

Research Article

The Impact of Sars-CoV-2 Pandemic on Patient Selection, Length of Stay, and Short-Term Postoperative Outcomes in Elective Total Joint Arthroplasty.

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Introduction:

The purpose of this study is to examine how COVID-19 has impacted patient selection and short-term outcomes for total joint arthroplasty (TJA).

Methods:

Retrospective study of patients who underwent TJA between 1/1/2019-8/1/2020 at an urban multi-center institution. Baseline characteristics and short term outcomes were reviewed. Study groups were assigned by date of procedure.

Results:

5448 patients (2871 total knee and 2677 total hip arthroplasties) met inclusion criteria with 652 TJA performed in post-COVID period. Patients undergoing TJA after COVID-19 were younger, had lower ASA scores, had increased operative times, decreased LOS, greater proportion of home discharges, and lower readmission and reoperation rates.

Discussion:

We observed significant differences in patient characteristics and short-term postoperative outcomes for patients undergoing TJA after the spread of COVID19.

INTRODUCTION

The global spread of SARS-CoV-2 (COVID-19) has dramatically impacted the practice of elective total joint arthroplasty (TJA) in the United States. Many hospitals and practices are seeing a dramatic decline in operative volume due to both limitations in resources and from the patient perception that accessing medical care for elective surgery poses an unnecessary health risk (Bedard, Elkins, and Brown 2020; Wilson et al. 2020). This perception is not without merit, as TJA patients and the population most at risk from COVID-19 sequelae share similar demographics in terms of age and comorbidities (Zheng et al. 2020).

Orthopedic surgeons should adopt strategies to mitigate unnecessary exposure to patients who are at higher risk

(Rizkalla et al. 2020). These strategies include initiatives to temporarily modify patient selection, reduce inpatient stay, increase the number of patients discharged to home rather than to a facility, and reduce unnecessary office follow-up and hospital readmissions (Kort et al. 2020). Regarding patient selection there is also likely a component of self-selection, as unhealthy patients may be delaying care to reduce their own risk (Wilson et al. 2020). At our institution, located in the New York metropolitan area, we have found that there have been strong patient preferences for decreased length of stay (LOS) and increased discharge to home.

There is a dearth of studies that examine how COVID-19 has impacted LOS, discharge location, and 90-day complication rates for patients undergoing TJA. We hypothesize

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that the spread of COVID-19 in the New York metropolitan area is likely associated with a decision to preferentially indicate an overall younger and healthier patient population for elective TJA relative to the prior year, a decrease in the average inpatient LOS, and an increase in patients being discharged to home.

MATERIALS AND METHODS

This is a retrospective study of patients who underwent primary total knee arthroplasty (TKA) and total hip arthroplasty (THA) between 1/1/2019-8/1/2020 at an urban multi-center academic institution. Patient charts were reviewed for inpatient length of stay (LOS), discharge location, 90-day readmission, and 90-day reoperation rates. Patient discharge disposition was then categorized into discharge to home and discharge to a facility - whereas patients discharged home with home care and home with self-care were differentiated from those discharged to inpatient acute rehabilitation facility (IRF), skilled nursing facilities (SNF), or expired/hospice. Secondary outcomes included operating surgeon, procedure performed, date of surgery, indications for index procedure, anesthesia type, American Society of Anesthesiologist physical status classification (ASA class), body mass index (BMI), and patient demographic information. Records and existing data were de-identified as part of the institutional quality improvement program, and therefore the present study was exempt from human subjects review by our institutional review board.

Patients were assigned to one of two study groups based on the date of their procedure: pre-COVID and post-COVID. March 13, 2020 was used as the date that delineates pre and post-COVID19 periods because this was the date elective cases were initially halted in the New York metropolitan area. Procedures performed between March 14 and May 3, 2020 were excluded because during this period there were significant limitations in hospital resources resulting in only emergent procedures performed as approved by hospital administration. Patients undergoing bilateral arthroplasties were excluded due to the expectation that these patients have higher demands in terms of postoperative care. Furthermore, non-elective TJA were excluded. Patients found to have a positive COVID-19 preoperative screening test did not undergo TJA at our institution during the study period.

THA and TKA cases were assessed both together as a single TJA cohort as well as a subgroup analysis of TKA and THA patient cohorts. Student t-tests were utilized in the analysis of numeric continuous variables. Chi-square tests were utilized for categorical variables. Length of stay, operative time, discharge location, and postoperative outcomes were evaluated using univariate analysis of covariance (ANCOVA), adjusting for baseline patient statistics (BMI, race, age, ASA class, smoking status), surgeon, and surgical indication. To account for differences the proportion of TKA and THA cases between the two study periods, the surgical procedure was also adjusted for in the TJA cohort (Bernstein et al. 2020).

RESULTS

During the study period, 5448 patients fit inclusion criteria. The composition of cases was 2871 TKAs and 2577 THAs. There were 652 patients who underwent elective TJA surgery after May 3rd and were assigned to the post-COVID group. When examining the cohort of all TJA cases, there were significant differences in patient demographics and surgical indications before and after the COVID-19 pandemic. Patients undergoing TJA in the post-COVID period were slightly younger (65.7 ± 10.6 vs 64.0 ± 10.6 , $p < 0.001$), had a significantly lower ASA score ($p = 0.001$), and a lower proportion of arthroplasties performed for the indication of arthritis (97.7 vs 92.5% , $p < 0.001$). There were no significant differences with respect to sex, BMI, race, smoking status, and anesthesia type (Table 1A).

Subgroup analysis of baseline demographics for THA patients demonstrated similar findings, with a decrease in age (64.6 ± 11.9 vs 62.8 ± 11.5 , $p = 0.007$), lower ASA Class ($p = 0.011$), and proportion of osteoarthritis as an indication for surgery (96.0% vs 89.2% , $p < 0.001$). There were no significant differences in smoking status, BMI, sex, and anesthesia type for patients undergoing THA (Table 1C). In the TKA cohort, there was a decrease in age (66.7 ± 9.3 vs 65.5 ± 9.2 years, $p = 0.031$), osteoarthritis as an indication for surgery (99.3 vs 96.3% , $p < 0.001$), and increased proportion of patients with no smoking history (58.6 vs 63.8% , $p = 0.02$). There were no significant differences in the TKA subgroup with regards to sex, BMI, race, and anesthesia type (Table 1B).

For all TJA patients, as well as THA and TKA subgroups, there were significant differences regarding operative time, LOS, proportion of patients discharged home, overall discharge disposition, and 90-day readmission rate. Patients undergoing TJA before and after COVID-19 had increased mean operative times (102.5 ± 24.7 vs 109.3 ± 25.7 min, $p < 0.001$), decreased LOS (55.6 ± 39.5 vs 42.1 ± 55.1 hours, $p < 0.001$), lower readmission rates (5.9 vs 2.3% , $p < 0.001$) and reoperation rates (1.9 vs 0.5% , $p = 0.006$). There was a greater proportion of home discharges (86.5 vs 95.3% , $p < 0.001$) (Table 2A).

In the TKA subgroup (Table 2B), patients were found to have decreased LOS (60.2 ± 38.4 vs 44.4 ± 62.1 hours, $p < 0.001$), and a lower 90-day readmission rate (5.1 vs 2.0% , $p = 0.033$). There were significant differences in the discharge disposition, with a trend towards patients being discharged home care rather than to a facility (84.6 vs 95.0% , $p < 0.001$). Operative times were marginally increased in the post-COVID period (103.0 ± 23.5 vs 107.3 ± 23.3 min, $p = 0.003$). In the THA cohort, LOS (50.2 ± 40.0 vs 40.2 ± 48.3 hours, $p = 0.001$), 90-day readmission rates (6.8% vs 2.6% , $p = 0.005$), and reoperation rates (2.8 vs 0.9% , $p = 0.044$) were significantly decreased in post-COVID period. Both operative times (101.8 ± 25.9 vs 110.9 ± 27.5 min, $p < 0.001$) and the proportion of patients discharged home (88.6 vs 95.7% , $p = 0.001$) were significantly increased (Table 2C).

Table 1A: TJA Patient Characteristics (n=5448)

	Pre-COVID19 (n=4796)	Post-COVID19 (n=652)	p-value
Sex			0.787
Female	3056 (63.7%)	412 (63.2%)	
Male	1739 (36.3%)	240 (36.8%)	
Age	65.7 +/- 10.6	64.0 +/- 10.6	<0.001
BMI	31.25 +/- 6.65	31.21 +/- 6.82	0.863
ASA Class			0.001
1	216 (4.5%)	37 (5.7%)	
2	2651 (55.3%)	404 (62.7%)	
3	1855 (38.7%)	198 (30.7%)	
4	68 (1.4%)	5 (0.8%)	
Race			0.206
White	2998 (62.5%)	427 (65.5%)	
African American/Black	821 (17.1%)	113 (17.3%)	
Asian - East	132 (2.8%)	9 (1.4%)	
Asian - South	40 (0.8%)	6 (0.9%)	
Other	765 (16.0%)	90 (13.8%)	
Unknown	39 (0.8%)	7 (1.1%)	
Smoking Status			0.238
Never	2687 (56%)	363 (55.7%)	
Former	1698 (35.4%)	247 (37.9%)	
Current	375 (7.8%)	39 (6.0%)	
Unknown	36 (0.8%)	3 (0.5%)	
Surgical Indication	4845	662	<0.001
Osteoarthritis/Rheumatoid Arthritis	4687 (97.7%)	603 (92.5%)	
Conversion of prior surgery to arthroplasty	10 (0.2%)	16 (2.5%)	
Subacute or Chronic Trauma/Fracture	10 (0.2%)	4 (0.6%)	
Other/Deformity	77 (1.6%)	16 (2.5%)	
Unspecified	12 (0.3%)	13 (2.0%)	
Anesthesia Type			0.530
Regional	4242 (88.4%)	586 (89.9%)	
Monitored Sedation	1 (0.0%)	0 (0.0%)	
General	553 (11.5%)	66 (10.1%)	

DISCUSSION

The global spread of COVID-19 has had a tremendous impact on the practice of medicine, and consequently on elective TJA. In the initial phase of our institution's COVID-19 response, the practice of all elective TJA was halted and only patients undergoing procedures for acute trauma or significant disability met the criteria for surgical intervention. During this phase, department personnel and resources were reassigned to provide support to medical teams (Schwarzkopf et al. 2020). Ultimately, state and surgical society guidelines restricted non-essential surgeries. It is estimated that as many as 30,000 primary and 3,000 revision hip and knee arthroplasties were cancelled or delayed each week (Sarac et al. 2020; Bedard, Elkins, and Brown 2020) resulting in a tremendous backlog of patients awaiting TJA.

In the state of New York on May 3rd, 2020, restrictions on non-essential surgery were partially lifted. However, with the implementation of infection control policies in health-care and the looming threat of increasing disease prevalence (O'Connor et al. 2020), orthopedic practices have not returned to normal business practices. In the coming months, this may be compounded by patient perceptions and economic factors that serve to influence patient selection in TJA. Similar phenomena have also been observed after the 2008-2009 recession in which the demand for TJA fell in the United States (Kurtz et al. 2014).

This study has identified that there have been significant changes in the demographics of patients undergoing elective TJA in the immediate aftermath of the peak in the pandemic, with a trend towards younger and healthier patients electing to undergo surgery. This shift in patient baseline characteristics is demonstrated by significantly lower av-

Table 1B: TKA Patient Characteristics (n=2871)

	Pre-COVID19 (n=2570)	Post-COVID19 (n=301)	p-value
Sex			0.468
Female	1785 (69.5%)	203 (67.4%)	
Male	784 (30.5%)	98 (32.6%)	
Age	66.7 +/- 9.3	65.5 +/- 9.2	0.031
BMI	32.85 +/- 6.55	33.00 +/- 6.73	0.712
ASA Class			0.149
1	58 (2.3%)	9 (3.0%)	
2	1362 (53.1%)	174 (58.8%)	
3	1113 (43.4%)	111 (37.%)	
4	34 (1.3%)	2 (0.7%)	
Race			0.257
White	1376 (53.5%)	180 (59.8%)	
African American/Black	530 (20.6%)	58 (18.9%)	
Asian - East	91 (3.5%)	6 (2.0%)	
Asian - South	35 (1.4%)	4 (1.3%)	
Other	516 (20.1%)	50 (16.6%)	
Unknown	22 (0.9%)	4 (1.3%)	
Smoking Status			0.02
Never	1506 (58.6%)	192 (63.8%)	
Former	863 (33.6%)	100 (33.2%)	
Current	179 (7.0%)	8 (2.7%)	
Unknown	22 (0.9%)	1 (0.3%)	
Surgical Indication			<0.001
Osteoarthritis/Rheumatoid Arthritis	2551 (99.3%)	290 (96.3%)	
Conversion of prior surgery to arthroplasty	4 (0.2%)	4 (1.3%)	
Subacute or Chronic Trauma/Fracture	1 (0.0%)	1 (0.3%)	
Other/Deformity	7 (0.3%)	1 (1.7%)	
Unspecified	7 (0.3%)	5 (1.7%)	
Anesthesia Type			0.550
Regional	2279 (88.7%)	274 (90.7%)	
Monitored Sedation	1 (0.0%)	0	
General	290 (11.3%)	28 (9.3%)	

erage ASA scores for the TJA and THA subgroups, and a higher proportion of never-smokers for the TKA subgroup in the post-COVID period. Although we did not examine specific comorbidities, ASA score has been found to be a reliable measure of health status with high inter-user agreement (Zheng et al. 2020). Furthermore, there was a significant trend toward fewer cases performed for the indication of arthritis, which may suggest that some patients with primary osteoarthritis may have elected to delay surgery until a later period. Although one study, looking at patient perceptions of the COVID-19 pandemic on elective arthroplasty, found that 90% of patients with end-stage joint disease wanted to have surgery as soon as possible (Tran et al. 2017; Johnson et al. 2014; Ihejirika et al. 2015).

There were also significant observed differences in short term postoperative outcomes. After controlling for patient baseline characteristics, we found that average LOS for TJA,

TKA, and THA cohorts had fallen by 13.6, 15.7, and 10 hours respectively in the post-COVID period. This was coupled with significant increases in the proportion of patients being discharged home, with observed increases of 10.4%, and 7.1% for TKA and THA respectively. Regarding 90-day readmission rates, there was a greater than 2.5-fold decrease in readmission rate for TJA, TKA, and THA, as well as significantly decreased 90-day reoperation rates for the TJA and THA cohorts. In short, we observed dramatically improved 90-day postoperative outcomes in the post-COVID period for both the TKA and THA cohorts of patients.

Improved LOS and discharge home rates are likely multifactorial. It is likely that surgeons may have selected patients with above average functional status and who are less frail, under the assumption that these patients are less susceptible to a severe disease course of COVID-19. We have seen anecdotally in clinical practice that there is increased

Table 1C: THA Patient Characteristics (n=2577)

	Pre-COVID19 (n=2226)	Post-COVID19 (n=351)	p-value
Sex			0.389
Female	1271 (57.1%)	209 (59.5%)	
Male	955 (42.9%)	142 (40.5%)	
Age	64.6 +/- 11.9	62.8 +/- 11.5	0.007
BMI	29.40 +/- 6.26	29.67 +/- 6.52	0.465
ASA Class			0.011
1	158 (7.1%)	28 (8.0%)	
2	1289 (58.0%)	230 (66.1%)	
3	742 (33.4%)	87 (25.0%)	
4	34 (1.5%)	3 (0.9%)	
Race			0.388
White	1622 (72.9%)	247 (70.4%)	
African American/Black	291 (13.1%)	56 (16.0%)	
Asian - East	41 (1.8%)	3 (0.9%)	
Asian - South	5 (0.2%)	2 (0.6%)	
Other	249 (11.2%)	40 (11.4%)	
Unknown	17 (0.8%)	3 (0.9%)	
Smoking Status			0.453
Never	1181 (53.1%)	171 (48.7%)	
Former	835 (37.5%)	147 (41.9%)	
Current	196 (8.8%)	31 (8.8%)	
Unknown	14 (0.6%)	2 (0.6%)	
Surgical Indication			<0.001
Osteoarthritis/Rheumatoid Arthritis	2136 (96.0%)	313 (89.2%)	
Conversion of prior surgery to arthroplasty	6 (0.3%)	12 (3.4%)	
Subacute or Chronic Trauma/Fracture	9 (0.4%)	3 (0.9%)	
Other/Deformity	70 (3.1%)	15 (4.3%)	
Unspecified	5 (0.2%)	8 (2.3%)	
Anesthesia Type			0.592
Regional	1963 (88.2%)	313 (89.2%)	
General	263 (11.8%)	38 (10.8%)	

motivation for patients and families to meet milestones to be discharged home. At our institution, we found that patients had strong preferences for going home after surgery rather than to rehabilitation centers due to the perception that discharge to a facility may place them at increased risk of transmission of infection.

There are several notable limitations to this study. This is a retrospective chart review and only a limited number of baseline patient characteristics were examined. Therefore, our conclusion of increased patient motivation is speculative and relies on our clinical experience during this period. Furthermore, we did not examine specific risk factors for a severe COVID-19 infection including hypertension, diabetes, cardiovascular disease or respiratory disease in our analysis of patient selection (Brown et al. 2020). Further research may be directed as to how specific risk factors have affected patient selection and outcomes after TJA. A confounder of improved 90-day outcomes is the observed the

trend toward a healthier population having elected to undergo surgery during the post-COVID period. This study was also limited to short term clinical outcomes because data on patient reported outcome measures were lacking, further research may focus on how the COVID-19 pandemic affected these outcomes. Although baseline patient statistics (BMI, race, age, ASA class, smoking status, and surgical indication) were controlled for in the analysis, there could be other factors were not specifically reviewed that play a role in improved outcomes.

In conclusion, this study has shown that there have been significant changes in patient baseline characteristics and in short-term postoperative outcomes following TJA in the period after the spread of COVID-19 to the New York area. Patients undergoing surgery in the post-COVID period may be characterized as younger and have a lower comorbidity burden, resulting in significant improvements in length of

Table 2A: 90-Day TJA Post-Operative Outcomes

	Pre-COVID	Post-COVID	p-value
Operative Time (min)	102.5 +/-24.7	109.3 +/-25.7	<0.001
Length of Stay (Hours)	55.6 +/-39.5	42.1 +/-55.1	<0.001
Discharge Home	4145/4793 (86.5%)	615/645 (95.3%)	<0.001
Discharge Disposition			<0.001
Home- Self Care	468 (9.8%)	117 (18.1%)	
Home - Home Care	3677 (76.7%)	498 (77.2%)	
Skilled Nursing Facility	587 (12.2%)	27 (4.2%)	
Acute Inpatient Rehab	60 (1.3%)	2 (0.3%)	
Expired/ Hospice	1 (0.0%)	1 (0.3%)	
90-Day Readmission Rate	282/4796 (5.9%)	15/652(2.3%)	<0.001
90-Day Reoperation Rate	92/4796 (1.9%)	3/652 (0.5%)	0.006
Reoperation Indication			0.072
Wound Complication/Superficial Infection	4 (4.3%)	0	
Deep Infection	16 (17.4%)	0	
Instability/ Dislocation	18 (19.6%)	0	
Fracture	26 (28.3%)	2 (66.7%)	
Mechanical Loosening/ Failure	12 (13.0%)	0	
Arthrofibrosis	4 (4.3%)	0	
Other/ Unspecified	12 (13.0%)	1 (33.3%)	

Table 2B: 90-Day TKA Post-Operative Outcomes

	Pre-COVID	Post-COVID	p-value
Operative Time (min)	103.0 +/-23.5	107.3 +/-23.3	0.003
Length of Stay (Hours)	60.2 +/-38.4	44.4 +/-62.1	<0.001
Discharge Home	2175/2570 (84.6%)	283/298 (95.0%)	<0.001
Discharge Disposition			<0.001
Home- Self Care	98 (3.8%)	36 (12.1%)	
Home - Home Care	2077 (80.8%)	247 (82.9%)	
Skilled Nursing Facility	357 (13.9%)	14 (4.7%)	
Acute Inpatient Rehab	37 (1.4%)	0	
Expired/ Hospice	1 (0.0%)	1 (0.3%)	
90-Day Readmission Rate	130/2570 (5.1%)	6/301 (2.0%)	0.033
90-Day Reoperation Rate	30/2570 (1.2%)	0/301 (0%)	0.078
Reoperation Indication			N/A
Wound Complication/Superficial Infection	1 (3.3%)	0	
Deep Infection	7 (23.3%)	0	
Instability/ Dislocation	1 (3.3%)	0	
Fracture	3 (10.0%)	0	
Mechanical Loosening/ Failure	8 (26.6%)	0	
Arthrofibrosis	4 (13.3%)	0	
Other/ Unspecified	6 (20.0%)	0	

stay, likelihood of discharge to home versus a facility, and reduction in the 90-day complication rate.

LEVEL OF EVIDENCE

Prognostic, Level III

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Table 2C: 90-Day THA Post-Operative Outcomes

	Pre-COVID	Post-COVID	p-value
Operative Time (min)	101.8 +/-25.9	110.9 +/-27.5	<0.001
Length of Stay (Hours)	50.2 +/-40.0	40.2 +/-48.3	0.001
Discharge Home	1970/2223 (88.6%)	332/356 (95.7%)	0.001
Discharge Disposition			<0.001
Home- Self Care	370 (16.6%)	81 (23.3%)	
Home - Home Care	1600 (72.0%)	251 (72.3%)	
Skilled Nursing Facility	230 (10.3%)	13 (3.7%)	
Acute Inpatient Rehab	23 (1.0%)	2 (0.6%)	
Expired/ Hospice	0	0	
90-Day Readmission Rate	152/2226 (6.8%)	9/351 (2.6%)	0.005
90-Day Reoperation Rate	62/2226 (2.8%)	3/351 (0.9%)	0.044
Reoperation Indication			0.043
Wound Complication/Superficial Infection	3 (4.8%)	0	
Deep Infection	9 (14.5%)	0	
Instability/ Dislocation	17 (27.4%)	0	
Fracture	23 (37.1%)	2 (66.6%)	
Mechanical Loosening/ Failure	4 (6.55)	0	
Arthrofibrosis	0	0	
Other/ Unspecified	6 (9.7%)	1 (33.3%)	

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DECLARATION OF CONFLICTING INTERESTS

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DOC+SOCIAL



The screenshot displays the Doc+Social interface. At the top, the 'DOC+SOCIAL' logo is visible. Below it, a large banner for the 'Journal of Orthopaedic Experience & Innovation' is shown, featuring the journal's title in large white text on a black background, followed by the subtitle 'Clinical, Economic, and Innovative Orthopaedic Experience'. To the left of the banner is a small image of the journal cover, which has a yellow background and a black circle with a white eye-like shape inside, with the text 'LET'S DISCUSS' below it. Below the banner, the text 'Journal of Orthopaedic Experience & Innovation > JOEI Article Discussions' is displayed. Underneath this, the title 'JOEI Article Discussions' is shown next to a 'Public Group' button. A brief description follows: 'In this subgroup of the main Journal of Orthopaedic Experience & Innovation group, members will have discussions about the articles posted.'

Click [here](#) to go to the discussion group on Doc+Social