.8%)             | 18 (17.3%)                          | 24 (23.1%)                    |

* Data are presented as number of participants (percentage %).

4. What has confounded the impact of COVID-19 on surgical training?
   a. Postgraduate Year (PGY):

   Wise et al. investigated the impact of COVID-19 on surgical residents’ education and coping. They demonstrated that 43.9% of junior residents perceived virtual learning better than traditional methods, in comparison to 36.8% of senior residents and fellows [31]. Rana et al. studied the residents’ perspectives on the effect of COVID-19 on medical education. They observed remarkable differences between junior and senior residents. Seniors indicated that the pandemic was disruptive to their training, more than juniors, due to the loss of opportunities to execute responsibilities independently and lack of time to make up for the lost opportunities. Nevertheless, seniors were more satisfied with the altered programs in comparison to junior residents. Seniors were more comfortable with online education, although they found online meetings less effective compared to junior residents [34].

   In a study conducted on general surgery clinical teaching units at three sites of the McGill University, the effects of the pandemic on operating room attendance and surgical case types differed across levels of training. Compared to senior residents, juniors were much more affected with 68% case attendance and 68% operating time in comparison to the pre-pandemic baseline. Senior trainees attended 73% of the baseline number of cases, with 77% of the baseline operating time [35].

   Our survey demonstrated that senior trainees (PGY3-4) had increased resting time (P = 0.003). They also spent more time on self-study (P = 0.05) and virtual classes (P = 0.03) during the pandemic. Furthermore, senior residents reported a smaller reduction in satisfaction in comparison to junior residents (P = 0.02). However, there were no statistically significant differences in terms of face-to-face class time among different training levels. According to our survey, the visit time for COVID-19 patients was higher in junior (PGY1-2) residents when compared to the senior ones.

b. Training Hospitals:

   Based on our survey, the difference in COVID-19 visit time was not statistically significant between residents of different hospitals. The increase in study time (P = 0.02) and virtual class time (P = 0.05) in IKHC residents was significantly higher in comparison to other hospitals, while the differences regarding resting time and face-to-face class time were not statistically significant. Unlike emergency services, the reduction in the time spent in the elective operating room and the number of elective surgeries was significantly higher in residents of IKHC when compared to other hospitals. In addition, the rate of attendance at the surgical clinic was higher for IKHC residents. It is noteworthy that among the studied hospitals, IKHC was the largest hospital, admitting more COVID-19 patients during the pandemic. Moreover, prior to and during the COVID-19 pandemic, IKHC had a higher volume of surgical cases in comparison to the other two hospitals.

c. Specialties:

   In a study conducted on general surgery units of the McGill University, the effects of the pandemic on operating room attendance and surgical case types differed across various specialties. The minimally invasive surgery and colorectal fellows were the most (14% of baseline cases) and the least (75% of baseline cases) affected specialties, respectively. In all levels, the reduction in operation time was compatible with the reduction in case number, except for the colorectal trainees who experienced 75.4% of case numbers, with 89.0% of baseline operating time, probably due to the more complex cases. The pandemic’s influence was largest on the minimally invasive surgery and bariatrics trainees, with 19% and 43% of baseline cases, respectively. Fewer
suggest that there are many adverse outcomes to consider when evaluating the impact of COVID-19 crisis on medical education, specifically surgical fields.

Decrease in clinical activities (emergency and elective operations as well as pre-operative and post-operative care) and educational activities (theoretical training) was notable among surgical residents of different specialties, which was comparable to previous reports [37]. This should be used as a reminder for medical education systems to evaluate and alter the training curriculum as needed during pandemics. The learning opportunities for surgical residents have decreased due to the cessation of elective surgeries during the pandemic. Conclusively, surgical residents are tending to experience a more disrupted training in comparison to residents of non-surgical specialties. Rana et al. reported that medicine residents were more comfortable than surgical residents using tele-medicine [34].

The results of this investigation also highlighted that the level of satisfaction with both theoretical training and clinical training was reduced especially in residents with more exposure to COVID-19 patients. The COVID-19 pandemic has significantly affected postgraduate medical education, but educators have responded promptly to flatten the impact. This attempt ranged from decreased working hours while maintaining enough exposure to emergency operations. At the same time, there was a shift from the reduced operative and clinical tasks towards more education, but educators have responded promptly to flatten the impact.

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The reported change in satisfaction levels with face-to-face classes.

| Demographic Characteristics | All participants | Change in Satisfaction with face-to-face Classes | P Value |
|-----------------------------|-----------------|-----------------------------------------------|---------|
|                             | Decreased (n = 42) | No Change (n = 43) | Increased (n = 19) |
| Age (Year)                  | 30.27 ± 2.87     | 31.54 ± 3.43    | 29.88 ± 2.33    | 30.84 ± 1.8    | 0.02   |
| Gender (female-male)        | 42–62            | 21–21           | 18–25           | 3–16            | 0.04   |
| Hospital                    |                  |                 |                 |                 |        |
| Imam Khomeini               | 39 (37.7%)       | 17 (40.5%)      | 14 (32.6%)      | 8 (42.1%)       | 0.66   |
| Sina                        | 44 (42.3%)       | 19 (45.2%)      | 14 (44.2%)      | 6 (31.9%)       |        |
| Sharati                     | 21 (20.2%)       | 6 (14.3%)       | 10 (23.3%)      | 5 (26.3%)       |        |
| General Surgery             | 62 (59.6%)       | 22 (52.4%)      | 24 (55.8%)      | 16 (84.2%)      |        |
| OB/GYN                      | 20 (19.2%)       | 11 (26.2%)      | 9 (20.9%)       | 0 (0.0%)        | 0.05   |
| Orthopedics                 | 9 (8.7%)         | 3 (7.1%)        | 4 (9.3%)        | 2 (10.5%)       |        |
| Urology                     | 7 (6.7%)         | 2 (4.8%)        | 4 (9.3%)        | 1 (5.3%)        |        |
| Neurosurgery                | 6 (5.8%)         | 4 (9.5%)        | 2 (4.7%)        | 0 (0.0%)        | 0.01   |
| Residency Year              |                  |                 |                 |                 |        |
| PGY1                        | 26 (25%)         | 10 (23.8%)      | 13 (30.2%)      | 3 (15.8%)       |        |
| PGY2                        | 28 (26.9%)       | 14 (33.3%)      | 10 (23.3%)      | 4 (21.1%)       |        |
| PGY3                        | 29 (27.9%)       | 14 (33.3%)      | 11 (25.6%)      | 4 (21.1%)       |        |
| PGY4                        | 21 (20.2%)       | 4 (9.3%)        | 9 (20.9%)       | 8 (42.1%)       |        |

* Data are presented as mean ± standard deviation, or number of participants (percentage %).

The reported change in satisfaction levels with clinical classes.

| Demographic Characteristics | All participants | Change in Satisfaction with Clinical Classes | P Value |
|-----------------------------|-----------------|---------------------------------------------|---------|
|                             | Decreased (n = 50) | No Change (n = 41) | Increased (n = 13) |
| Age (Year)                  | 30.27 ± 2.87     | 31                     | 30                     | 30                     | 0.70   |
| Gender (female-male)        | 42–62            | 26–24                   | 7–34                   | 9–4                    | 0.001  |
| Hospital                    |                  |                         |                         |                         |        |
| Imam Khomeini               | 39 (37.7%)       | 21 (42.0%)              | 13 (31.7%)             | 5 (38.5%)              | 0.60   |
| Sina                        | 44 (42.3%)       | 19 (38.0%)              | 18 (45.9%)             | 7 (35.8%)              |        |
| Sharati                     | 21 (20.2%)       | 10 (20.0%)              | 10 (24.4%)             | 1 (7.7%)               |        |
| General Surgery             | 62 (59.6%)       | 27 (54.0%)              | 28 (68.3%)             | 7 (53.8%)              | 0.35   |
| OB/GYN                      | 20 (19.2%)       | 13 (26.0%)              | 3 (7.3%)               | 4 (30.8%)              |        |
| Orthopedics                 | 9 (8.7%)         | 0 (0.0%)                | 7 (17.1%)              | 2 (15.4%)              |        |
| Urology                     | 7 (6.7%)         | 5 (10.0%)               | 2 (4.9%)               | 0 (0.0%)               |        |
| Neurosurgery                | 6 (5.8%)         | 5 (10.0%)               | 1 (2.4%)               | 0 (0.0%)               | 0.05   |
| Residency Year              |                  |                         |                         |                         |        |
| PGY1                        | 26 (25%)         | 11 (22.0%)              | 15 (36.6%)             | 0 (0.0%)               | 0.43   |
| PGY2                        | 28 (26.9%)       | 13 (26.0%)              | 10 (24.4%)             | 5 (38.5%)              |        |
| PGY3                        | 29 (27.9%)       | 16 (32.0%)              | 6 (16.4%)              | 7 (53.8%)              |        |
| PGY4                        | 21 (20.2%)       | 10 (20.0%)              | 10 (24.4%)             | 1 (7.7%)               |        |

* Data are presented as mean ± standard deviation, or number of participants (percentage %).

Limitations were imposed on colorectal and hepatopancreatobiliary surgery trainees, with 91% and 82% of baseline cases, respectively [35].

According to our survey, general surgery residents reported higher in time for self-study and resting. The increase in virtual class time was lower for general surgery residents in comparison to other surgical specialties, while the face-to-face class time was not significantly different between residents of different surgical specialties. The reduction in the number of emergency and elective surgeries for specialties other than general surgery were higher than general surgery residents and the observed difference was marginally significant (P = 0.07 and P = 0.02 respectively).

Discussion

More than two years has passed since the worldwide emergence of COVID-19 and the effects of this catastrophic pandemic is explicit in all aspects of daily life [36,37]. Colleges around the world have been closed, and online instruction has unexpectedly become an academic standard. Under these circumstances, teachers and students might consider the rapid transition to online instruction disappointing and distracting. Based on previous experiences, specialists have anticipated that it might take 5–10 years to recover from this pandemic [38]. In addition to reviewing the current literature, we asked surgical residents of different surgical disciplines to report on the quality of training and satisfaction with medical education during this pandemic. Our results suggest that there are many adverse outcomes to consider when evaluating the impact of COVID-19 crisis on medical education, specifically surgical fields.

Decrease in clinical activities (emergency and elective operations as well as pre-operative and post-operative care) and educational activities (theoretical training) was notable among surgical residents of different specialties, which was comparable to previous reports [37]. This should be used as a reminder for medical education systems to evaluate and alter the training curriculum as needed during pandemics. The learning opportunities for surgical residents have decreased due to the cessation of elective surgeries during the pandemic. Conclusively, surgical residents are tending to experience a more disrupted training in comparison to residents of non-surgical specialties. Rana et al. reported that medicine residents were more comfortable than surgical residents using tele-medicine [34].

The results of this investigation also highlighted that the level of satisfaction with both theoretical training and clinical training was reduced especially in residents with more exposure to COVID-19 patients. The COVID-19 pandemic has significantly affected postgraduate education, but educators have responded promptly to flatten the impact. This attempt ranged from decreased working hours while maintaining enough exposure to emergency operations. At the same time, there was a shift from the reduced operative and clinical tasks towards more educational and scientific programs [39–41].

This study shows that the surgical residency curriculum requires revisions as well as innovative approaches. The results indicate that improvement of educational programs in referral centers (such as IKHC)
is essential since such hospitals have limited resources and are affected more strongly due to the high number of COVID-19 patients. This shortage of resources in turn has a direct negative impact on the surgical training plans due to the limited number of patients receiving surgical treatment. Moreover, surgical residents of such referral hospitals have to participate in the COVID-19 wards and provide care for COVID-19 patient. This extra duty can deviate residents from their training programs. Although we investigated almost all surgical specialties, further research into the experiences of different surgical and non-surgical disciplines will shed light on the difference between subgroups and facilitate technical performance and skills for all surgical trainees. In other words, operations performed by the attending faculty and a team of residents at the hospital can be live-streamed and successively discussed with other residents who could not attend the operation in person.

As another suggestion for improving education during the pandemic, surgical simulator devices, which were previously used for laparoscopic training, can be more extensively integrated into the training programs. This could allow for more hands-on experience and improvements in technical performance and skills for all surgical trainees. In other words, residents can perform the selected procedures and operations using simulator devices under the supervision of a senior resident or attending faculty and then independently. Finally, virtual reality and online simulator applications designed for the training of open and laparoscopic surgeries can be played for trainees during online classes while the faculty explains the procedure and answers any queries or concerns the residents may have. Moreover, operations performed by the attending faculty and a team of residents at the hospital can be live-streamed and successively discussed with other residents who could not attend the operation in person.

Conclusions

The COVID-19 pandemic has posed a substantial impact on the training of different surgical disciplines. Reduced clinical and surgical opportunities, decreased case volume, and disruption in face-to-face education are considered as main concerns in surgical training. Despite its disadvantages, increased time for resting, self-study, and satisfaction with virtual learning platforms to some extent, had made an opportunity out of the pandemic for surgical residents. We suggest that online training methods, virtual 3D platforms for physical examinations, anatomic dissections, and basic surgical skills can be implemented into the surgical curriculum. For example, videos of operations can be played for trainees during online classes while the faculty explains the procedure and answers any queries or concerns the residents may have. Moreover, operations performed by the attending faculty and a team of residents at the hospital can be live-streamed and successively discussed with other residents who could not attend the operation in person.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amsu.2022.104598.

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