









Indirect impact of the COVID-19 pandemic on diabetes-related lower extremity amputations: A regional study

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The outbreak of severe acute respiratory syndrome-Coronavirus 2 (SARS-CoV-2) was first began in China and led to a global novel coronavirus disease 2019 (COVID-19) pandemic in 2020.^[1] As the spread of the pandemic has continued, more than a million deaths were reported due to COVID-19 infection worldwide.^[2] Due to the rapid spread of the virus, healthcare systems were exposed to a large number of COVID-19 infection patients which created a potential collapse risk of healthcare systems.^[3] Healthcare authorities and governments around the world have made several attempts to overcome the rapid spread of the virus such as lockdowns, school closures, cessation of international transportation.^[3]

A curfew was announced in Turkey on March 21st, 2020, for the citizens over the age of 65 years and who had chronic diseases and individuals aged below 20 years. In addition, many businesses

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ABSTRACT

Objectives: This study aims to evaluate the indirect impact of the novel coronavirus disease 2019 (COVID-19) pandemic on diabetes-related lower extremity amputations.

Patients and methods: Patients who underwent lower limb amputation due to complications of diabetes between August 2019 and February 2020 (control group) and August 2020 and February 2021 (pandemic group) were retrospectively reviewed. None of the patients had a previous COVID-19 infection. Patients' amputation level and latest diabetes follow-up date until amputation were recorded.

Results: A total of 19 feet of 19 patients (14 males, 5 females; mean age: 70.0±10.5 years; range, 53 to 91 years) in the control group and 18 feet of 18 patients (12 males, 6 females; mean age: 70.4±11.3 years; range, 54 to 91 years) were included. There was no statistically significant difference in amputation levels between the two groups (p=0.959). The mean time elapsed from the last diabetes control in the control and the pandemic group was 5.9±12.8 months and 8.2±9.8 months, respectively (p=0.038). A total of eight (42.1%) patients in the control group and seven (38.9%) patients in the pandemic group did not have a follow-up for diabetes in the last year prior to amputation (p=0.842).

Conclusion: Although the COVID-19 pandemic seems to cause a delay in the routine medical care of patients with diabetes, it appears not to have an indirect effect on the lower extremity amputation level and incidence. Patients' adherence may be the major determinant in amputation surgery.

Keywords: Amputation, COVID-19 pandemic, diabetes, diabetic foot, diabetic ulcer.

were shut down or encouraged to work remotely.^[4] These self-isolation regulations changed the routine daily activities of individuals. The reflection of the self-isolation principles that kept individuals at home was observed in daily life such as decreased traffic density, trauma prevalence, and reduced associated hospital admissions.^[5,6]

As the first year of the COVID-19 pandemic ended, many indirect effects of the pandemic have developed

on patients' health due to the obstacles caused by self-isolation principles and lockdowns. Most of the patients with chronic illnesses did not have a regular follow-up during the pandemic due to individuals' fear of getting the virus or self-isolation regulations.^[7] Since patients with diabetes require regular follow-ups, the COVID-19 pandemic turned out to be a barrier in diabetic patients' glycemic control indirectly in addition to its direct effects on glycemic control such as disturbing B-cell dysfunction.^[8,9] Moreover, COVID-19 has been shown to cause vascular problems including coagulopathy and vasculopathy,^[10] which is an important direct effect of the virus for diabetic patients. The disruption of achieving routine diabetes control have been reported to increase diabetes-related complications including diabetic foot and lower extremity amputations.^[11]

There are few studies investigating the combined effect, both indirect and direct, of the COVID-19 pandemic on amputation incidence and levels;^[12,13] however, the literature is lacking for a study examining the indirect impact of the pandemic individually on diabetes-related amputations. In the present study, we hypothesized that the delay in the time of admission to the medical centers due to COVID-19 pandemic might cause an increase in the amputation level and frequency due to the uncontrolled period of the blood glucose. We, therefore, aimed to evaluate the indirect impact of the COVID-19 pandemic on diabetes-related lower extremity amputation incidence and levels in a single institution in a patient population without a history of COVID-19 infection during the pandemic.

PATIENTS AND METHODS

This single-center, retrospective study was conducted at Karabük University Faculty of Medicine, Department of Orthopedics and

Traumatology. We reviewed patients who underwent lower limb amputation due to complications of diabetes between August 2019 and February 2020 (control group) and August 2020 and February 2021 (pandemic group). None of the patients had a previous COVID-19 infection. Patients who had a COVID-19 infection history, traumatic amputations, secondary amputations due to previous failed amputation, and without a diagnosis of diabetes were excluded. A written informed consent was obtained from each patient. The study protocol was approved by the Karabük University Faculty of Medicine Ethics Committee (1.10.2021/No: 626). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patients' age, sex, amputation level, latest diabetes follow-up date, and hemoglobin A1c (HbA1c) levels prior to amputation were obtained from the hospital registry records. Time elapsed from the latest diabetes follow-up until amputation was calculated for each patient. The presence of any diabetes follow-up in the last year before the amputation was noted. Amputation levels were classified as follows: at or below ankle, below the knee, at or above knee. Postoperative wound complications were recorded.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 23.0 software (IBM Corp., Armonk, NY, USA). Descriptive data were expressed in mean \pm standard deviation (SD) for continuous, while categorical variables were expressed in number and frequency. Distribution of variables was measured with the Kolmogorov-Smirnov test. The Student t-test and Mann-Whitney U test were used for statistical analysis. Categorical variables were compared using the Pearson chi-square test. A *p* value of <0.05 was considered statistically significant.

	Control group (n=19)		Pandemic group (n=18)		<i>p</i>
	n	Mean \pm SD	n	Mean \pm SD	
Age (year)		70.0 \pm 10.5		70.4 \pm 11.3	0.902
Sex					0.641
Male	14		12		
Female	5		6		
HbA1c (%)		9.4 \pm 1.9		9.9 \pm 2.9	0.542
Length of stay at hospital (days)		10.5 \pm 9.5		8.6 \pm 7.2	0.552

SD: Standard deviation.

RESULTS

A total of 19 feet of 19 patients (14 males, 5 females; mean age: 70.0 ± 10.5 years; range, 53 to 91 years) in the control group and 18 feet of 18 patients (12 males, 6 females; mean age: 70.4 ± 11.3 years; range, 54 to 91 years) in the pandemic group met the inclusion criteria and were included in the study. There was no statistically significant difference in the mean age and sex distribution between the control and pandemic group (Table I).

Of the 19 feet in the control group, four feet had an amputation at or distal to ankle joint, 10 feet had below knee amputation, and five feet had an amputation at or proximal to knee joint. Of the 18 feet who underwent amputation in the pandemic group, there were four amputations at or distal to ankle joint, 10 below knee amputations, and four amputations at or above the knee joint. There was no statistically significant difference in amputation levels between the two groups ($p=0.959$) (Figure 1).

A total of eight (42.1%) patients in the control group and seven (38.9%) patients in the pandemic group did not have a follow-up for diabetes in the last year prior to amputation ($p=0.842$). The mean time elapsed from the last diabetes control to amputation in the control and the pandemic group was 5.9 ± 12.8 months and 8.2 ± 9.8 months, respectively ($p=0.038$).

There was no statistically significant difference in the mean HbA1c levels before the amputation and mean length of stay at hospital in the control and the pandemic groups (Table I). In the control group, five (26.3%) patients had postoperative wound complications, while four (22.2%) patients had in the pandemic group ($p=0.772$).

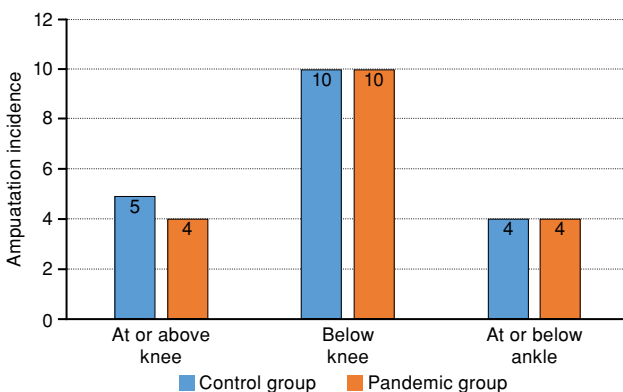


FIGURE 1. Distribution of amputation levels and incidence in the control group and pandemic group.

DISCUSSION

The COVID-19 outbreak has caused several health issues due to the suspension of routine healthcare practice. Most of the patients with chronic conditions such as cardiac diseases and diabetes mellitus were unable to have a regular follow-up visit due to the lockdowns.^[14] In the current study, we investigated the indirect effect of COVID-19 on the lower extremity amputation incidence and levels in diabetic patients, and we showed that there was no change in the amputation incidence and levels due to complications of diabetes during the pandemic period.

Apart from the indirect effect of COVID-19 on pursuing healthcare, it is also certain that the virus has direct impacts on extremity circulation. Recent studies have demonstrated that SARS-CoV-2 infection may lead to coagulopathy and vasculopathy.^[10] These vascular problems may end up with amputation of the extremity.^[15] Studies reporting the amputation incidence after the COVID-19 pandemic mostly have heterogeneous patient populations, with or without previously infected COVID-19 patient cohorts.^[12,13] We believe that this heterogeneity may mislead the literature regarding the effect of the COVID-19 pandemic on amputation levels. Our series is unique to investigate the indirect effect of the COVID-19 pandemic, since none of our patients had a COVID-19 infection history prior to amputation. We may argue that not finding a difference between the groups in amputation incidences and levels may be due to our unique homogenous patient cohort.

There is still a controversy in the literature regarding the impact of COVID-19 pandemic on amputation incidences and levels. Goldman et al.^[12] reported increased amputation incidences and levels after pandemic. On the contrary, Mariet et al.^[13] demonstrated a reduction in amputation frequencies, as well as amputation levels following the pandemic. In the current study, there was no change in the amputation incidence or levels after the pandemic. These contradictory results may be caused by the heterogeneous patient populations regarding previous COVID-19 infection status, varying national lockdown protocols or overwhelmed healthcare systems. Further studies are warranted investigating the indirect or direct effects of COVID-19 pandemic separately in more a homogenous patient population.

Patient adherence is a major problem in diabetic patients. At least 50% of the patients have been reported to fail to achieve target glycemic control.^[16] It is obvious that lockdowns negatively affected regular diabetes follow-ups. In the current study,

there was a significant delay in the time elapsed from the latest diabetes follow-up to amputation in the pandemic group, which is consistent with the existing literature.^[7,8] On the other hand, 42.1% of the patients in the control group and 38.9% of the patients in the pandemic group did not seek a regular diabetes follow-up in the last year before the amputation. In addition, patients in both groups had a similar mean HbA1c levels which is a significant indicator of glycemic control and risk factor for lower extremity amputation.^[17] For patients with diabetes, although the COVID-19 pandemic seems to be a barrier to reach healthcare, it may be concluded that diabetic patients' non-compliance had a superior impact than pandemic to achieve medical care. The reason that there was no significant difference between the groups in the current study on lower extremity amputation incidences and levels may be related to non-adherence of the diabetic patients.

The effect of COVID-19 on amputation requirements is multifactorial.^[13] Lockdowns during the pandemic forced patients to stay at home, thereby reducing daily activities. Consequently, diabetic patients' feet were exposed less loads than previous pandemic period. This off-loading may be a positive protective factor from amputation after the pandemic. Nonetheless, reduction in routine healthcare and vascular involvement of COVID-19 disease may be a negative factor. The variable results in the effect of COVID-19 on amputation incidences and levels may be due to its multifactorial status which represents the direct and indirect mechanisms.

Postoperative wound healing problems pose an important percentage of complications of amputation surgery. Wound healing complication rate varies from 6 to 34% following major amputation surgery.^[18] In the current study, the control group (26.3%) and the pandemic group had (22.2%) had comparable postoperative wound complication rates. Furthermore, complication rates in both groups are consistent with the previous literature. We believe that similar surgical site complication rate between groups is due to similar patient characteristics and the absence of COVID-19 infection history within both groups.

There are some limitations of the current study. First, it has a retrospective design. Second, our patient population is limited, as the study was conducted in a regional single center and, therefore, the results cannot be generalized to the general population. Nevertheless, the current study has several strengths. Our patient population is homogenous, as all were diagnosed with diabetes and none of them had a

history of previous COVID-19 infection. Moreover, we did not include patients who had amputation in the first six months of the pandemic which eliminated the patients who had recent diabetes control prior to the spread of pandemic, thereby providing better evidence for the indirect effect of the pandemic.

In conclusion, COVID-19 pandemic appears not to have an indirect effect caused by inability to achieve routine medical care on the lower extremity amputation incidences and levels due to diabetes-related complications. Although the COVID-19 pandemic seems to cause a delay in the routine medical care of patients with diabetes, patients' adherence may be the major determinant in amputation surgery.

Declaration of conflicting interests

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