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Prior Knee Arthroscopy Is Associated With Increased Risk of Revision After Total Knee Arthroplasty

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ABSTRACT

Background: Knee arthroscopy (KA) is frequently performed to provide improved joint function and pain relief. However, outcomes following total knee arthroplasty (TKA) after prior KA are not fully understood. The purpose of this study is to determine the relationship between prior KA within 2 years of TKA on revision rates after TKA.

Methods: Data were collected from the Humana insurance database using the PearlDiver Patient Records Database from 2006 to 2017. Subjects were identified using Current Procedural Terminology and International Classification of Diseases procedure codes to identify primary TKA. Patients were stratified into 2 groups based upon a history of prior KA. Univariate and multivariate analyses were conducted to determine association between KA and outcomes at 2-year postoperative period.

Results: In total, 138,019 patients were included in this study, with 3357 (2.4%) patients receiving a KA before TKA and 134,662 (97.6%) patients who did not. The most common reason for KA was osteoarthritis (40.0%), followed by medial tear of the meniscus (26.0%) and chondromalacia (21%.0). After adjustment, prior KA was associated with increased revision rate (odds ratio [OR], 1.392; $P = .003$), postoperative stiffness (OR, 1.251; $P = .012$), periprosthetic joint infection (OR, 1.326; $P < .001$), and aseptic loosening (OR, 1.401; $P = .048$).

Conclusion: Prior KA is significantly associated with increased 2-year TKA revision rate. The most common etiology for arthroscopy was osteoarthritis. The results of the study, showing that arthroscopy before TKA substantially increases the rates of revision, PJI, aseptic loosening, and stiffness, lend further credence to the idea that patients may be better served by nonsurgical management of their degenerative pathology until they become candidates for TKA. Subjecting this population to arthroscopy appears to offer limited benefit at the cost of poorer outcomes when they require arthroplasty in the future.

Level of Evidence: Level III therapeutic study.

Symptomatic osteoarthritis (OA) of the knee joint is an extremely common condition, affecting at least 14 million Americans [1]. Many patients are diagnosed relatively early in life, with median age of diagnosis around 55 years [2]. Furthermore, 9.3% of the US population will have symptomatic OA by 60 years of age [2]. Generally, the treatment algorithm for knee OA involves initial nonsurgical treatment including pharmacologic pain relief and anti-inflammatory medications, physical therapy, and joint injections before surgical management with total knee arthroplasty (TKA) [3].

Based on the American Academy of Orthopaedic Surgeons guidelines, knee arthroscopy (KA) with lavage and/or debridement

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is not recommended for treatment of knee OA [4]. Despite this, arthroscopy is still frequently employed in patients with knee OA to provide improved joint function and pain relief [5]. The National Survey for Ambulatory Surgery showed that from 1996 to 2006 the number of outpatient arthroscopic knee surgeries increased by 49% [5]. In this study, the most frequent indications for arthroscopy were medial cartilage or meniscus pathology, patellar chondromalacia, lateral cartilage or meniscus pathology, ligamentous injury, and OA of the knee. Many older patients who undergo arthroscopy of the knee have some level of concurrent OA contributing to their symptoms and thus have risk of inadequate symptomatic relief and progression to TKA. A systematic review of patients who had arthroscopic surgery for OA showed an annual rate of progression to TKA of 2.6% [6]. Progression to TKA was substantially more common in patients with more severe OA (4.1% annually) and patients over 50 years old (3.9% annually) [6].

Several prior studies have sought to evaluate the effect of prior arthroscopic knee surgery on outcomes after primary TKA, with some studies reporting a deleterious effect [7–9] and others reporting equivalent outcomes [10,11]. Among studies documenting worse outcomes in patients who underwent prior arthroscopic surgery, an interval of less than 6 months between arthroscopy and TKA was most predictive of poor post-TKA outcomes [7,9].

This observational national database study sought to clarify the association between prior KA and TKA outcomes. The primary objective was to determine whether KA performed within 2 years of primary TKA impacts complication rates and implant survival. We leveraged the large sample size afforded by an administrative data set to minimize the risk of type II error. We hypothesized that previous KA would be associated with an increase in 2-year revision rate after primary TKA.

Methods

Data were collected from the Humana subset insurance database using the PearlDiver Patient Records Database (www.pearldiverinc.com) from 2006 to 2017. The PearlDiver database contains records for over 22 million patients, further describing hospital and physician billing records, as well as prescription medication information. Subjects were identified using Current Procedural Terminology (CPT) and International Classification of Diseases (ICD) procedure codes to identify primary TKA further outlined in Table 1. Modifier code "-50" was used to exclude patients who had undergone simultaneous bilateral TKA. In addition, patients were queried for staged bilateral TKA and excluded from this analysis. Patients were only included if they had at least 2-year follow-up from index TKA (Table 1). Patients were then stratified into 2 groups based upon a history of KA. Patients with prior KA within 2 years of TKA were identified using CPT and ICD codes (Table 1). As our query included time periods using ICD-9 and ICD-10 codes, we included both in our analysis. Lastly, patients were excluded if they were younger than 18 years of age. In order to maintain laterality, modifier codes were used. If modifier codes were not available, the patient was excluded from the analysis.

Patient demographic characteristics including age, sex, medical comorbidities, and smoking status were collected. Selection of predictor variables was based upon prior work conducted by Elixhauser et al [12]. The primary outcome of this study was the frequency of revision TKA within 2 years of primary TKA. Other outcomes included frequencies of aseptic loosening, manipulation under anesthesia (MUA), periprosthetic joint infection (PJI), periprosthetic fractures, and postoperative stiffness at 2 years after primary TKA. All outcomes were identified with either CPT or ICD codes outlined in Table 1.

Statistical Analysis

Data on patients' demographics, comorbidities, and postoperative complications were analyzed with univariate and multivariate analyses using software provided by PearlDiver. Univariate analysis was conducted using chi-square or analysis of variance where appropriate. A logistic multivariate analysis was performed at 2 years to determine adjusted associations of risk factors of the postoperative complications. If a postoperative outcome was significant on univariate, a multivariate analysis was conducted to adjust for other potential risk factors. Risk factors that were included in the multivariate analysis were selected if there was a significant difference among the cohorts seen on univariate analysis. The multivariate analysis results were reported as odds ratios (OR) and 95% confidence intervals (CIs). For both univariate and multivariate analyses, a P value of <.05 was used as the cutoff for significance. Age less than 50 years and female sex were considered as the baseline for multivariate analysis.

Results

Study Cohort

In total, 138,019 patients were included in this study, with 3357 (2.4%) patients receiving a KA before TKA and 134,662 (97.6%) patients who did not. The average time from KA to TKA was 0.93 years (standard deviation, 0.75 years; range, 0.01-2.00 years). Patients who received a KA before TKA were less likely to have congestive heart failure ($P < .001$), arrhythmia ($P < .001$), hypertension ($P < .001$), and diabetes mellitus ($P = .001$; Table 2) and were more likely to have pulmonary disease ($P = .003$), hypothyroidism ($P = .001$), chronic kidney disease ($P = .022$), rheumatoid or collagen disease ($P = .018$), depression ($P < .001$), and psychosis ($P < .001$; Table 2). The remaining differences

Table 1
CPT and ICD Codes.

Category	Codes
Total knee arthroplasty	CPT-27447, ICD-9-P-8154, ICD-10-P-0SRD0J9, ICD-10-P-0SRC0J9, ICD-10-P-0SRC0JA, ICD-10-P-0SRD0JA
Knee arthroscopy	CPT-29884, CPT-29850, CPT-29851, CPT-29855, CPT-29856, CPT-29870, CPT-29871, CPT-29873, CPT-29874, CPT-29875, CPT-29876, CPT-29877, CPT-29879, CPT-29880, CPT-29881, CPT-29882, CPT-29883, CPT-29884, CPT-29885, CPT-29886, CPT-29887, CPT-29888, CPT-29889, CPT-29870, CPT-29877, ICD-9-P-8026, ICD-10-P-OSBC4ZZ, ICD-10-P-OSBB4ZZ
Knee osteoarthritis	ICD-10-D-M161, ICD-10-D-M1610, ICD-10-D-M1611, ICD-10-D-M1612, ICD-9-D-71515, ICD-9-D-71525, ICD-9-D-71535, ICD-9-D-71595
PJI	ICD-9-D-99666, ICD-10-D-T8450XA
Revision	CPT-27486, CPT-27487, CPT-27488, ICD-9-P-8155, ICD-10-P-0SWC0XX, ICD-10-P-0SWD0XX
Stiffness	ICD-10-D-M25661, ICD-10-D-M25662, ICD-9-D-71956, ICD-10-D-M2566, ICD-10-D-M25669
Aseptic loosening	ICD-10-D-T84033A, ICD-10-D-T84032A, ICD-9-D-99641
Periprosthetic fracture	ICD-10-D-M9711XA, ICD-10-D-M9712XA, ICD-9-D-99644

CPT, current procedural terminology; ICD, international classification of diseases; PJI, periprosthetic joint infection.

Table 2
Demographics and Comorbidities of Patients Undergoing THA.

Category	Knee Arthroscopy		No Prior Knee Arthroscopy		*P* Value
	3357		134,662		
	N	%	N	%	
Gender					.895
Male	1155	34.41	49,838	37.01	
Female	2202	65.59	84,824	62.99	
Age					.241
<50	100	2.98	2005	1.49	
50-59	523	15.58	12,051	8.95	
60-69	1258	37.47	48,621	36.11	
70-79	1251	37.27	55,321	41.08	
80-89	200	5.96	14,652	10.88	
>90	25	0.74	2012	1.49	
Congestive heart failure	65	1.94	4699	3.49	**<.001**
Arrhythmia	251	7.48	13,582	10.09	**<.001**
Heart valve disease	85	2.53	3971	2.95	.168
Pulmonary circulation disorder	19	0.57	997	0.74	.295
Peripheral vascular disorder	73	2.17	3104	2.31	.659
Hypertension	1692	50.40	76,171	56.56	**<.001**
Paralysis	[a]	0.18	206	0.15	.879
Neurological deficit	71	2.11	2288	1.70	.070
Pulmonary disease	565	16.83	20,108	14.93	**.003**
Diabetes mellitus	754	22.46	33,930	25.20	**.001**
Hypothyroidism	625	18.62	21,825	16.21	**.001**
Chronic kidney disease	146	4.35	4793	3.56	**.022**
Liver disease	25	0.74	1069	0.79	.819
Peptic ulcer disease	37	1.10	1238	0.92	.319
HIV/AIDS	0	0.00	41	0.03	1.000
Lymphoma	[a]	0.06	375	0.28	.804
Cancer, metastatic	[a]	0.03	100	0.07	.542
Cancer, not metastatic	183	5.45	8742	6.49	**.018**
Rheumatoid or collagen disease	121	3.60	5932	4.41	**.028**
Coagulation deficiency	61	1.82	2941	2.18	.169
Electrolyte abnormalities	248	7.39	11,481	8.53	**.022**
Anemia, blood loss	34	1.01	1605	1.19	.436
Anemia, deficiency	318	9.47	14,315	10.63	**.035**
Alcohol dependency	14	0.42	708	0.53	.465
Drug use	19	0.57	536	0.40	.158
Obesity	581	17.31	24,922	18.51	.076
Smoking	175	5.21	6162	4.58	.087
Depression	494	14.72	15,199	11.29	**<.001**
Psychosis	92	2.74	2043	1.52	**<.001**

Bold indicates statistical significance: $P < .05$.
THA, total hip arthroplasty.
[a] Cohort size less than 11.

between demographics and comorbidities are further outlined in Table 2. The most common reason for undergoing KA was for OA (40.0%), medial meniscus tears (26.0%), and chondromalacia (21.0%; Figure 1).

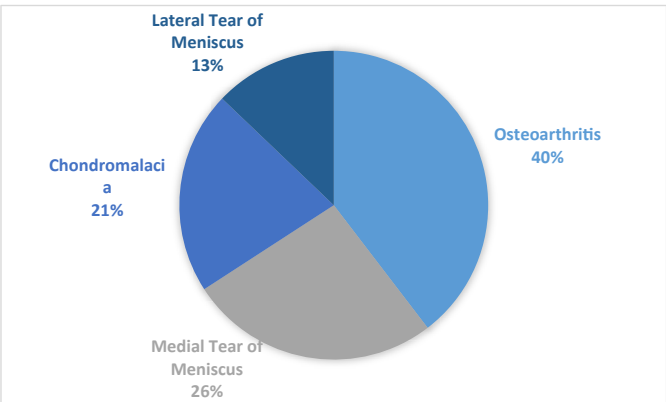

Fig. 1. Etiologies of arthroscopy.

Complications

In total, 93 patients (2.8%) in the KA cohort and 2406 patients (1.8%) in the nonarthroscopy control cohort required revision surgery within 2 years ($P = .001$; Table 3). At 2 years, patients in the arthroscopy cohort had a higher incidence rate of stiffness (17.7% vs 11.5%; $P < .001$), PJI (2.7% vs 1.8%; $P = .022$), MUA (4.3% vs 3.3%; $P = .003$), and aseptic loosening (1.3% vs 0.8%; $P = .043$; Table 3). There was no significant difference in postoperative frequency of periprosthetic fractures observed between the cohorts.

Following multivariate analysis, patients who had undergone a prior KA had an increased likelihood of requiring a revision surgery (OR, 1.392; 95% CI, 1.118-1.733; $P = .003$). Patients who underwent prior KA also had an increased likelihood of developing stiffness (OR, 1.251; 95% CI, 1.021-1.462; $P = .012$), requiring MUA (OR, 1.207; 95% CI, 1.015-1.436; $P = .033$), PJI (OR, 1.326; 95% CI, 1.057-1.663; $P < .001$), and aseptic loosening (OR, 1.401; 95% CI, 1.002-1.961; $P = .048$; Table 4).

Discussion

With roughly 2 million arthroscopic knee surgeries performed globally each year for degenerative knee disease, the modern

Table 3
Incidence of Postoperative Complications Following TKA at 2 Years.

Category	Knee Arthroscopy Before TKA		No Knee Arthroscopy		*P* Value
	3357		134,662		
	N	%	N	%	
All-cause revision	93	2.77	2406	1.79	**.001**
Postoperative stiffness	597	17.78	15,529	11.53	**<.001**
Manipulation under anesthesia	144	4.28	4404	3.27	**.003**
PJI	89	2.65	2466	1.83	**.022**
Aseptic loosening	42	1.25	1016	0.75	**.043**
Periprosthetic fracture	[a]	0.15	462	0.34	.075

P values given in bold equals significance <.05.
TKA, total knee arthroplasty; PJI, periprosthetic joint infection.
[a] Cohort size less than 11.

arthroplasty surgeon will inevitably encounter patients who underwent arthroscopy who are now candidates for TKA [13]. In 2006 within the United States, surgeons performed nearly 1 million arthroscopic procedures of the knee including nearly 500,000 for meniscal pathology, over 100,000 for chondromalacia of the patella, and over 50,000 for knee OA [5]. Patients with prior knee surgery are more likely to develop OA at a younger age, particularly males and patients with a history of ligamentous reconstruction, which makes them more likely to require subsequent arthroplasty [14].

Predicting which patients being evaluated for arthroscopy will do poorly and require arthroplasty in the near future is a challenge. Over the last decade, there have been many studies suggesting that arthroscopic surgery for degenerative meniscus tears or OA has little or no clinically significant efficacy compared to therapy and conservative management [13,15–17]. In particular, patients who undergo arthroscopy at a more advanced age and those with more severe OA are at greater risk of progression to TKA [6,18]. As older patients are thought to be at greater risk of conversion to TKA, one study used a 2-surgeon independent evaluation system to determine whether patients older than 50 years with knee pain thought to be more related to meniscal pathology than OA would improve with arthroscopy or whether they should undergo TKA [19]. The goal of the study is to reduce the rate of TKA within 3 years of arthroscopy to below 10% [19]. Even with a 2-surgeon system, 12% of patients aged 50-65 years and 36% of patients older than 65 years who underwent arthroscopy for suspected meniscal pathology received TKA within 3 years [19]. This illustrates the difficulty in using current criteria to determine the adequacy of arthroscopy for managing knee pain in older patients with OA and concurrent meniscal pathology.

The present study examined the largest cohort of patients to date who underwent arthroscopy within 2 years before TKA. Our goal is to determine the impact of arthroscopy on revision risk after TKA. In this cohort, the most frequent indications for arthroscopy were OA, medial or lateral meniscus tears, and chondromalacia. Patients who underwent arthroscopy and required TKA within 2 years were compared to patients with no recent arthroscopy. In a matched cohort, multivariate analysis, prior arthroscopy was associated with greater risk of revision surgery (OR, 1.4), stiffness (OR, 1.5), MUA (OR, 1.2), PJI (OR, 1.3), and aseptic loosening (OR, 1.4; Table 4).

The relationship between prior arthroscopy and complications after TKA remains controversial in the current literature. Two previous studies identified that a short time interval between arthroscopy and TKA is predictive of postoperative complications [7,9]. A single-center study evaluating the outcomes of 187 patients who had TKA within a year of arthroscopy showed that this cohort had lower Oxford knee scores (33.8 vs 36.3) and higher revision rates (3.8% vs 1.6%) than a large TKA cohort from the same institution [7]. A subgroup analysis showed that this difference was driven by patients who underwent arthroscopy and TKA within 6 months of each other [7]. A retrospective database study using data from Medicare and UnitedHealth Group found that, compared to an age-matched TKA cohort, those who had arthroscopy within 6 months of TKA had greater risk of infection (OR, 2.0), stiffness (OR, 2.0), and VTE (OR, 1.6) within 90 days of TKA [9]. Those who had arthroscopy greater than 6 months before TKA had similar outcomes to the control cohort [9].

While these studies suggest that the detrimental effect of arthroscopy on outcomes after TKA is time-limited to approximately 6 months, a single-center cohort study evaluating 60 patients with prior arthroscopy who underwent TKA (mean interval, 53 months) found that prior arthroscopy was associated with increased complications and more frequent reoperations and revisions [8]. The survival curve showed that patients with prior arthroscopy who underwent TKA had an 87% implant survival rate at 10 years, substantially below the control population's rate of 98% [8]. In this study, no time-dependent effect was found and arthroscopy did not predict International Knee Society knee and functional score outcomes [8]. A separate study by the same author found that a combined group of patients who underwent

Table 4
Multivariate Analysis of Knee Arthroscopy on Postoperative Complications at 2 Years.

Category	Odds Ratio	95% Confidence Interval		*P* Value
		Lower	Upper	
All-cause revision	1.392	1.118	1.733	**.003**
Postoperative stiffness	1.251	1.021	1.462	**.012**
Manipulation under anesthesia	1.207	1.015	1.436	**.033**
PJI	1.326	1.057	1.663	**<.001**
Aseptic loosening	1.401	1.002	1.961	**.048**

P values given in bold are significant.
PJI, periprosthetic joint infection.

arthroscopy or open meniscectomy, however, had more local complications and lower International Knee Society scores [20].

While the above studies associate prior arthroscopy with increased rates of complications and revision, other studies have contradicted these findings [10,11]. A single center, retrospective, matched cohort study showed that arthroscopy (excluding ligament reconstruction) before TKA did not affect improvement in Knee Society score after TKA, range of motion, and survivorship free of complications [10]. Additionally, aseptic loosening, revision, and reoperation rates were similar over a mean follow-up period of over 8 years [10]. These findings held true when the authors examined the subset of patients with arthroscopy within 1 year of TKA [10]. Another 2-institution study evaluated TKA outcomes in patients with 2 or more prior arthroscopic surgeries, finding that they had similar Knee Society scores, implant survivorship, and radiographic outcomes to control patients over about 3 years of follow-up [11].

Overall, the current literature is suggestive of poor efficacy of arthroscopy for degenerative meniscus and cartilaginous pathology. Additionally, there is a high rate of progression to TKA among older patients who undergo arthroscopy for these indications. Before this study, the limited literature on the subject has suggested a possible deleterious effect of prior arthroscopy on TKA outcomes, particularly if the surgeries are performed within a short time interval. The present study is the largest to date evaluating the impact of arthroscopy on TKA outcomes. The results of the study, showing that arthroscopy before TKA substantially increases the rates of revision, PJI, aseptic loosening, and stiffness, lend further credence to the idea that patients may be better served by nonsurgical management of their degenerative pathology until they become candidates for TKA. Subjecting this population to arthroscopy appears to offer limited benefit at the cost of poorer outcomes when they require arthroplasty in the future.

In light of our findings, surgeons should be cognizant of the increased risk that patients who had previously received KA for degenerative knee conditions. In particular, patients should be counseled about the increased risk of postoperative stiffness. In our analysis, there was an increased association between prior KA and postoperative stiffness and frequency of MUA. This may be due to fat pad scarring inevitably caused by KA, resulting in increased fibrosis around the knee. Patients may benefit from increased mobility in order to limit this risk.

There are several limitations to the present study. This study has the limitations characteristic of a large administrative dataset, including the potential for inaccuracies caused by incorrect billing. As this study only includes patients who required TKA within 2 years of KA, it selects for patients who had suboptimal outcomes after their arthroscopic procedure. A separate study would be required to evaluate the long-term outcomes of patients who have significant relief with arthroscopy and are able to delay or avoid TKA. In this analysis, we are unable to address this separate cohort who had KA and were able to delay TKA for a significant amount of time. In addition, we are unable to account for race and socioeconomic indications as well as delineate body mass index. While we were able to account for patients who were considered obese (body mass index > 30), these 3 variables may play important roles in overall outcome following KA and TKA. Lastly, as this is a national insurance database, we are unsure of specific criteria that individual surgeons use for determining patients who require a revision surgery, or MUA.

Prior KA is significantly associated with increased 2-year TKA revision rate. The most common etiology for arthroscopy was OA. The results of the study, showing that arthroscopy before TKA substantially increases the rates of revision, PJI, aseptic loosening, and stiffness, lend further credence to the idea that patients may be better served by nonsurgical management of their degenerative pathology until they become candidates for TKA. Subjecting this population to arthroscopy appears to offer limited benefit at the cost of poorer outcomes when they require arthroplasty in the future.

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