

# Prior COVID-19 infection is associated with statistically lower but clinically minimal blood loss after total knee and hip arthroplasty

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## ABSTRACT

**Aims:** The influence of previous COVID-19 infection on perioperative blood loss in total joint arthroplasty remains uncertain. Although COVID-19-related inflammatory and vascular alterations have been described, their impact on early postoperative hemoglobin and hematocrit changes after total knee arthroplasty (TKA) and total hip arthroplasty (THA) has not been well established.

**Methods:** This retrospective comparative study included patients who underwent primary TKA or THA between April 2022 and April 2025. Demographic characteristics, comorbidities, vaccination status, and perioperative laboratory values were recorded. Patients were categorized based on prior COVID-19 infection history. Changes in hemoglobin and hematocrit from the preoperative period to postoperative day 1 were calculated. Intergroup comparisons were performed, and multivariable linear regression analysis was used to identify independent predictors of postoperative hemoglobin decline.

**Results:** A total of 381 patients were included (244 TKA, 137 THA; mean age 63.4±10.1 years). Overall mean decreases were -2.53±1.32 g/dl for hemoglobin and -7.85±5.34% for hematocrit. Patients with a history of COVID-19 infection demonstrated smaller reductions in hemoglobin (-2.22±1.37 vs -2.65±1.25 g/dl, p=0.003) and hematocrit (-7.02±4.33 vs -8.18±5.76%, p=0.031) compared with COVID-negative patients. Multivariable analysis identified prior COVID-19 infection, BNT162b2 vaccination, and undergoing TKA (vs THA) as independent factors associated with reduced postoperative hemoglobin decline. Despite statistical significance, the absolute differences were small.

**Conclusion:** Prior COVID-19 infection and vaccination status were associated with statistically lower early postoperative hemoglobin and hematocrit decreases following TKA and THA; however, these differences were not clinically meaningful. A history of COVID-19 does not appear to significantly alter perioperative bleeding profiles in arthroplasty patients.

**Keywords:** COVID-19, total knee arthroplasty, total hip arthroplasty, blood loss, hemoglobin, hematocrit

## INTRODUCTION

The COVID-19 pandemic markedly disrupted healthcare delivery worldwide. Elective orthopedic procedures were widely restricted, and many scheduled operations were postponed or cancelled. Previous studies have reported a substantial decline in arthroplasty volume during peak pandemic periods.<sup>1</sup> In addition, COVID-19 has been associated with increased perioperative morbidity and mortality in several orthopedic procedures.<sup>2-4</sup> Furthermore, the hypercoagulable state related to COVID-19 has been linked to an increased risk of thromboembolic complications in arthroplasty patient.<sup>5</sup>

The demand for hip and knee arthroplasty continues to rise due to population ageing, increased life expectancy, and higher functional expectations.<sup>6</sup> Total joint arthroplasty is a major procedure that may be associated with considerable intraoperative and postoperative blood loss.<sup>7</sup> Published data suggest that mean blood loss ranges from 1,000 to 1,400 ml

after total knee arthroplasty (TKA) and from 1,200 to 1,600 ml after total hip arthroplasty (THA).<sup>7,8</sup> Excessive perioperative blood loss may increase the need for allogeneic transfusion and may adversely affect length of stay, periprosthetic joint infection risk, and overall postoperative morbidity.<sup>9,10</sup>

Although the effect of COVID-19 on orthopedic surgery has been widely investigated, its influence on perioperative bleeding in arthroplasty patients remains insufficiently studied. Accordingly, we aimed to compare perioperative blood loss parameters in arthroplasty patients with and without a prior history of COVID-19 infection. We hypothesized that arthroplasty-related blood loss would be lower in patients with prior COVID-19 infection because of persistent prothrombotic and vascular changes associated with the disease. To our knowledge, limited data exist regarding the effect of prior COVID-19 infection on perioperative blood

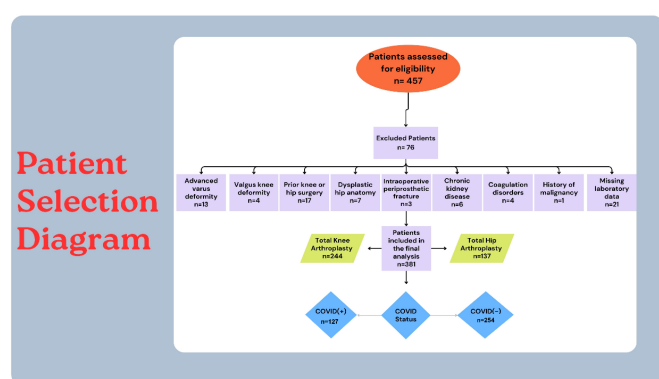
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loss in arthroplasty patients, and the clinical relevance of this relationship remains unclear.

## METHODS

This was a retrospective comparative study. Data collection was initiated after approval had been obtained from our institutional clinical research Ankara Bilkent City Hospital Medical Researches Ethics Committee (Date: 18.03.2026, Decision No: TABED 2-26-1873). All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki. Patients who underwent primary arthroplasty for gonarthrosis or coxarthrosis between April 2022 and April 2025 were eligible for inclusion. Patients with advanced varus deformity, valgus knee deformity, previous knee or hip surgery, dysplastic hip anatomy, intraoperative periprosthetic fracture, chronic renal failure, bleeding disorders, prior malignancy treatment, or incomplete clinical or laboratory data were excluded. The patient selection process is illustrated in **Figure 1**.



**Figure 1.** Study flowchart

Flow diagram demonstrating application of inclusion/exclusion criteria and final allocation of patients into COVID-positive (n=127) and COVID-negative (n=254) arthroplasty cohorts

Prior COVID-19 infection status was determined using the health registry system, and patients were categorized as COVID-positive or COVID-negative. Vaccination status, including vaccine type and cumulative dose, was also retrieved from the health registry for each patient.

Patient demographics including age, sex, comorbidities, and operated side were recorded. Laboratory parameters including hemoglobin, hematocrit, and transfusion data were recorded preoperatively and on postoperative days 0 and 1. Changes between preoperative and postoperative values were calculated.

All procedures were performed by experienced arthroplasty surgeons. Patients were admitted one day prior to surgery. Prophylactic cefazolin was administered 30 minutes before incision. Tranexamic acid (10 mg/kg) was given preoperatively to reduce blood loss. Thromboprophylaxis with low-molecular-weight heparin was initiated 8 hours after surgery.

### Total Knee Arthroplasty

TKA procedures were performed under spinal or epidural anesthesia using a standard medial parapatellar approach following tourniquet inflation. The patella was everted, osteophytes were removed, and lateral facetectomy with denervation was performed. Femoral and tibial bone resections were performed in alignment with the mechanical axis. After cement fixation and adequate hemostasis, a closed-suction drain was inserted and the wound was closed

in layers. After the effect of post-operative spinal/epidural anesthesia wore off, passive quadriceps exercises were started. A compressive dressing was applied after wound closure. The drain and dressing were removed on postoperative day 1. Patients were mobilized with full weight bearing and allowed unrestricted range of motion.

### Total Hip Arthroplasty

All patients underwent spinal/epidural anesthesia. THA procedures were performed via a posterolateral approach. Following release of the short external rotators and capsule, the femoral head was dislocated. After trialing, the definitive acetabular component was implanted at the planned inclination and anteversion. Depending on the surgeon's preference, a ceramic or polyethylene liner was implanted. After proper access to the femoral canal, trial femoral components were used to determine appropriate stem size and offset. Hip stability, limb length, and range of motion were assessed during trial reduction. The definitive femoral stem and head were then implanted. Following bleeding control, the capsule and external rotators were repaired. All patients were started passive muscle exercises after the effect of spinal/epidural anesthesia wore off. All patients were mobilized with full weight bearing on postoperative day 1.

### Statistical Analysis

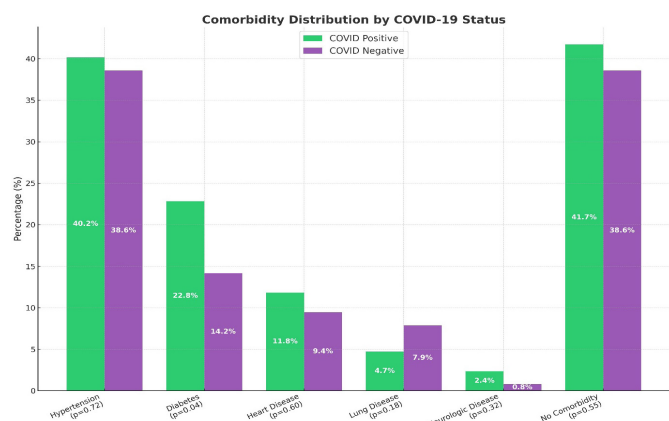
Continuous variables are presented as mean±standard deviation, whereas categorical variables are expressed as frequencies and percentages. Normality of data distribution was assessed using histogram evaluation, Q-Q plots, and the Kolmogorov-Smirnov test because of the relatively large sample size. For comparisons between two groups, the independent-samples T test was used for normally distributed continuous variables, and the Mann-Whitney U test was applied when normality assumptions were not met. Comparisons among three or more groups were performed using one-way analysis of variance (ANOVA), with appropriate post hoc analyses when indicated. Categorical variables were compared using the chi-square test or Fisher's exact test, as appropriate. Multivariable linear regression analysis was performed to identify factors associated with postoperative hemoglobin change. Variables entered into the regression model included age, sex, comorbidities, type of arthroplasty (total knee arthroplasty vs total hip arthroplasty), prior COVID-19 infection status, and vaccination status. Regression coefficients were reported with corresponding p values.

p<0.05 was considered statistically significant. All statistical analyses were performed using SPSS software (version 26.0; IBM Corp., Armonk, NY, USA).

## RESULTS

Following application of eligibility criteria, a total of 381 patients' data were included in the study. 244 (64%) of these patients underwent TKA and 137 (36%) underwent THA. The mean age of the patients in the study was 63.4±10.1 years. 64.8% of the patients had no history of COVID infection, while 33.3% had a history of COVID infection. Of the patients with a history of COVID infection, 15 (4.1%) had a history of hospitalization due to COVID infection. The mean age of patients without a history of COVID infection was 63.2±10.5 years, while the mean age of patients with a history of infection was 63.9±9.3 years. No significant difference in age was

observed between the two groups (p=0.47). The distribution of comorbid diseases of patients in both groups is shown in **Figure 2**.



**Figure 2.** Comorbidity distribution between cohorts  
Bar chart comparing the prevalence of major comorbidities in COVID-positive and COVID-negative patients undergoing arthroplasty, with percentage values displayed and p-values indicating between-group differences

The Charlson Comorbidity Index was 2.24±1.23 in patients without a history of COVID infection and 2.28±1.17 in patients with a history of infection. No significant difference was observed between the groups (p=0.715).

Among patients without a history of COVID-19 infection, 98 underwent THA and 156 underwent TKA, whereas among patients with prior infection, 39 underwent THA and 88 underwent TKA. No significant difference was observed between the groups in terms of arthroplasty distribution (p=0.162).

While 140 of the patients without a history of COVID infection were women, 75 of the patients with a history of infection were women. There was no significant difference was observed between the groups in terms of sex distribution (p=0.43).

The data on the mean blood values of the patients in the study on preoperative and post-operative day 1 are presented in **Table 1**.

**Table 1. Mean hemoglobin, hematocrit values of the patients in the study on pre-operative and post-operative day 1 and the changes between the two values**

| Parameter         | Preop mean±SD | Postop day 1 mean±SD | Change (postop-preop), mean±SD |
|-------------------|---------------|----------------------|--------------------------------|
| Hemoglobin change | 13.27±1.35    | 10.73±1.37           | -2.53±1.32                     |
| Hematocrit change | 40.81±4.48    | 32.95±4.52           | -7.85±5.34                     |

Postop: Postoperative, Preop: Preoperative, SD: Standard deviation

Data on the changes in pre-operative and post-operative laboratory values of the groups (patients with and without a history of COVID infection) and their comparison are presented in **Table 2**.

**Table 2. Data on the mean changes in pre-operative and post-operative laboratory values of patients with and without COVID infection history and the evaluation of both patient groups in terms of change**

| Parameter  | Group     | Mean change (postop-preop)±SD | n   | p-value |
|------------|-----------|-------------------------------|-----|---------|
| Hemoglobin | COVID (-) | -2.65±1.25                    | 254 | -       |
| Hemoglobin | COVID (+) | -2.22±1.37                    | 127 | 0.003   |
| Hematocrit | COVID (-) | -8.18±5.76                    | 254 | -       |
| Hematocrit | COVID (+) | -7.02±4.33                    | 127 | 0.031   |

Postop: Postoperative, Preop: Preoperative, SD: Standard deviation

No significant difference was observed was found between the hemogram and hematocrit change values of patients hospitalized due to COVID infection and patients with a history of COVID infection but without hospitalization (p=0.282) (p=0.305).

When the changes in hemoglobin and hematocrit values were compared with vaccination status, the mean change in Hgb was -2.14±1.25 g/dl in the group vaccinated only with Sinovac and -2.86±1.45 g/dl in the group vaccinated only with BioNTech (p=0.0002). Htc change was -6.57±3.73 in the group vaccinated only with Sinovac and -8.59±6.70 in the group vaccinated only with BioNTech (p=0.0087). When the relationship between the total vaccine dose (0, 1-2, or ≥3 doses) and the changes in the parameters was examined, no significant difference was found between the changes in Hgb and Htc values and vaccine dose (p>0.05).

To evaluate the independent factors affecting postoperative hemoglobin change, age, history of COVID-19 infection, hospitalization due to COVID-19 infection, type of arthroplasty (knee/hip), Sinovac and BioNTech vaccination doses, and Charlson Comorbidity Index were included in a multiple linear regression model, and the backward elimination method was applied. The analysis revealed that a history of COVID-19 infection, receipt of the BioNTech vaccine, and undergoing total knee arthroplasty (TKA) were significant independent factors associated with postoperative hemoglobin change. Patients with a history of COVID-19 infection demonstrated a 0.36 g/dl lower mean hemoglobin decrease. In addition, receipt of the BioNTech vaccine and undergoing TKA were negatively associated with hemoglobin decline. Hemoglobin change in patients who underwent TKA was 1.2 g/dl lower compared to those who underwent total hip arthroplasty (THA) (**Table 3**).

**Table 3. Multiple linear regression analysis of independent factors affecting postoperative hemoglobin change**

| Variable                     | Coefficient (β) | SE   | t-value | 95% CI (lower-upper) | p-value |
|------------------------------|-----------------|------|---------|----------------------|---------|
| Constant                     | -3.09           | 0.19 | -16.58  | (-3.45)-(-2.72)      | <0.001  |
| COVID-19 history (1 vs 0)    | +0.36           | 0.12 | 2.86    | 0.11-0.60            | 0.004   |
| BioNTech dose (per increase) | -0.15           | 0.07 | -2.27   | (-0.29)-(-0.02)      | 0.024   |
| Knee arthroplasty (vs hip)   | +1.18           | 0.12 | 9.51    | 0.93-1.42            | <0.001  |

SE: Standard error, CI: Confidence interval

## DISCUSSION

The most important finding of this study was that although COVID infection and vaccination history were statistically different in early blood loss after arthroplasty surgery, these changes did not have a clinically significant effect.

Although normalization in daily life and health has been achieved after the COVID-19 pandemic, which is a serious process for the whole world, the effects of the pandemic on patients have become a very interesting topic in the literature. In the literature, it has been shown that complications related to cardiopulmonary, thromboembolic and kidney damage may occur more frequently in patients with a history of COVID infection after total joint arthroplasty.<sup>11,12</sup> The increased risk of post-operative complications and mortality has also been

demonstrated in other studies.<sup>13</sup> Lung et al.<sup>14</sup> compared patients with and without a history of COVID infection and reported that blood loss was significantly higher in patients with a history of COVID infection, but there was no difference in other complications such as venous thromboembolism and pneumonia. Weinberg et al.<sup>15</sup> also evaluated the effect of COVID infection by comparing patients with and without a history of infection and showed that patients with a history of COVID infection had lower ferritin and hemoglobin values before arthroplasty surgery compared to the control group, but surgery-related blood loss and transfusion requirement were similar to the control group. Since there are different results in the literature regarding the effect of COVID infection history on blood loss in arthroplasty operations, a study was designed on this subject. In the present study, we found statistically lower hemoglobin and hematocrit in patients with COVID infection in both TKA and THA, but this difference was clinically quite small. The authors hypothesized that the amount of bleeding due to hypercoagulability may be less because it is known to cause hypercoagulability due to the inflammatory state caused by COVID infection.<sup>5</sup> Although statistically significant differences in postoperative hemoglobin and hematocrit decreases were observed between patients with and without prior COVID-19 infection, the absolute magnitude of these differences was small (approximately 0.4 g/dl for hemoglobin). Therefore, these findings are unlikely to be clinically meaningful or to influence perioperative management, transfusion requirements, or postoperative recovery. This distinction between statistical significance and clinical relevance is important, particularly in large retrospective cohorts where small numerical differences may achieve statistical significance without reflecting a meaningful impact on patient outcomes.

### Limitations

First of all, the fact that it is a retrospective and single-center study is an inherent limitation. The fact that the surgeries were not performed by a single surgeon limits the generalizability of the results. Another limitation is that blood loss assessment is based on hemoglobin/hematocrit change instead of direct intra-operative bleeding, drainage amount or occult blood loss calculation.

### CONCLUSION

The hemoglobin and hematocrit decreases in TKA and THA patients with a history of COVID-19 infection were statistically significantly lower than in the control group. However, even though there is a numerical difference, the difference between both groups is not at a level that can make a clinical difference and affect the need for transfusion. Multicenter studies with larger participation are needed to evaluate the effects of COVID-19 infection on the bleeding profile of arthroplasty patients.

### ETHICAL DECLARATIONS

#### Ethics Committee Approval

This study was approved by the Ankara Bilkent City Hospital Medical Researches Ethics Committee (Date: 18.03.2026, Decision No: TABED 2-26-1873).

#### Informed Consent

This retrospective study used pre-existing anonymized patient data. No additional intervention was performed, and

there was no direct patient contact. The study was approved by the Ethics Committee, and the requirement for written informed consent was waived by the ethics committee.

### Peer Review Process

This manuscript was subject to external peer review.

### Conflict of Interest

The authors declare no conflicts of interest related to this study.

### Financial Disclosure

The authors received no financial support for the conduct or publication of this research.

### Author Contributions

Concept: MCK; Design: MCK; Control: CÇ, MCK; Resources: CÇ, MU, MCK; Materials: CÇ, MU, MCK; Data Collection and/or Processing: MCK, AY, SV, MU, MİSK; Analysis and/or Interpretation: SV, MD, AY, CÇ; Literature Review: MCK, MU, MİSK; Writing the Article: MCK; Critical Review: AY, SV, CÇ, MU, MİSK, MD.

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