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Impact of COVID-19 Protocols on Primary and Revision Total Hip Arthroplasty

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Background: Surgical site infection (SSI) after total hip arthroplasty (THA) is associated with increased morbidity, mortality, and healthcare expenditures. Our institution intensified hygiene standards during the COVID-19 pandemic; hospital staff exercised greater hand hygiene, glove use, and mask compliance. We examined the effect of these factors on SSI rates for primary THA (pTHA) and revision THA (rTHA).

Methods: A retrospective review was performed identifying THA from January 2019 to June 2021 at a single institution. Baseline characteristics and outcomes were compared before (January 2019 to February 2020) and during (March 2020 to June 2021) the COVID-19 pandemic. Cohorts were compared using the Chi-squared test and independent samples t-test.

Results: A total of 2,682 pTHA (prepandemic: 1,549 [57.8%]; pandemic: 1,133 [42.2%]) and 402 rTHA (prepandemic: 216 [53.7%]; Pandemic: 186 [46.2%]) were included. For primary and revision cases, superficial and deep SSI rates were similar before and during COVID-19. During COVID-19, the incidence of all (−0.43%, P = .029) and deep (−0.36%, P = .049) SSIs decreased between the first and second periods for rTHA. pTHA patients had longer operative times (P < .001) and shorter length of stay (P = .006) during COVID-19. Revision cases had longer operative times (P = .004) and length of stay (P = .046). Both pTHA and rTHA were discharged to skilled nursing facilities less frequently during COVID-19.

Conclusion: During COVID-19, operative times were longer in both pTHA and rTHA and patients were less likely to be discharged to a skilled nursing facility. Although intensified hygienic standards may lower SSI rates, infection rates did not significantly differ after our hospital implemented personal protective guidelines and a mask mandate.

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perioperative metrics of primary and revision THA after the implementation of hospital-wide COVID protocols, including frequent hand washing and continuous mask use.

Materials and Methods

This retrospective study examined all patients aged more than 18 years who underwent primary or revision THA (pTHA and rTHA) between January 2019 and June 2021 at a single academic orthopedic specialty hospital. Exclusion criteria included THA for fracture, oncologic indications, and bilateral THA. Patients were separated into 2 cohorts based on the date of surgery: the pre-pandemic group (January 2019 to February 2020) and the pandemic group (May 2020 to June 2021). We have excluded the months of March and April 2020 because our institution suspended elective surgeries and only performed emergent cases from March 15 through May 4, 2020. The pandemic group was further stratified into 2 time periods: period 1 (May 2020 to November 2020) and period 2 (December 2020 to June 2021). Patient records and data were deidentified as part of our institutional quality improvement program; however, a human-subjects review by our institutional review board was obtained prior to this study.

Data Collection

Patient demographic data including gender, race, body mass index (BMI, kg/m²), American Society of Anesthesiology (ASA) classification, smoking status, and surgical status (pTHA or rTHA) were collected. In addition, clinical data including length of stay (LOS; days), surgical time (minutes), SSI, and discharge disposition were collected from our electronic patient medical record system, Epic (Epic Caboodle, version 15; Verona, Wisconsin) using Microsoft SQL Server Management Studio 2017 (Redmond, Washington). LOS was evaluated in days spent in the hospital following surgery and surgical time was calculated as the time difference between initial skin incision and closure.

Outcome Measures

The primary outcomes included all SSIs, superficial SSIs, and deep SSIs. The secondary outcomes included perioperative data, such as surgical time, LOS, and discharge disposition.

Statistical Analysis

All data were organized and collected using Microsoft Excel software (Microsoft Corporation, Richmond, Washington). A binary variable was created to identify patients who underwent THA during the prepandemic and pandemic periods, and if during the pandemic, periods 1 and 2 as well. Demographic and clinical baseline characteristics of study participants were described as means with standard deviations (SDs) for continuous variables and frequencies with percentages for categorical variables. Statistical differences in continuous categorical variables were detected using independent sample t-test and Chi-squared ($\chi^2$) test, respectively. Changes in the incidence of categorical outcomes were expressed in absolute and relative percentages.

Results

Primary Total Hip Arthroplasty

A total of 2,682 primary THA patients from January 2019 to June 2021 were included: 1,549 (57.8%) in the prepandemic group and 1,133 (42.2%) in the pandemic group. Further sub-analysis of the pandemic cohort yielded 574 (50.7%) patients in period 1 and 559 (49.3%) patients in period 2.

An analysis of demographic characteristics (Table 1) showed a lower proportion of males in the pandemic group (41.8% versus 37.2%, $P = .016$). In addition, there were significant differences in racial demographics between cohorts ($P = .008$), with a 4% decrease in the proportion of White patients and a 3.6% increase in the proportion of Black patients during the pandemic. There were no differences in age ($P = .077$), BMI ($P = .493$), ASA Classification ($P = .121$), and smoking status ($P = .961$). In a subgroup analysis of the pandemic cohort, the first period had younger patients than the second period (65.2 versus 66.5 years, $P = .046$).

For perioperative outcomes (Table 2), the incidence of all SSIs ($P = .372$), superficial SSIs ($P = .242$), and deep SSIs ($P = .221$) did not significantly differ between groups. Operative times were significantly longer (114.7 ± 28.5 versus 104.0 ± 27.6 minutes, $P < .001$) during COVID-19. Hospital LOS decreased during the pandemic period (2.00 ± 1.56 versus 2.15 ± 1.30 days, $P = .006$). Furthermore, there was a significant decrease in hospital LOS between period 1 and period 2 of the pandemic (2.10 ± 1.87 versus 1.90 ± 1.16, $P = .025$). In addition, discharge disposition also differed ($P < .001$): during the pandemic, patients were more likely to be discharged home (94.9% versus 88.9%), less likely to be discharged to skilled nursing facilities (4.1% versus 10.3%), and similarly likely to be discharged to acute rehab centers (1.1% versus 0.8%). There were no additional differences in perioperative outcome metrics between the pandemic subgroups.

Revision Total Hip Arthroplasty

A total of 402 revision THA patients were included, including 216 (53.7%) in the prepandemic group and 186 (46.2%) in the pandemic group. In a subgroup analysis of the pandemic cohort, period 1 had 100 (53.5%) patients and period 2 had 87 (46.5%) patients. At baseline, the prepandemic cohort had a higher mean BMI than the pandemic cohort (29.5 ± 6.7 versus 28.1 ± 6.2, $P = .030$) (Table 1). Age ($P = .206$), gender ($P = .303$), ASA classification ($P = .888$), race ($P = .313$), and smoking status ($P = .232$) did not significantly differ between groups.

For SSI in revision THA, there were no significant differences for all SSIs ($P = .420$), superficial SSIs ($P = .282$), and deep SSIs ($P = .583$) between the prepandemic and pandemic groups. In a subgroup analysis of the pandemic cohort, both all SSIs (−0.43% [−82.9%], $P = .029$) and deep SSIs (−0.36% [−80.5%], $P = .049$) significantly decreased from period 1 to period 2. Similar to the primary THA cohort, the revision THA cohort showed significant differences in operative time, LOS, and discharge disposition (Table 2). During the pandemic, operative times were longer (150.5 ± 57.3 versus 134.8 ± 51.8 minutes, $P = .004$). In contrast to the primary THA cohort, LOS for revision THA increased during the pandemic (3.62 ± 2.64 versus 3.10 ± 2.58 days, $P = .046$). Discharge disposition also differed between groups ($P < .001$). More patients were discharged home (85% versus 83.8%) and to acute rehab centers (8.6% versus 14.4%), whereas few were discharged to skilled nursing facilities (6.4% versus 14.8%).

Discussion

The COVID-19 pandemic provoked a surge in the use of handwashing and personal protective equipment (PPE) both in and out of the hospital setting. In our orthopedic hospital, strict mask use and hand hygiene were enforced in all areas of the hospital for all patients and staff. In addition, patient visitor limitations were employed as a measure of social distancing. The purpose of this article was to retrospectively analyze if the implementation of
Table 1
Demographic Characteristics of Patients Undergoing Total Hip Arthroplasty Before and After the Introduction of COVID-19 Motivated Hygienic Practices.

| Time Period | Primary THA Overall | Revision THA Overall | 
|-------------|---------------------|----------------------|
|             | Prepandemic<sup>a</sup> (n = 1,549) | Pandemic<sup>b</sup> (n = 1,133) | P Value | Prepandemic<sup>a</sup> (n = 216) | Pandemic<sup>b</sup> (n = 186) | P Value | 
|             | Period 1<sup>c</sup> (n = 574) | Period 2<sup>d</sup> (n = 559) | | Period 1<sup>c</sup> (n = 100) | Period 2<sup>d</sup> (n = 87) | 
| Age (y)     | 65.0 ± 11.7 | 65.8 ± 11.2 | .077 | 65.7 ± 10.9 | 67.1 ± 11.7 | .206 | 
| Male- no. (%) | 644 (41.8) | 421 (37.2) | .016<sup>e</sup> | 104 (48.1) | 80 (43.0) | .303 | 
| BMI (kg/m<sup>2</sup>) | 29.8 ± 6.2 | 30.0 ± 6.4 | .493 | 29.5 ± 6.7 | 28.1 ± 6.2 | .030<sup>e</sup> | 
| ASA Classification- no. (%) | 96 (6.2) | 54 (4.8) | 121 | 7 (3.2) | 7 (3.7) | 6 (6.0) | 
| Race- no. (%) | 1,094 (70.6) | 755 (66.6) | 0.08<sup>e</sup> | 157 (72.7) | 130 (69.5) | 70 (70.0) | 
| Smoking Status- no. (%) | 197 (12.7) | 160 (14.1) | .961 | 34 (15.7) | 32 (17.1) | 17 (17.0) | 

ASA, American Society of Anesthesiologists; BMI, body mass index; No., number; SD, standard deviation; THA, total hip arthroplasty.

<sup>a</sup> Before COVID-19 includes all patients undergoing arthroplasty from January 2019 to February 2020.

<sup>b</sup> During COVID-19 includes all patients undergoing arthroplasty from May 2020 to June 2021.

<sup>c</sup> Period 1 includes all patients undergoing arthroplasty from May 2020 to November 2020.

<sup>d</sup> Period 2 includes all patients undergoing arthroplasty from December 2020 to June 2021.

<sup>e</sup> P < .05.
Table 2: Outcomes of Patients Undergoing Total Hip Arthroplasty Before and After the Introduction of COVID-19 Motivated Hygienic Practices.

| Time Period | Pandemic | Pre-pandemic | Overall Pandemic | Overall Prepandemic | pValue | Period 1 | Period 2 | Period 1 | Period 2 | pValue |
|-------------|----------|--------------|------------------|---------------------|--------|----------|----------|----------|----------|--------|
|             | 1,549/1.00 | 1,075/1.00 | 186/1.00          | 100/1.00            |        | 82.9/1.00 | 216/1.00 | 87/1.00  | 100/1.00 |        |
|             |           |              |                  |                     |        |          |          |          |          |        |
| Infection- no. (% | -0.34 (75.8) | -0.37 (84.1) | -0.36 (80.5) | -0.39 (80.5) |        | 0.26 (79.4) | 0.25 (75.8) | 0.37 (84.1) | 0.26 (79.4) |        |
| Superficial | 0 (0.0)    | 1 (0.1)      | -0.08 (32.0)     | -0.08 (32.0)        | -0.05    | -0.03 (51.8) | 0.05       | 0.06 (51.8) | 0.03 (51.8) | -0.05 |
| Deep        | 0.36 (52.4) | 0.37 (52.4)  | 0.37 (52.4)      | 0.37 (52.4)         | -0.05    | 0.36 (52.4) | 0.37 (52.4) | 0.37 (52.4) | 0.36 (52.4) | -0.05 |
| Discharge Position- no. (%) | 0.5 (4.1) | 0.6 (4.1) | -0.06 (100.0) | -0.06 (100.0) | -0.05    | -0.06 (100.0) | 0.05 | -0.06 (100.0) | 0.05 | -0.05 |
| Acute Rehab Center | 5 (0.9) | 7 (0.9) | -0.06 (100.0) | -0.06 (100.0) | -0.05    | 0.05 | -0.06 (100.0) | 0.05 | -0.06 (100.0) | 0.05 | -0.05 |
| Skilled Nursing Facility | 10 (10.0) | 6 (6.4) | -0.06 (100.0) | -0.06 (100.0) | -0.05    | 0.05 | -0.06 (100.0) | 0.05 | -0.06 (100.0) | 0.05 | -0.05 |
| Home | 83 (83.0) | 74 (70.0) | -0.06 (100.0) | -0.06 (100.0) | -0.05    | 0.05 | -0.06 (100.0) | 0.05 | -0.06 (100.0) | 0.05 | -0.05 |
| Discharge Disposition- no. (%) | 0.5 (4.1) | 0.6 (4.1) | -0.06 (100.0) | -0.06 (100.0) | -0.05    | 0.05 | -0.06 (100.0) | 0.05 | -0.06 (100.0) | 0.05 | -0.05 |
| Acute Rehab Center | 5 (0.9) | 7 (0.9) | -0.06 (100.0) | -0.06 (100.0) | -0.05    | 0.05 | -0.06 (100.0) | 0.05 | -0.06 (100.0) | 0.05 | -0.05 |
| Skilled Nursing Facility | 10 (10.0) | 6 (6.4) | -0.06 (100.0) | -0.06 (100.0) | -0.05    | 0.05 | -0.06 (100.0) | 0.05 | -0.06 (100.0) | 0.05 | -0.05 |
| Home | 83 (83.0) | 74 (70.0) | -0.06 (100.0) | -0.06 (100.0) | -0.05    | 0.05 | -0.06 (100.0) | 0.05 | -0.06 (100.0) | 0.05 | -0.05 |

p < 0.05

p < 0.001

p < 0.01

p < 0.0001

p < 0.0005

p < 0.000001

p < 0.0000001

p < 0.00000001

p < 0.000000001

p < 0.0000000001

p < 0.00000000001

p < 0.000000000001

p < 0.0000000000001

p < 0.00000000000001

p < 0.000000000000001

p < 0.0000000000000001

p < 0.00000000000000001

p < 0.000000000000000001

p < 0.0000000000000000001

p < 0.00000000000000000001

p < 0.000000000000000000001

p < 0.0000000000000000000001

p < 0.00000000000000000000001

p < 0.000000000000000000000001

p < 0.0000000000000000000000001

p < 0.00000000000000000000000001
The COVID-19 pandemic led to the implementation of increased hygiene protocols, mask use, and social distancing throughout the hospital setting. Our study did not show a correlation between the implementation of pandemic protocols and a change in SSI. We did demonstrate longer operative times and decreased discharge to skilled nursing facilities in both pTHA and rTHA during the pandemic. In addition, there was a 9.5% decrease in LOS between periods 1 and 2 of the pandemic. This trend could have been due to an increased proportion of urgent or complex revision cases requiring longer postoperative stays. It is also possible that LOS increased in revision THA due to avoidance of placing patients to skilled nursing facilities for the fear of increased COVID exposure.

Our analysis showed a statistically significant change in discharge disposition for both pTHA and rTHA. For both primary and revision cases, the proportion of patients discharged to skilled nursing facilities decreased by 6.2% and 8.4% during the pandemic, respectively. Moreover, the pTHA group demonstrated a compensatory 6% increase in home disposition, whereas the rTHA group had a 1.2% and 7.2% increase in home and acute rehabilitation center disposition, respectively. In power analysis for the pTHA cohort, discharge to home and skilled nursing facilities were sufficiently powered. Our rTHA cohort was only adequately powered for the acute rehab disposition. This observed trend in discharge disposition during the pandemic likely corresponds with a conscious avoidance of discharging patients to skilled nursing facilities, as many of these facilities had higher COVID-19 case volumes [33].

**Limitations**

There are limitations to be considered in the present study. This study was retrospective, and therefore, selection bias and the possibility of errors in recorded data cannot be controlled for. Our analysis was underpowered with the exception of pTHA operative time, home and skilled nursing disposition, and rTHA acute rehab disposition. We were unable to adjust for this issue due to the temporal brevity of the COVID-19 pandemic. In addition, factors such as implant design, surgical approach, and the use of robotics and navigation may have also influenced the examined outcomes, but these variables were not recorded in this present study. Moreover, previous studies have found shorter LOS and lower discharge to skilled nursing facility rates during more recent years [34,35], and we were unable to differentiate between the effect of these trends and mask use alone. Finally, our institution employed multiple interventions simultaneously during the pandemic and we were also unable to distinguish between the effect of these changes and masks alone.

**Conclusion**

The COVID-19 pandemic led to the implementation of increased hygiene protocols, mask use, and social distancing throughout the hospital setting. Our study did not show a correlation between the implementation of pandemic protocols and a change in SSI. We did demonstrate longer operative times and decreased discharge to skilled nursing facilities in both pTHA and rTHA during the pandemic, although these results are likely due to the pandemic itself and not the implementation of hygiene protocols.

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