



The effect of the COVID-19 pandemic on orthopedic surgeries in a tertiary referral center

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Since its emergence in December 2019,^[1] severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2), which is the culprit agent of novel coronavirus 2019 (COVID-19) disease, has led to a global pandemic. The first case in Turkey was diagnosed on March 10th, 2020.^[2] As of July 2020, the total number of cases in Turkey has surpassed 200,000 with a death toll over 5,000.^[3] The rapid spreading of this disease has been shown to overload hospitals and hinder healthcare services.^[4,5] To overcome a potential collapse of the healthcare system, numerous measures of infection control have been established countrywide. These include social isolation protocols, personal protective equipment (PPE) standardization, and patient selection by prioritizing the urgency of their treatment.

The limitation or cancellation of elective surgeries was one of the methods used to reduce the number of patients having orthopedic surgery.^[6] In our

ABSTRACT

Objectives: The aim of this study is to investigate the effect of the novel coronavirus-2019 (COVID-19) pandemic on the operational trends in the orthopedic surgery department of a tertiary referral center.

Patients and methods: A total of 305 orthopedic surgical procedures in 245 patients (136 males, 109 females; mean age: 34±26.6 years; range, 0 to 91 years) between March 16th and June 27th, 2020 were retrospectively analyzed. The same period of the year before including 860 procedures in 783 patients (364 males, 419 females; mean age: 33.6±25.8 years; range, 0 to 95 years) was also reviewed as a pre-pandemic control group. Patient demographics, surgical indications, COVID-19 polymerase chain reaction (PCR) test status, method of anesthesia, surgical subspecialties (trauma, sports, etc.), trauma mechanisms, and surgical priorities were evaluated. The pandemic and the pre-pandemic periods were compared.

Results: The rate of elective surgeries decreased compared to the previous year, and priority C type surgeries had the highest frequency (42.5%). Orthopedic trauma was the leading subspecialty with 91 (29.8%) cases and had a higher share, compared to the pre-pandemic period (17.0%). Hip fractures (18.7%) were the most common cause of trauma surgery, and simple falls (42.3%) composed the largest group of trauma mechanisms, which was similar to the pre-pandemic period (hip fractures, 13.6%; simple falls, 42.5%). The distribution of surgical urgency levels and subspecialties differed significantly between the pre-pandemic and pandemic periods ($p<0.001$). Post-hoc analysis of subspecialty distribution revealed a significant decrease in arthroplasty ($p=0.002$) and hand surgery ($p<0.001$), and a significant increase in trauma ($p<0.001$) and the “other” category ($p<0.001$).

Conclusion: Our experience in a tertiary referral center illustrated a shift toward performing emergent and urgent surgeries, when the severity of the outbreak increased. Prioritizing surgical urgencies during the outbreak changed the orthopedic surgery practice with an emphasis on trauma and oncology surgeries. Hip fractures were the most common cause of trauma surgery, and simple falls composed the largest group of trauma mechanisms.

Keywords: COVID-19, elective surgical procedure, orthopedic surgery, pandemic, trauma.

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institution, a tertiary referral center, all elective surgeries were cancelled on March 16th, five days after the arrival of the outbreak in Turkey. Thereafter, only emergent or urgent surgeries and procedures for which delays would have negatively affected the outcome of treatment were performed. On June 8th, the restrictions on elective low-priority surgeries were lifted.

In Turkey, the fear of the outbreak became widespread around mid-to-late March. Soon, most businesses shut down, numerous groups of individuals began remote working, and most recreational facilities including parks, gyms, bars, restaurants, and shopping malls were gradually closed. Citizens over the age of 65 years and those who had chronic illnesses were prohibited from leaving their home on March 24th, and another curfew was enacted for those under 20 years of age on April 3rd.^[7] Stay-at-home calls urged individuals to isolate themselves, unless otherwise necessary. Starting April 11th, the government implemented curfews on the weekends, which continued until May 31st. Changes in social life such as curfews have been shown to potentially alter the modes of trauma presentation.^[8]

The disease control measures, alongside the disrupted social life of citizens and lockdowns, have caused a shift in the operation portfolio of the orthopedic practice. In the present study, we aimed to investigate the effect of the COVID-19 pandemic on the operational trends in the orthopedic surgery department of a tertiary referral center.

PATIENTS AND METHODS

This single-center, retrospective study was conducted at Hacettepe University Faculty of Medicine, Department of Orthopedics and Traumatology between March 16th (the date of the cancellation of elective surgeries) and June 27th, 2020. A written informed consent was obtained from each patient. The study protocol was approved by the Republic of Turkey, Ministry of Health and Institutional Review Board of the Hacettepe University Non-Interventional Clinical Research Ethics Board (Date: 09.22.2020, No: 2020/15-09). The study was conducted in accordance with the principles of the Declaration of Helsinki.

A retrospective review of the procedures that took place in our department was conducted. Patient demographics, surgical indications, COVID-19 polymerase chain reaction (PCR) test status, and the method of anesthesia were retrieved from the patient charts. A total of 305 orthopedic surgical procedures in 245 patients (136 males, 109 females;

mean age: 34±26.6 years; range, 0 to 91 years) were retrospectively analyzed. The same period of the year before (March 16th and June 27th, 2019) including 860 procedures in 783 patients (364 males, 419 females; mean age: 33.6±25.8 years; range, 0 to 95 years) was also reviewed as a pre-pandemic control group.

Surgical notes were reviewed and surgeries were categorized according to subspecialty (orthopedic trauma, orthopedic oncology, spine surgery, orthopedic sports surgery, hand surgery, arthroplasty or pediatric orthopedics). Procedures that fit into none of these subspecialties were labeled as "other" (e.g., infections, non-traumatic amputations). The mechanism of trauma and the time from admission to surgery were also recorded for surgeries.

Surgeries were classified according to their urgency status.^[6] Emergent surgeries which should be performed within 24 h were categorized as priority A; urgent surgeries which should not be delayed for longer than 48 h were categorized as priority B; surgeries with better outcomes if performed no later than two weeks were categorized as priority C; surgeries which could be delayed up to three months were categorized as priority D, and surgeries which were affected the least by delays were categorized as priority E.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 26.0 software (IBM Corp., Armonk, New York, USA). Descriptive data were expressed in mean ± standard deviation (SD), median (min-max) or number and frequency, where applicable. The Pearson's chi-square test was performed to analyze the significance of distributions between the pre-pandemic and pandemic periods. *Post-hoc* analyses were carried out to determine the factors of significance. The Mann-Whitney U test was performed to compare the mean delay to surgery values between the two periods. A *p* value of <0.05 was considered statistically significant.

RESULTS

The pre-pandemic period

A total of 860 procedures were performed in 783 patients by 11 attending surgeons between March 16th and June 27, 2019. Of the patients, 339 (43.3%) were under 20 years of age, 310 (39.6%) were between 20 and 64 years of age, and 134 (17.1%) were older than 65 years. A total of 669 patients (77.8%) received general anesthesia, 94 (10.9%)

TABLE I Demographic data of patients								
	Pre-pandemic				Pandemic			
	n	%	Mean±SD	Range	n	%	Mean±SD	Range
Age (year)			33.6±25.8	0-95			34.0±26.6	0-91
Total number of procedures	860				305			
Total number of patients	783				245			
Sex								
Male	364	46.5			136	55		
Female	419	53.5			109	45		
Age group								
0-19	339	43.3			111	45.3		
20-64	310	39.6			89	36.3		
>65	134	17.1			45	18.4		

SD: Standard deviation.

received spinal anesthesia, and 37 (4.3%) received intraoperative sedation. Fifty-one (5.9%) procedures were performed under local anesthesia and six (0.7%) procedures were performed under regional anesthesia. Priority E surgeries had the highest frequency with 52.2%, followed by Priority C, D, and B. Priority A was the least frequent with only 5.0% of all surgeries (Table I, Figure 1).

Orthopedic trauma surgery was the most frequent category with 146 procedures (17.0%) (Figure 2, Table II). However, in this study, secondary surgeries (infection, nonunion or malunion surgery for fracture complications, implant removal, etc.) were analyzed under the same category. These

secondary surgeries represented 29 procedures (19.9%). The actual number of acute traumas corresponded to 117 procedures. Orthopedic sports surgery, arthroplasty, pediatric orthopedics, and spine surgery demonstrated similar frequencies. Orthopedic oncology procedures were further classified into subcategories. Benign tumors had the largest share (28.9%), followed by biopsies (27.8%).

Hip fractures (13.6%) and elbow fractures (13.6%) were the most common indications for trauma surgery. The most common cause of trauma was simple fall (42.5%), followed by falling on an outstretched hand (14.8%), and fall from height (10.1%). The mean time to surgery was

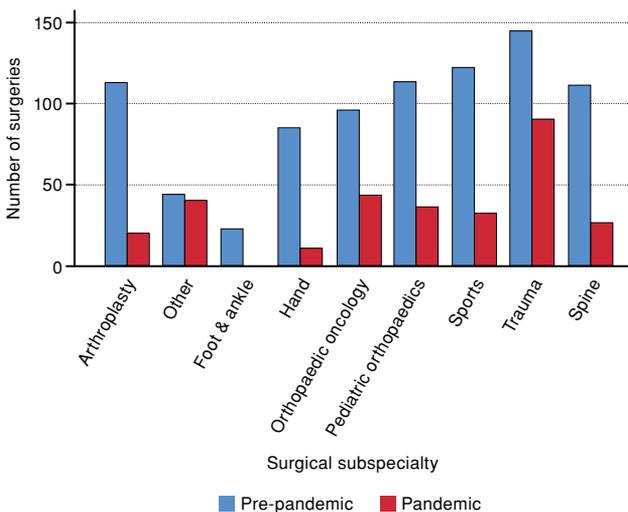


FIGURE 1. Comparison of the distribution of surgical urgencies between the pre-pandemic and pandemic periods.

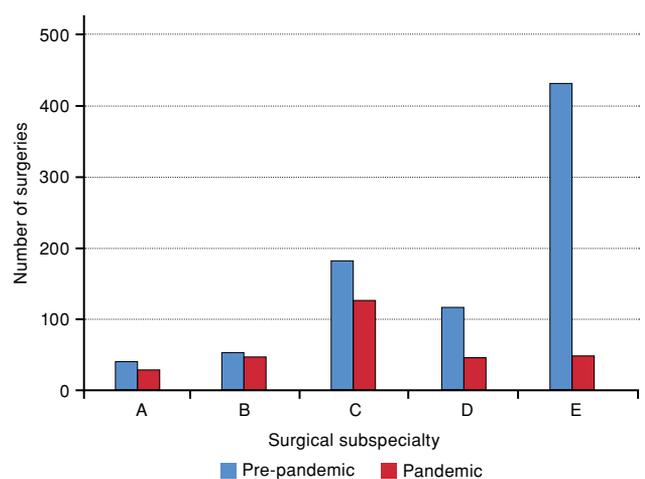


FIGURE 2. Comparison of the surgical subspecialty distribution between the pre-pandemic and pandemic periods.

TABLE II

The distribution of cases based on orthopedic subspecialty category for each period of the pandemic and the control period

	Week 1-4		Week 5-8		Week 9-12		Week 13-16		Pandemic period Total		Pre-pandemic Period	
	n	%	n	%	n	%	n	%	n	%	n	%
Arthroplasty	6	7.2	2	3.2	2	4.0	11	10.1	21	6.9	114	13.3
Hand	4	4.8	-	-	1	2.0	6	5.5	11	3.6	86	10.0
Orthopaedic oncology	18	21.7	13	21.6	8	16.0	5	4.6	44	14.4	97	11.3
Other	17	20.5	9	14.3	8	16.0	7	6.4	41	13.4	68	7.9
Pediatric orthopaedics	2	2.4	8	12.7	-	-	27	24.8	37	12.1	114	13.3
Spine	3	3.6	7	11.1	8	16.0	9	8.3	27	8.9	112	13.0
Sports	10	12.0	-	-	1	2.0	22	20.2	33	10.8	123	14.3
Trauma	23	27.7	24	38.1	22	44.0	22	20.2	91	29.8	146	17.0
Total	83	100	63	100	50	100	109	100	305	100	860	100

2.4±9.6 (range, 0 to 43) days for priority A, 1.5±2.0 (range, 0 to 10) days for priority B, and 4.5±4.5 (range, 0 to 17) days for priority C type trauma. It should be noted, however, that some patients became outliers due to their general condition being too unfit for surgery, despite having an orthopedic emergency.

The pandemic period

A total of 305 procedures were performed in 245 patients by the same group in the pandemic period. One-hundred-eleven patients (45.3%) were under the age of 20, 89 (36.3%) were between 20 and 64 years, and 45 (18.4%) were over the age of 65. Age groups between the pandemic and the pre-pandemic groups were not significantly different ($p=0.65$). General anesthesia was utilized in 188 (61.6%), spinal anesthesia in 26 (8.5%), intraoperative sedation in 33 (10.8%), regional anesthesia in 11 (3.7%), and local anesthesia in 47 procedures (15.4%). Preoperative COVID-19 PCR test was obtained from 130 patients (42.6%), and only one patient had a positive test result.

Priority C type surgeries were the most prominent with a 42.5% frequency. This was followed by priority E (16.7%), B (15.7%), D (15.4%), and A (9.75%). Priority C had its highest frequency (57.0%) during the first four weeks.

Orthopedic trauma was the leading subspecialty with 91 (29.8%) cases. This was followed by orthopedic oncology with 44 (14.4%) cases. Hand surgery and arthroplasty were the least frequently performed with 11 (3.6%) and 21 (6.9%) cases, respectively. Although orthopedic trauma load remained similar throughout the pandemic, the return of elective surgeries led to a decrease in

the trauma percentage after Week 12. There was a notable increase of pediatric orthopedics and sports surgeries in the same period, and a decrease in orthopedic oncology procedures.

A total of 196 procedures belonged to the period of further restrictions (March 16th and June 7th, 2020). Priority E (3.1%) comprised the lowest percentage of surgeries, while priority C (51.8%) was the most common group of urgency. Trauma surgery (35.2%) had the highest share, followed by orthopedic oncology (19.9%). Simple falls were the most common trauma mechanisms (12.2%).

A total of 109 procedures belonged to the pandemic period after elective surgeries were reopened (June 8th and June 27th, 2020). Priority E (40.7%) became the most frequent group of urgency, followed by priority C (25.9%). Pediatric orthopedics (24.8%) surpassed trauma (20.2%) and was the most commonly performed subspecialty. Simple falls (8.3%) remained the most common trauma mechanisms.

Comparison of pre-pandemic and pandemic periods

The demographics between two groups were similar. The Pearson chi-square test revealed a significant difference regarding the distribution of surgical urgency levels between the pre-pandemic and pandemic periods ($p<0.001$). *Post-hoc* analysis revealed the difference resulting from the increase of priority A ($p=0.003$), B ($p<0.001$), and C ($p<0.001$) procedures, and the decrease of priority E ($p<0.001$). No significant difference was found for priority D surgeries ($p=0.617$).

The change in surgical subspecialty distribution was statistically significant between the pre-pandemic and pandemic periods ($p < 0.001$). *Post-hoc* analysis revealed a significant decrease in arthroplasty ($p = 0.002$) and hand surgery ($p < 0.001$), and a significant increase in trauma ($p < 0.001$) and the "other" category ($p < 0.001$). The increase in orthopedic oncology ($p = 0.161$), and the decrease in pediatric orthopedics ($p = 0.617$), and sports surgeries ($p = 0.133$) were not found to be statistically significant.

Among orthopedic oncology procedures, benign tumor surgery was drastically reduced to 6.8%. Following biopsies (45.5%), pathological fractures and impending fractures of long bones due to metastases (18.2%) had the largest share, followed by spinal tumors (13.6%), and malignant extremity tumors (9.1%), respectively. Secondary surgeries including hematoma and infection debridement were also performed.

Hip fractures (18.7%) surpassed elbow fractures (mostly pediatric supracondylar humerus fractures) (12.1%) as the most common cause leading to trauma surgery. Ankle fractures had a smaller share compared to the previous year. The mean delay to surgery was 0.6 ± 1.5 (range, 0 to 7) days for priority A, 1.9 ± 2.6 (range, 0 to 14) days for priority B, and 3.1 ± 6.1 (range, 0 to 28) days for priority C type injuries. Simple falls (42.3%) composed the largest group of trauma mechanisms, followed by falling on an outstretched hand (15.3%). No significant difference was found in length of delays between the two periods for priority A ($p = 0.07$), B ($p = 0.21$), or C ($p = 0.07$).

DISCUSSION

Since the cancellation of elective surgeries in the mid-March 2020, our orthopedic surgery practice adopted a priority-focused approach. The shift from low-priority to high-priority surgeries was a common theme in most orthopedics clinics, leading a decrease in the total surgical volume.^[8-10] As a result of this, the weight of surgical subspecialties differed, particularly until the return of elective surgeries. Due to urgent or life-threatening diseases, we provided healthcare mostly to trauma and orthopedic oncology patients. Hip fractures were the most common cause of trauma surgery, and simple falls composed the largest group of trauma mechanisms.^[11] Some complications of other subspecialties including infection were also among the treated majority.

The distribution of surgical subspecialties was somewhat similar within the first 12 weeks. Elective surgeries were reopened at the end of the 12th week. Therefore, we observed a surge in the numbers of pediatric orthopedics and sports surgery which comprise mostly elective procedures. We also noted a decrease in the number of orthopedic oncology surgeries in the same period. This is likely due to a change in resource allocation, including operation room (OR) usage, postoperative intensive care unit (ICU) bed reservation, and the availability of the attending surgeon.

As a center of pediatric spinal deformity surgery, spinal instrumentation for scoliosis or kyphosis was not performed throughout the pandemic period. Spine surgeries decreased by 75% which is similar to the findings of Mehta and Chiu^[9] who found a 63% lower rate after the restrictions on elective surgery. The spine surgeries we performed consisted of mostly spinal infections and lengthening of traditional growing rods.

We delayed benign musculoskeletal tumor surgeries to provide care primarily to malignancies. Overall, orthopedic malignant tumor surgeries were not disrupted. However, there have been reports of diminished orthopedic oncology healthcare during the pandemic.^[12] We recommend that, as long as a center can afford the treatment of priority C surgeries, malignant tumor surgery should continue even during an outbreak.

The societal state of a community undoubtedly affects the distribution of orthopedic trauma. The curfew for those under 20 years and the closure of parks might have been a cause for the slight decrease in the rate of supracondylar humerus fractures. There was a notable decrease in sports-related injuries and workplace accidents in the pandemic period. In contrast, a higher percentage consisted of motor vehicle accidents. The rate of hip fractures increased with the pandemic, since most hip fracture patients injure themselves by falling at home. This is also consistent with the findings of Nuñez et al.^[10]

In the present study, the rate of COVID-19 PCR positivity was dramatically lower, compared to a similar study.^[10] We believe that we achieved such a low COVID-19 (+) rate, as the outbreak arrived relatively later in Turkey, which allowed the hospitals to prospectively prepare for a healthcare crisis. Our institution was never overwhelmed by COVID-19 patients, and we fortunately managed to maintain priority healthcare services throughout the pandemic. When elective surgeries were restarted,

preoperative COVID-19 testing became mandatory in our institution.^[6,13]

The donning/doffing procedure of PPE including gowns, N95 masks, gloves, goggles, and face shields for anesthesia induction has been standardized for all surgery patients in our institution.^[14] All patients undergo intubation with a video laryngoscope. Hazmat suits are donned by the entire OR team for COVID-19 (+) surgeries. The remaining OR staff are kept outside until 10 min have passed after the intubation process. The OR is left vacant for 30 min between each surgery. The frequency of general anesthesia decreased compared to the previous year. Although some centers recommend general anesthesia to avoid contamination from droplets from the mouth and nose,^[15] the overall evidence has been limited and there are no contraindications for spinal anesthesia until now.^[16]

The financial burden of the pandemic is yet to be revealed. In the case of arthroplasty, O'Connor^[17] suggested eliminating the use of auxiliary components such as robotics and navigation for cost mitigation. The restriction on elective surgeries not only delays the needed healthcare, it may also increase the incidence of complications and the difficulty of the required treatment. These may increase the potential cost of treatment expected from a patient in long-term.

Our experience as a tertiary referral center illustrated a shift toward performing emergent and urgent surgeries, when the severity of the outbreak increased. The altered social state of the population led to a lower rate of injuries related to outdoor activities, whereas indoor trauma and motor vehicle accidents had a larger share.

Nonetheless, this study has several limitations. Although we did not investigate the status of outpatient trauma, most surgeons in our institution assumed a bias toward conservative treatment whenever possible as per recommendations to avoid COVID-19-related complications.^[18] This is a confounding factor, as even if the incidence of trauma remained the same, the rate of trauma surgery might have been lowered. Another confounding factor is the patient referrals from other hospitals with obstructed surgical healthcare due to the pandemic. This might have increased our rates of trauma surgery, although the total incidence of trauma in the population might have fallen.

In conclusion, the COVID-19 pandemic has transformed orthopedic surgery healthcare. Trauma and orthopedic oncology comprised the majority

of surgeries during the outbreak. Hip fractures were the most common cause of trauma surgery, and simple falls composed the largest group of trauma mechanisms. The establishment of new protocols including preoperative COVID-19 testing, PPE standardization, and safer anesthetic induction methods are crucial preventive measures, when elective surgeries have reopened.

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