



The effect of the COVID-19 pandemic on revision total hip and knee arthroplasty at a large academic hospital network

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ABSTRACT

We sought to quantify the impact of COVID-19 on canceled revision total joint arthroplasty (TJA) in a large academic hospital network. We performed a retrospective analysis of revision TKA and THA in a healthcare system containing 5 hospitals in a time period of 8 months prior to and 8 months after the cessation of elective surgery. We found a 30.1% decrease in revision TKA and a 6.80% decrease in revision THA. Revision TJA volume decreased in our healthcare system during COVID-19 compared to prior to the pandemic, which will likely have lasting financial and clinical ramifications for the healthcare system.

1. Introduction

The SARS-CoV-2 (COVID-19) pandemic has had far-reaching effects on the United States (US) healthcare system.¹ The World Health Organization declared COVID-19 a worldwide pandemic on March 10, 2020.² The US Surgeon General recommended canceling all elective surgical cases on March 14, 2020, and the Center for Medicare and Medicaid Services (CMS) recommended the same on March 18, 2020.² Although recommendations for halting elective procedures varied by state, Massachusetts advised healthcare facilities to cancel elective surgeries on March 15, 2020.³ As of April 16, 2021, over 31,000,000 cases of COVID-19 were confirmed in the US, with 559,000 deaths due to SARS-CoV-2.⁴

The goal of canceling elective surgeries at the start of the COVID-19 pandemic was to mitigate infection risk to patients and healthcare workers, conserve personal protective equipment (PPE), and preserve inpatient hospital beds.⁵ Primary total hip arthroplasty (THA) and total knee arthroplasty (TKA) are two elective procedures that were significantly affected by state and national restrictions on elective surgery. 2020 projected primary TKA volume in the United States was 820,514, and primary THA projected volume was 476,730, with March–June 2020 estimated at 267,343 TKA and 159,132 THA. The exact number of

delayed or canceled arthroplasty cases is unknown, but between 77,000 and 372,000 THA and TKA cases required rescheduling due to the COVID-19 pandemic.⁵

In addition to its effect on elective primary knee and hip arthroplasty, the COVID-19 pandemic has had far-reaching effects on revision total joint arthroplasty (TJA) volume. Annual volume of revision TKA and revision THA for 2020 in the United States were projected at 128,000 and 66,000, respectively.⁶ There is currently no unified database to capture all revision TJA procedures in the United States, so it is challenging to determine exactly how many revision TJA procedures were delayed due to the pandemic. However, recent studies have shown that there were likely more than 22,500 primary and 2000 revision TJA cases not performed each week in April and May 2020 at the height of COVID-19 elective surgery restrictions in the US.⁷

Revision TJA can be further separated into indication for surgery, with a dichotomy of urgent cases, which are more time-sensitive procedures, and non-urgent cases, which are more elective. Urgent revision TJA, which ideally should not be delayed, include revision for infection or periprosthetic fracture. According to the 2019 American Joint Replacement Registry (AJRR) Annual Report, revision for infection constituted 20.5% of revision TKA cases and revision for fracture was 2.3% of revision TKA cases.⁶ Revision for infection was 13.3% of THA

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revision cases and revision for periprosthetic fracture was 5.4% of revision THA cases.⁶ However, the effect of the COVID-19 pandemic on revision TJA cases are unknown. Thus, the purposes of this study were to compare the volume and indications for revision TJA to primary TJA in a single network prior to and during the COVID-19 pandemic.

2. Materials and methods

An institutional review board-approved retrospective analysis of primary and revision TKA and THA procedures in a single hospital network was performed. The data was queried from a multi-institutional registry for all TJA procedures performed in 5 large hospitals consisting of approximately 2600 inpatient beds between July 15, 2019 and November 15, 2020. Procedures were separated into 8 months prior to the initial shutdown of elective surgery at a single geographic location (July 15, 2019–March 14, 2020) and 8 months following the initial shutdown (March 15, 2020–November 15, 2020), and the percentage change in primary and revision TJA were compared between groups.

Patient demographic and surgical information was collected, including patient age, sex, body mass index (BMI), date of revision TJA, indication for revision, surgeon, and hospital. The indications for revision TJA were stratified by urgent, which included periprosthetic joint infection and periprosthetic fracture, and semi-elective, which included cases such as aseptic loosening or instability. The percentage change in urgent revision TJA was compared to the percentage change in revision TJA for all other indications during the same time periods. Additionally, the number of primary TKA and THA in the 8 months prior to the initial shutdown of elective surgeries and the 8 months following the initial shutdown were obtained and the percentage decrease in primary TKA and THA was calculated. Subsequently, the decrease in revision TKA and THA volume was compared to the decrease in primary TKA and THA volume during the same time periods.

2.1. Statistical analysis

The two groups were revision TJAs in our healthcare system 8 months prior to the initial shutdown (July 15, 2019–March 14, 2020) and 8 months following the initial shutdown (March 15, 2020–November 15, 2020). We compared the two groups by demographic (including age, sex, and BMI). We then compared revision TKA and THA volume to primary TKA and THA volume over the same time periods. We then compared the revision TKA and THA indications by percentage of total cases in both the pre-pandemic and post-shutdown time periods. Student's t-test was utilized to compare the two groups and calculate p-value.

3. Results

There were 196 revision TJAs in the eight months prior to the pandemic. Patients had a mean age of 75.2 years (SD 1.02), consisting of 51.9% females and 48.1% males, and had a mean BMI of 30.5 kg/m² (SD 6.7). In comparison, there were 161 revision TJAs in the eight months after the shutdown. Patients had a mean age of 68.7 years (SD 11.58), comprised of 56.2% females and 43.8% males, and had an average BMI of 30.3 kg/m² (SD 6.9). There was no difference between the groups in terms of age ($p = 0.37$), sex ($p = 0.37$), and BMI ($p = 0.82$) (Table 1).

93 revision TKA procedures were performed prior to the shutdown, and 65 revision TKA procedures were performed after shutdown (30.1% decrease). 103 revision THA procedures were performed prior to shutdown, and 96 revision THA procedures were performed after the shutdown (6.8% decrease). The proportion of revision THA compared to primary THA pre-pandemic and post-shutdown was unchanged ($p = 0.60$). Similarly, the proportion of revision TKA was unchanged from the time period prior to the pandemic to the time period after the shutdown ($p = 0.82$) (Table 1).

Table 1

Revision total joint arthroplasty demographics and indications.

	Pre-Covid	Post-Covid	% Change	p-value
TJA Revisions	196	161	17.9	0.676
Male	48.1%	43.8%		
Female	51.9%	56.2%		
BMI	30.5 (SD = 6.1)	30.3 (SD = 6.9)		0.815
Age	75.2 (SD = 1.02)	68.7 (SD = 11.58)		0.371
Revision TKA Procedures	93	65	30.1	0.822
Aseptic loosening	41 (44.1%)	30 (46.2%)		0.871
Periprosthetic joint Infection	22 (23.7%)	14(21.5%)		0.848
Instability	17 (18.3%)	12 (18.5%)		0.977
Fracture	3 (3.2%)	6 (9.2%)		0.162
Arthrofibrosis	3 (3.2%)	1 (1.5%)		0.644
Polyethylene Wear	2 (2.2%)	0		0.513
Metal Allergy	2 (2.2%)	1 (1.5%)		0.781
Intractable Pain	2 (2.2%)	1 (1.5%)		0.781
Patellar Instability	1 (1.1%)	0		0.402
Urgent Revisions	25 (26.9%)	20 (30.8%)		0.597
Revision THA Procedures	103	96	6.8	0.603
Aseptic loosening	29 (28.2%)	15 (15.6%)		0.04
Periprosthetic joint Infection	24 (23.3%)	28(29.2%)		0.42
Instability	17 (16.5%)	21 (21.9%)		0.37
Fracture	12 (11.7%)	16 (16.7%)		0.318
Metallolosis or Trunnionosis	9 (8.8%)	10 (10.4%)		0.81
Osteolysis	6 (5.8%)	1 (1.0%)		0.12
Polyethylene Wear	5 (4.9%)	2 (2.1%)		0.447
Heterotopic Ossification	1 (1.0%).	0		0.333
Hematoma		2 (2.1%)		0.234
Urgent Revisions	36 (34.9%)	45 (46.9%)		0.112

3.1. Indications for revision TJA

Of the 93 revision TKA prior to shutdown, indications included aseptic loosening (41, 44.1%), periprosthetic joint infection (22, 23.7%), instability (17, 18.3%), fracture (3, 3.2%), arthrofibrosis (3, 3.2%), polyethylene wear (2, 2.2%), metal allergy (2, 2.2%), intractable pain (2, 2.2%), and patellar instability (1, 1.1%). Urgent revision TKA consisted of 25 (26.9%) cases. (Table 1).

After the shutdown, indications for revision TKA included aseptic loosening (30, 46.2%), periprosthetic joint infection (14, 21.5%), instability (12, 18.5%), periprosthetic fracture (6, 9.2%), metal allergy (1, 1.5%), arthrofibrosis (1, 1.5%), and intractable pain (1, 1.5%). Urgent revision TKA consisted of 20 (30.8%) cases. There was no significant difference in revision TKA indications between the two time periods (Table 1).

Of 103 revision THA prior to shutdown, indications included aseptic loosening (29, 28.2%), periprosthetic joint infection (24, 23.3%), instability (17, 16.5%), periprosthetic fracture (12, 11.7%), metallosis or trunnionosis (9, 8.8%), osteolysis (6, 5.8%), polyethylene wear (5, 4.9%), and heterotopic ossification (1, 1.0%). Urgent revision THA consisted of 36 (34.9%) cases (Table 1).

Of the 96 revision THA patients during the shutdown, indications included periprosthetic joint infection (28, 29.2%), instability (21, 21.9%), periprosthetic fracture (16, 16.7%), aseptic loosening (15, 15.6%), metallosis or trunnionosis (10, 10.4%), polyethylene wear (2, 2.1%), hematoma (2, 2.1%), and osteolysis (1, 1.0%). Urgent revision THA consisted of 45 (46.9%) cases. There were no significant differences between revision THA indications between the two time periods, with the exception of a significant decrease in aseptic loosening as an indication for revision THA from the pre-pandemic time period to the time period after the shutdown ($p = 0.04$) (Table 1).

3.2. Revision versus primary TJA

2086 primary TKA procedures were performed in our healthcare system in the 8 months prior to the pandemic, and 1513 primary TKA procedures were performed during the shutdown, for a 27.5% decrease in primary TKA. 1576 primary THA procedures were performed prior to the pandemic, and 1361 primary THA procedures were performed during the shutdown, which accounted for 215 fewer primary THA surgeries, or a 13.6% decrease in primary THA. There was a greater percentage reduction in revision TKA cases (30.1%) compared to primary TKA (27.5%), but a lower percentage reduction in revision THA cases (6.8%) compared to primary THA (13.6%). The decrease in revision THA and TKA when compared to the decrease in primary THA and TKA was not statistically significant (Table 1).

4. Discussion

The effects of the COVID-19 pandemic on revision TKA and THA case volumes in the United States have far-reaching effects on patients and surgeons alike. There were likely more than 22,500 primary and 2000 revision TJA cases not performed each week in April and May 2020 in the United States at the height of COVID-19 elective surgery restrictions.⁷ No previous study, to our knowledge, has published the effects of revision TJA volume on their healthcare system based on volume and indications with comparison to primary TJA volume.

There was no statistically significant difference between the two groups in terms of demographic information such as age, sex, and BMI. There was a 30.1% decrease in revision TKA and a 6.8% decrease in revision THA 8 months prior to the pandemic to 8 months after this initial shutdown of elective surgery. However, this revision THA and TKA volume did not reduce in a greater proportion than primary THA and TKA volume in our healthcare system as we hypothesized. We suspected that there would be a larger decrease in revision TJA surgery due to the restrictions on inpatient surgery and need to preserve inpatient beds. However, in our hospital system, there was a proportional decrease in revision TJA compared to primary TJA (Table 1).

We also sought to determine if the COVID-19 pandemic had a greater effect on more elective revision TJA cases than more urgent cases, like those for periprosthetic joint infection and periprosthetic fracture. We hypothesized that the more urgent indications for revision TJA would stay at a similar volume, while more elective indications for revision TJA would decrease. However, there was no difference in the pre-pandemic group and post-shutdown group in terms of each revision TKA indication. For revision THA, there was no difference in the pre-pandemic group and post-shutdown group in terms of each revision THA indication with one exception. There was a decrease in revision THA for aseptic loosening from the pre-pandemic time period to the time period following the shutdown (Table 1).

Our hypothesis that revision TJA had decreased more than primary TJA from the pre-pandemic to the post-shutdown time period and that more urgent indications for revision TJA like fracture and infection would not decrease as much did not hold true. In our large academic hospital system, there was a proportional decrease in revision and primary TJA and proportional decrease when stratified by indication (except for aseptic loosening in revision THA). Aseptic loosening is usually a more elective indication for revision THA, so it is likely that patients with this problem in the challenging 8-month time period at the beginning of the pandemic elected to wait to schedule revision THA. Because infection as an indication for revision TJA decreased proportionally from one time period to the next, it is possible some patients that otherwise would be seen for periprosthetic infection deferred or delayed care and that there still could be a future increase in our hospital system. As expected (although it was not statistically significant), there did not seem to be a decrease in periprosthetic fracture from one time period to the next (Table 1).

There are several limitations to the present study. First, a single

healthcare system internal registry may not represent national trends in revision TJA. There is currently no unified database to capture all revision TJA procedures in the US. Second, the assumption was made that all changes related to primary and revision TJA volume were due to the COVID-19 pandemic. Any number of other confounding factors may have played a role in changing the volume of primary and revision TJA in our healthcare system. Of note, there were 3 more arthroplasty surgeons employed in our healthcare system by the end of the study period compared to the beginning of data collection. Finally, the comparison time periods of 8 months prior to and during the shutdown were relatively short.

Future studies may compare the difference in patient-reported outcome scores for revision TKA or THA patients prior to the pandemic and after shutdown. It has been shown that patients who delay their primary TKA and THA have health deterioration due to increased pain and decreased function.⁸ It would be interesting to determine if the same holds true for revision TJA patients that delay their care. Additional long-term studies comparing re-revision TJA rates prior to the pandemic and after the shutdown time period would also be of interest.

In conclusion, revision TKA and THA volume decreased in our healthcare system during COVID-19 compared to prior to the pandemic, but urgent cases increased. The decrease in revision TKA and THA procedures during the COVID-19 pandemic have likely created a backlog that may require substantial catch-up time that can have long-lasting financial and clinical effects on the healthcare system. Understanding the impact that this change has on patients can potentially provide useful information if we undergo a future pandemic.

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Declaration of competing interest

The authors declare they have no conflicts of interest.

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References

- 1 Shereen MA, Khan S, Kazmi A, Bashir N, Siddique R. COVID-19 infection: origin, transmission, and characteristics of human coronaviruses. *J Adv Res.* 2020;24:91e8. <https://doi.org/10.1016/j.jare.2020.03.005>.
- 2 Brown TS, Bedard NA, Rojas EO, et al. The effect of the COVID-19 pandemic on electively scheduled hip and knee arthroplasty patients in the United States. *J Arthroplasty.* 2020;35(7S):S49–S55. <https://doi.org/10.1016/j.arth.2020.04.052>.
- 3 LeRoy Taryn E, Theriault Raminta V, Sinz Nathan J, Perrone Gabriel S, et al. Reopening of elective total joint replacement surgery in a high-volume single-specialty hospital within a COVID-19 epicenter. *Journal of Hospital Management and Health Policy.* 2021. n. pag. Web. 11 Apr.
- 4] World Health Organization: United States. <https://www.who.int/countries/usa/> [accessed April 17, 2021].
- 5] Wilson JM, Schwartz AM, Farley KX, Roberson JR, Bradbury TL, Guild GN. Quantifying the backlog of total hip and knee arthroplasty cases: predicting the impact of COVID-19. *HSS J.* 2020;16:85–91. <https://doi.org/10.1007/s11420-020-09806-z>.
- 6] Bedard NA, Elkins JM, Brown TS. Effect of COVID-19 on hip and knee arthroplasty surgical volume in the United States. *J Arthroplasty.* 2020 Jul;35(7S):S45–S48. <https://doi.org/10.1016/j.arth.2020.04.060>. Epub 2020 Apr 24. PMID: 32381441; PMCID: PMC7194697.
- 7 Stambough JB, Deen JT, Walton SL, et al. Arthroplasty during COVID-19: surveillance of AAHKS members in the first year of the pandemic. *Arthroplasty Today.* 2021 Feb;7: 209–215. <https://doi.org/10.1016/j.artd.2020.12.029>. Epub 2021 Jan 9. PMID: 33521187; PMCID: PMC7831437.
- 8 Pietrzak JRT, Maharaj Z, Erasmus M, Sikhauli N, Cakic JN, Mokete L. Pain and function deteriorate in patients awaiting total joint arthroplasty that has been postponed due to the COVID-19 pandemic. *World J Orthoped.* 2021 Mar 18;12(3): 152–168. <https://doi.org/10.5312/wjo.v12.i3.152>. PMID: 33816142; PMCID: PMC7995341.