

The influence of the COVID-19 pandemic on total hip and knee arthroplasty in Ontario: a population-level analysis

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Background: The effects of the COVID-19 pandemic on elective orthopedic surgery have yet to be reported at the population level in Canada. We sought to detail the effect of the pandemic on patients who underwent total hip arthroplasty (THA) and total knee arthroplasty (TKA), and on surgeons with respect to surgical volume, wait times and health care quality.

Method: We compared patient length of hospital stay, revisions, readmissions and emergency department presentations between pre-pandemic (April 2019 to February 2020) and postpandemic (April 2020 to February 2021) cohorts of patients who underwent inpatient THAs or TKAs. Wait times for THA and TKA in Ontario were similarly collected.

Results: Case volumes for THA and TKA decreased by 30% during the pandemic. There were significantly fewer medically complex cases during this time period ($p < 0.001$). Length of hospital stay was reduced from 2.2 to 1.8 days ($p < 0.001$). Patients were less likely to visit the emergency department within 30 days of surgery ($p < 0.001$). Patients who underwent TKA were also more likely to be discharged directly home ($p = 0.025$). There was no difference in rate of revision surgery or readmission within 30 days. The proportion of patients meeting the standard benchmark wait time in Ontario was significantly lower ($p < 0.001$). The corresponding wait time to treatment increased significantly ($p < 0.001$).

Conclusion: The effects of the COVID-19 pandemic on elective THA and TKA case volumes and wait times was significant. Patients having surgery during the pandemic were less medically complex, had shorter length of hospital stays and had significantly less health care utilization.

Contexte : Il convient de faire un bilan des répercussions de la pandémie de COVID-19 sur les chirurgies orthopédiques non urgentes à l'échelle de la population canadienne. Nous avons voulu analyser ces répercussions sur les malades soumis à une chirurgie pour prothèse totale de la hanche (PTH) et pour prothèse totale du genou (PTG), et sur les orthopédistes aux plans des volumes de cas, des temps d'attente et de la qualité des soins.

Méthodes : Nous avons comparé la durée des séjours hospitaliers, les révisions, les réadmissions et les consultations dans les services d'urgence entre les cohortes hospitalisées pour PTH et PTG en période pré- (d'avril 2019 à février 2020) et postpandémique (d'avril 2020 à février 2021). Les temps d'attente pour les PTH et les PTG en Ontario ont également été consignés.

Résultats : Les volumes de PTH et de PTG ont diminué de 30% durant la pandémie. On a enregistré un nombre significativement moindre de cas médicalement complexes pendant cette période ($p < 0,001$). La durée des séjours hospitaliers est passée de 2,2 jours à 1,8 jour ($p < 0,001$). Les patients étaient moins susceptibles de consulter dans un service d'urgence dans les 30 jours suivant leur chirurgie ($p < 0,001$). Les cas de PTG étaient aussi plus susceptibles de recevoir leur congé pour retourner directement à la maison ($p = 0,025$). On n'a noté aucune différence quant aux révisions chirurgicales ou aux réadmissions dans les 30 jours. La proportion de patients pour qui le délai d'attente correspondait aux temps de référence en Ontario a été significativement moindre ($p < 0,001$). Le temps d'attente correspondant avant le traitement a significativement augmenté ($p < 0,001$).

Conclusion : La pandémie de COVID-19 a eu des répercussions significatives sur les volumes de cas de PTH et de PTG non urgents et sur les temps d'attente. Les cas soumis à la chirurgie durant la pandémie étaient médicalement moins complexes, la durée des séjours a été plus brève et l'utilisation des services de santé a diminué significativement.

The arrival of SARS-CoV-2 in late 2019 and the global pandemic that followed resulted in worldwide cancellations of elective surgery as hospitals attempted to conserve resources and limit physician and patient exposure to the virus.¹ Cancellation of elective total hip arthroplasty (THA) and total knee arthroplasty (TKA) surgeries to conserve hospital resources had a substantial effect on surgical volumes in the province of Ontario.² About 890 primary joint replacements were cancelled per week in the province during the various lockdowns.³ Cancellations were not unique to Ontario, as other provinces and countries similarly sought to conserve resources.⁴⁻⁷ In Canada, reductions in THA and TKA surgical volumes are expected to persist as a result of the pandemic and subsequent staffing shortages.⁸ With wait times for joint replacement already having been a critical issue before the pandemic, the need for better access to care has been exacerbated.⁹ Addressing the surgical backlog created by the pandemic has thus been an area of increased interest and provincial funding.²

While the influence of the COVID-19 pandemic on elective joint replacement has been explored in the United States, Australia and the United Kingdom, it has yet to be extensively reported on at the population level in Canada.^{5,6,10,11} We sought to assess the effects of the COVID-19 pandemic on patients undergoing THA and TKA and on orthopedic surgeons in Ontario, Canada's most populous province. We aimed to identify changes at the population level in surgical volume, wait times and health care quality.

METHODS

Study design and setting

We performed an aggregate, retrospective population-based analysis of administrative health data from Ontario, Canada, where all medically necessary services are publicly funded by a single provincial health care insurer. Our sample comprised 2 cohorts of patients who underwent THAs and TKAs: the pre-pandemic cohort (April 2019 to February 2020) and the pandemic cohort (April 2020 to February 2021). These time periods were chosen to account for the COVID-19 pandemic beginning to affect Canadian hospitals in March 2020. April marked the start of the fiscal year for data collection. Canadian Institute for Healthcare Information (CIHI) data for THA and TKA were subsequently reviewed back to April 2016 to collect year-after-year changes in surgical volume.

Data sources and case identification

We accessed multiple population-wide administrative health databases through CIHI and the Canadian Joint Replacement Registry. Elective inpatient primary THA

and TKA procedures were identified using Canadian Classification of Health Intervention codes and confirmed to have a main diagnosis code of osteoarthritis. The Discharge Abstract Database and National Ambulatory Care Reporting Services databases were used to identify cases that matched our inclusion criteria. These cases were then linked with revision surgeries, readmissions and visits to the emergency department (ED) within 30 days from Ontario-based facilities. Patients were excluded if they were younger than 18 years or did not have osteoarthritis.

Covariates

Age, sex and comorbidity status were collected and reported. Comorbidity status was ascertained using the Charlson Comorbidity Index (CCI).¹² The CCI scores and groups were calculated based on CIHI's formula.¹³

Quality outcomes

We measured the mean \pm standard deviation (SD) of length of hospital stay (LOS), percentage of patients discharged directly home and volume of revision surgeries, readmissions and visits to the ED within 30 days. Wait times for THA and TKA were collected from CIHI's publicly available data for Ontario.¹⁴ The standard benchmark wait time for surgery is within 184 days from treatment decision.

Statistical analysis

We compared demographic characteristics and quality outcome data between the cohorts using χ^2 and Student *t* tests.

RESULTS

The total joint replacement volume increased by 20%–26% year over year in the 4 years preceding the COVID-19 pandemic. In the year following the start of the pandemic, 27 536 THAs and TKAs were performed, representing a 30% reduction in case volumes. During this period, THA volumes decreased by 20%, while TKA volumes decreased by 36% (Figure 1). Significantly fewer patients underwent THA (Table 1) and TKA (Table 2) and there were significantly fewer medically complex cases during the pandemic time period, as measured by the CCI ($p < 0.001$). There was no significant difference in patient mean age or sex between the pre-pandemic and pandemic cohorts.

There was significantly less health care utilization associated with THA and TKA procedures during the pandemic (Table 3 and Table 4). Following surgery, LOS was reduced from 2.2 to 1.8 days ($p < 0.001$) for both THA and TKA. Patients who underwent TKA were more likely to be discharged directly home from hospital during the pandemic time period (95.0% v. 95.5%, $p = 0.025$). Patients who underwent THA and TKA

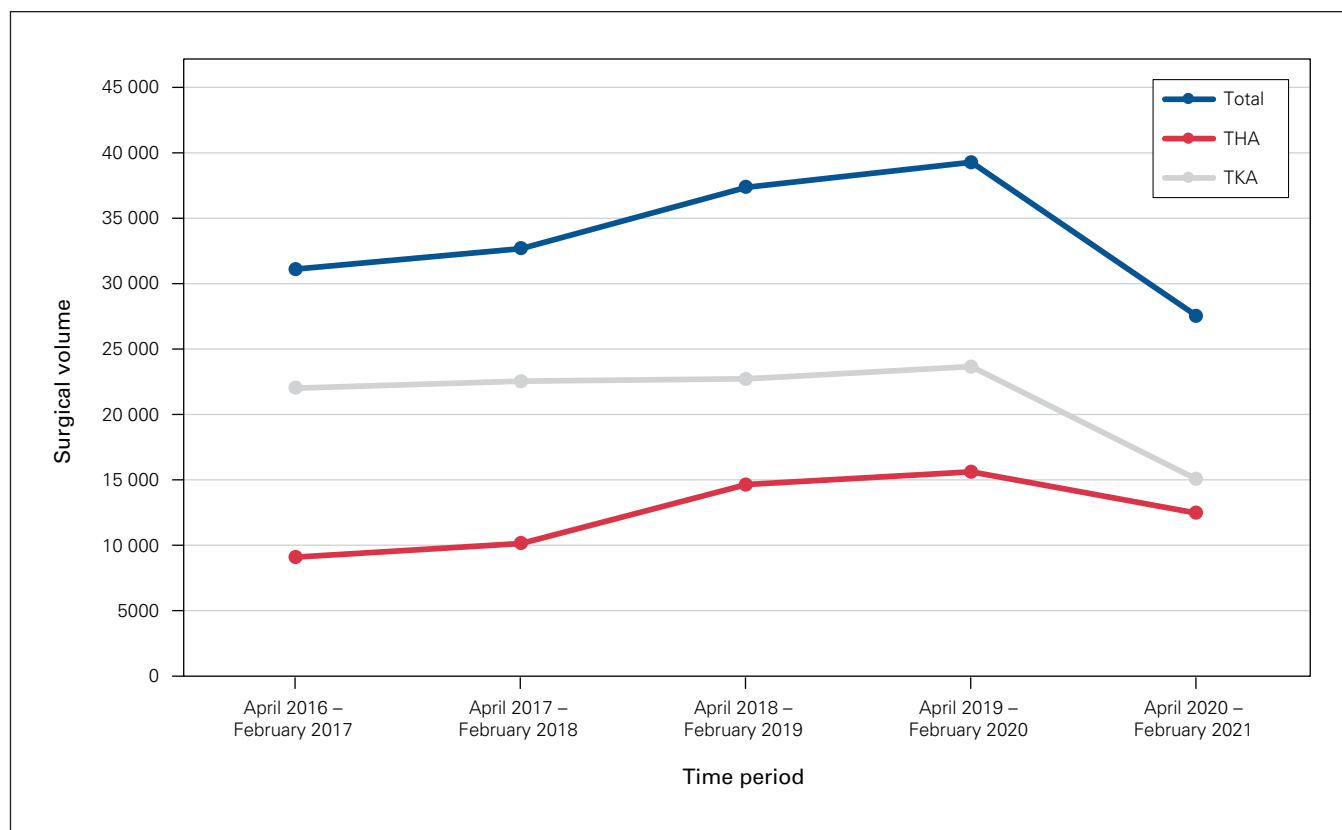


Fig. 1. Surgical volumes for total hip arthroplasty (THA) and total knee arthroplasty (TKA) in Ontario.

Table 1. Demographic and clinical characteristics of patients who underwent total hip arthroplasty in the pre-pandemic and pandemic periods

Characteristic	Period		p value
	April 2019 – February 2020	April 2020 – February 2021	
Age, yr, mean ± SD	67.3 ± 10.7	67.3 ± 10.6	1.00
Sex, female, %	54.6	54	0.32
CCI, no. (%)			
0	15 024 (96.2)	12 058 (96.6)	0.07
1	562 (3.6)	399 (3.2)	0.07
2	31 (0.2)	25 (0.2)	1.00

CCI = Charlson Comorbidity Index; SD = standard deviation.

Table 2. Demographic and clinical characteristics of patients who underwent total knee arthroplasty in the pre-pandemic and pandemic periods

Characteristic	Period		p value
	April 2019 – February 2020	April 2020 – February 2021	
Age, yr, mean ± SD	68.3 ± 8.7	68.2 ± 8.7	0.27
Sex, female, %	61.4	60.6	0.11
CCI, no. (%)			
0	22 525 (95.2)	14 436 (95.9)	0.001
1	1 088 (4.6)	617 (4.1)	0.02
2	47 (0.2)	1 (0.03)	< 0.001

CCI = Charlson Comorbidity Index; SD = standard deviation.

were less likely to visit the ED within 30 days of surgery (14.4% v. 12.0% for THA, 15.6% v. 13.3% for TKA, $p < 0.001$). There was no difference in rate of revision surgery and readmission within 30 days of procedure.

Surgical wait times for THA and TKA were significantly longer as a result of the pandemic (Figure 2 and Figure 3). The proportion of patients meeting the standard wait time for treatment decreased from 85% in 2019 to 64% in 2020 for THA and decreased from 80% to 56% for TKA ($p < 0.001$). The corresponding wait time to treatment increased by 64 days for THA and 78 days for TKA ($p < 0.001$).

DISCUSSION

The effects of the COVID-19 pandemic on elective THA and TKA case volumes in Ontario during the first year of the pandemic was significant. Following 3 years of successive annual increases in surgical volumes, we found an overall 30% decrease in primary THA and TKA volumes between Apr. 1, 2020, and Mar. 1, 2021. This corresponded with a significant increase in surgical wait times for patients.

Ontario's reduction in THA and TKA surgical volumes during the pandemic mirrors that in British Columbia and

Table 3. Quality assessment of total hip arthroplasty outcomes in the pre-pandemic and pandemic periods

Quality indicator	Period		p value
	April 2019 – February 2020	April 2020 – February 2021	
LOS, d, mean ± SD	2.2 ± 2.7	1.88 ± 2.5	< 0.001
Discharged to home, %	14 647 (93.8)	11 746 (94.1)	0.30
Revision within 30 d, %	142 (0.91)	137 (1.1)	0.11
Readmission within 30 d, %	495 (3.2)	437 (3.5)	0.16
ED visit within 30 d, %	2241 (14.4)	1498 (12.0)	< 0.001

ED = emergency department; LOS = length of stay in hospital; SD = standard deviation.

Table 4. Quality assessment of total knee arthroplasty outcomes in the pre-pandemic and pandemic periods

Quality indicator	Period		p value
	April 2019 – February 2020	April 2020 – February 2021	
LOS, d, mean ± SD	2.2 ± 1.8	1.82 ± 1.8	< 0.001
Discharged to home, %	22 479 (95.0)	14 377 (95.5)	0.02
Revision within 30 d, %	63 (0.27)	38 (0.25)	0.71
Readmission within 30 d, %	638 (2.7)	361 (2.4)	0.07
ED visit within 30 d, %	3695 (15.6)	2002 (13.3)	< 0.001

ED = emergency department; LOS = length of stay in hospital; SD = standard deviation.

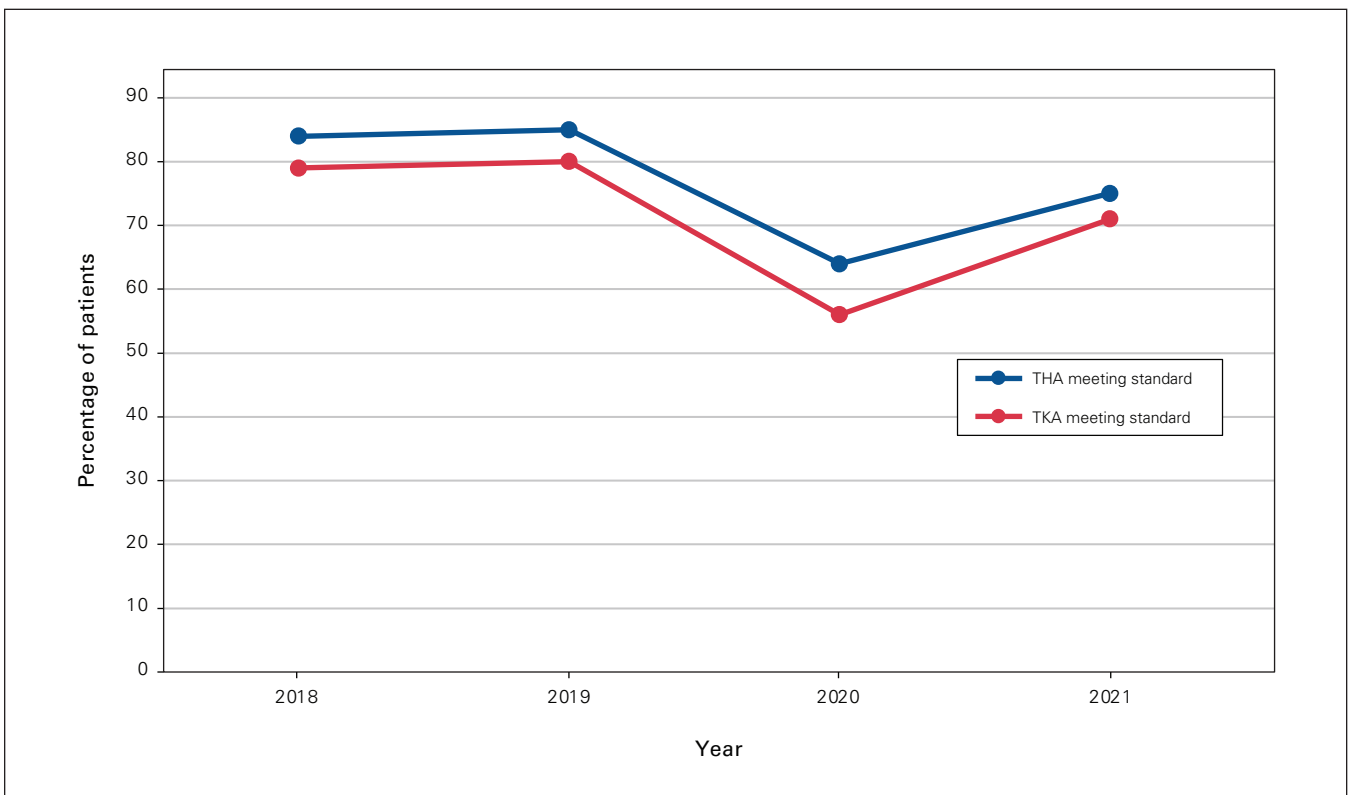


Fig. 2. Meeting standard benchmark wait times for total hip arthroplasty (THA) and total knee arthroplasty (TKA). *Standard benchmark is surgery within 184 days from treatment decision.

Alberta.^{4,8} A greater emphasis was placed on performing THAs during the pandemic as evidenced by only a 20% reduction in THA volumes as compared with 36% in TKAs. The TKA surgical volume varied considerably on a month to month basis, reflecting the potential influence of spikes in SARS-CoV-2 infection and restrictions.⁸ Considerably more THAs were performed for femoral neck fractures during the pandemic, as operating time remained available for emergent procedures.⁸

Changes in case complexity were also evident during the pandemic. Fewer medically complex THAs or TKAs were performed during this time period. This could either be the result of patients choosing to defer surgery until after the pandemic or an emphasis being placed on treating healthier patients. These are both reasonable assumptions considering the significant risk to patients with more medical complexity if afflicted by SARS-CoV-2 infection and the potential of more efficiently using health care resources

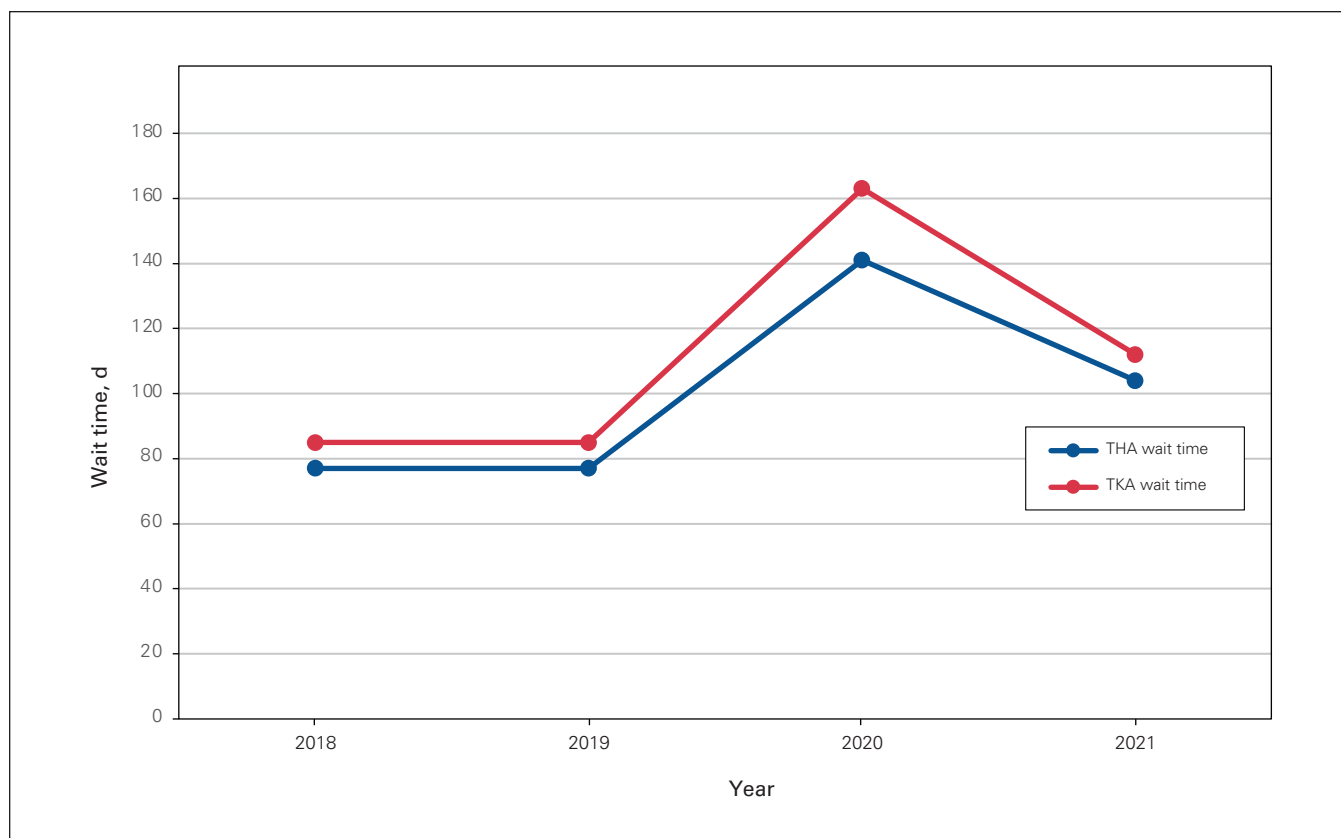


Fig. 3. Patient wait times for total hip arthroplasty (THA) and total knee arthroplasty (TKA).

when treating healthier patients. Regardless, this shift highlights the increasing disparities in access to care among patients with more medical complexity and the lack of resources or supports to allow them to undergo rapid recovery or early discharge after joint replacement.

Hospital efficiency and health care utilization improved during the COVID-19 pandemic. The LOS decreased significantly from 2.2 to 1.8 days, reflecting the emphasis placed on preserving hospital resources and the development of surgeon-led quality improvement initiatives.^{15–17} Practices evolved to hybrid models of inpatient and outpatient care for total joint arthroplasty.¹⁵ With careful patient selection, optimized anesthesia, early ambulation and virtual postoperative care, about 25% of total joint arthroplasty procedures were performed on an outpatient basis.¹⁶ Patients were also more likely to be discharged directly home as opposed to rehabilitation during this time period. This change in practice could be attributed to decreased rehabilitation resources, healthier patients having surgery or streamlined perioperative care. Despite a shorter LOS and more discharges directly home, there was no resulting increase in postdischarge health care utilization. Patients were less likely to visit the ED than before the pandemic and had similar readmission and revision surgery rates. The decrease in visits to the ED could be a result of the emphasis placed

on avoiding nonessential visits and person to person contact, which were key components of hospital and provincial government messaging campaigns. These results show that providers can offer safe, efficient and patient-centred care when faced with resource restrictions.

Wait times for elective surgery in Ontario have been a longstanding concern.¹⁸ There was a significant increase in wait times for both THA and TKA during the pandemic. There was also a corresponding decrease in the percentage of patients having surgery within provincial target times. This has resulted in a substantial backlog of surgical cases and the issue receiving considerable media attention.¹⁹ The discussion has been centred around the ability of our health care system to clear this backlog. In the United States, postpandemic modelling has suggested it will take 7–16 months to catch up on more than 1 million orthopedic surgeries if surgical volumes increase by 20%.¹⁰ Operating room closures and public health restrictions in Ontario have ended, but wait times for surgery remain near all-time high levels.²⁰ This is despite an increase in provincial funding and initiatives such as evening and weekend elective operating rooms at select hospitals. This is a complex, multifactorial issue complicated by the human resource shortages that are affecting health care systems across the province, provider burnout and an exodus of health care providers to early retirement and alternative careers.

Limitations

Our study has several limitations. It is a retrospective, population health study limited to identifying our target population through accurate coding and database collection. Patients were included only if their intended treatment was for osteoarthritis. This primarily would have excluded patients with avascular necrosis or other forms of arthritis and cases performed for fracture or on an urgent or emergent basis. Similarly, data collection and release are limited to fiscal year constraints. This is represented by our 11-month time periods of case identification, allowing for the final month of the fiscal year to account for potential 30-day complications. There are no patient-reported outcome data presented as part of this study and therefore our study may not have fully captured patients' outcomes following surgery.

CONCLUSION

It is unclear how our health care system will recover from the COVID-19 pandemic. The effects on elective surgery and specifically on THA and TKA case volumes during the first year of the pandemic were significant. Along with reductions in case volumes and an increase in wait times, practice patterns were also altered. Patients having surgery during the COVID-19 time period were less medically complex, had shorter LOS, were more likely to be discharged directly home and less likely to visit the ED following surgery. These changes, along with the push for outpatient arthroplasty, may forever change THA and TKA care in Ontario.

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Competing interests: Jesse Wolfstadt received research grants from the Canadian Institutes of Health Research, American Association of Hip and Knee Surgeons (AAHKS), Canadian Orthopaedic Foundation and the Arthritis Society. He also received consulting fees from Microport Orthopedics Inc., and participated on a data safety advisory board for Depuy-Synthes. He was on the board of directors for AAHKS, chair for AAHKS Young Arthroplasty Group and a member of the Canadian Orthopaedic Association nominating committee and the Canadian Arthroplasty Society educational committee. No other competing interests were declared.

Contributors: J. Sniderman designed the study and acquired the data, which A. Khoshbin and J. Wolfstadt analyzed. J. Sniderman and J. Wolfstadt wrote the article, which A. Khoshbin reviewed. All authors approved the final version to be published.

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