10.5005/jp-journals-10017-1093

RETROSPECTIVE REVIEW

Osteoporosis Patients have Higher Rates of Periprosthetic Fracture but Lower Rates of All-cause Revision Surgery following Total Knee Arthroplasty

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ABSTRACT

Introduction: Total knee arthroplasty (TKA) is commonly performed in the geriatric population in which osteoporosis (OP) is a common medical condition. This study aimed to compare complications in Medicare patients undergoing primary TKA with or without OP.

Materials and methods: The Medicare Standard Analytical Files were analyzed from 2005 to 2010, and patients undergoing primary TKA with and without OP were identified. Perioperative complications and revision rates were compared between groups.

Results: Osteoporosis patients undergoing TKA had a higher rate of periprosthetic fracture, but a decreased rate of revision surgery. In the postoperative period, OP patients had an increased risk of surgical wound complications and thromboembolic complications.

Conclusion: Caution should be taken when performing TKA in osteoporotic patients.

Keywords: Osteoporosis, Periprosthetic joint fracture, Total knee arthroplasty.

Lampley A, Penrose C, Watters T, Green CL, Wellman S, Chen AF. Osteoporosis Patients have Higher Rates of Periprosthetic Fracture but Lower Rates of All-cause Revision Surgery following Total Knee Arthroplasty. The Duke Orthop J 2018;8(1):37-42.

Source of support: Nil

Conflict of interest: None

INTRODUCTION

An increasing number of geriatric patients with advanced knee osteoarthritis (OA) are undergoing TKA.[1,2] While OP is a common medical condition in this patient population, OA has been shown to have an inverse relationship with OP in several cross-sectional studies.[3-6] In addition, several longitudinal studies found that increased axial bone mineral density (BMD) correlates with a higher risk of OA of the knee.[7,8] However, it is important to note that OA was defined by osteophytes and Kellgren-Lawrence grade[9] in these studies. No association between BMD and OA was found when OA was defined by joint space narrowing.[3,4] In patients with advanced stages of OA undergoing total joint arthroplasty (TJA), recent studies have demonstrated rates of OP and osteopenia to be 23 to 31% and 42 to 45% respectively.[10-13] Overall, the association between OA and OP is complex and may differ based on definition and degree of OA.

Osteoporosis is thought to be a risk factor for adverse complications of TJA, such as periprosthetic fracture and poor implant fixation. The overall incidence of periprosthetic fractures following TKA ranges from 0.3 to 2.5% after primary surgery and from 1.6 to 38% after revision surgery.[14-17] Patients with decreased BMD are at increased risk of fractures from low-energy mechanisms. While many studies report increased risk of periprosthetic fracture following TJA based on poor bone stock caused by various conditions, such as older age, inflammatory arthritis, and chronic steroid use,[16,18,19] no studies, to the authors' knowledge, have evaluated complications after TKA between Medicare patients with and without OP.

Therefore, the objective of this study was to compare perioperative complications in patients undergoing primary TKA with and without OP.

MATERIALS AND METHODS

We analyzed the Medicare Standard Analytical Files from 2005 to 2010 using PearlDiver technologies software. All patients who underwent primary TKA between 2005 and 2010 were identified using the International Classification of Disease, Clinical Modification (ICD-9-CM) code (81.54) and Current Procedural Terminology (CPT) codes (27445, 27446, and 27447). Patients who had TKA after December 31, 2010 were excluded to ensure that all patients had a minimum of 2-year follow-up data. There were a total of 1,252,081 patients. The OP patients were identified by

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ICD-9-CM codes (733.0, 733.00, 733.01, 733.02, 733.03, and 733.09) and DEXA scan (V82.81), resulting in a final cohort of 10,895 patients who were diagnosed with OP prior to TKA. The OP cohort was compared with a reference group of 1,241,186 patients who underwent TKA without a previous diagnosis of OP or osteopenia.

The CPT and ICD-9-CM procedure and diagnosis codes were used to identify comorbidities and complications of interest for TKA. Both cohorts were cross-referenced for the occurrence of each complication at 30 days, 1 year, and 2 years after TKA. Diagnoses from the same admission as the index surgery were included in each time point. Comorbidities were identified using ICD-9-CM codes for the Elixhauser measure.[20] The Charlson Comorbidity Index and demographic information were also obtained for both groups.

Unfortunately, there were missing demographic data, specifically gender and age. The non-OP group had 2.2% unknown gender and 2.2% unknown age while the OP group had 2.7% unknown gender and 2.7% unknown age. When the missing gender and age data were analyzed, we found a similar amount of unknown gender [odds ratio (OR) 1.2, 95% confidence interval (CI) 1.06–1.34, p = 0.003] and age (OR 1.2, 95% CI 1.06–1.34, p = 0.003) data between the groups. Therefore, we included these patients in our overall analysis with the understanding that the data are similar between the groups. Moreover, the amount of missing data is low and likely would have little impact on the reported demographic analysis. By reporting the missing data, we also demonstrate that the administrative data have greater than 97% complete demographic data. Furthermore, the demographic data are reported in age ranges rather than specific ages for each patient. This precludes us from reporting mean ages for each group. The descriptive characteristics of both groups are shown in Table 1. When compared with the non-OP group, the OP group had a higher percentage of patients in the 70 to 85 and older age group and a smaller percentage of subjects in the 69 and younger age group. The patients in the OP group were predominately female (94.5%), while the non-OP group was 59.3% female.

Statistical Analysis

Data are presented using standard methods for categorical variables (counts and percentages). For each comorbidity and complication, chi-square tests were used to determine differences between the OP and non-OP groups at each postoperative time point. Fisher's exact test was used in the presence of small cell counts (<5). The OR comparing the OP group with the reference group was also determined with 95% CI. SAS version 9.4 was used for all analyses, and a p-value < 0.05 was considered statistically significant.

RESULTS

Overall, the OP group had a higher percentage of each comorbidity (Table 2). Specifically, the OP group had significant more rheumatoid arthritis and collagen vascular disorders (OR 3.3, 95% CI 3.13–3.49, p≤0.001), chronic peptic ulcer disease (OR 3.1, 95% CI 2.32–4.24, p≤0.001), tobacco use (OR 1.29, 95% CI 1.22–1.37, p≤0.001), and hypothyroidism (OR 3.1, 95% CI 2.94–3.19, p≤0.001) compared with the non-OP group.

Overall, the rate of periprosthetic fracture was much higher in the OP group compared with the non-OP group at 30-day (OR 2.7, 95% CI 1.63–4.53, p=0.026), 1-year (OR 2.5, 95% CI 1.84–3.39, p≤0.001) and 2-year (OR 2.7, 95% CI 2.11–3.40, p≤0.001) follow-ups. With regards to postoperative complications 30 days after TKA (Table 3), patients with OP had significantly higher rates of surgical wound complications (OR 1.28, 95% CI 1.04–1.56, p=0.017) and deep vein thrombosis (OR 1.2, 95% CI 1.08–1.33, p=0.001). Meanwhile, the OP group had lower rates of acute renal failure (ARF, OR 0.76, 95% CI 0.66–0.86, p≤0.001), myocardial infarction (MI, OR 0.85, 95% CI 0.72–1.0, p=0.047), and periprosthetic joint infection (PJI, OR 0.74, 95% CI 0.57–0.97, p=0.026) in the first 30 postoperative days.

Table 1: Demographics of the patient population with and without OP

Variable	*Non-OP group (n = 1,241,186)*	*OP group (n = 10,895)*	*OR (95% CI)*	*p-value*
Sex				
Male	484,862 (39.1%)	371 (3.4%)	0.06 (0.05–0.06)	<0.001
Female	736,544 (59.3%)	10,297 (94.5%)	11.80 (10.86–12.81)	<0.001
Unknown gender	27,916 (2.2%)	292 (2.7%)	1.20 (1.06–1.34)	0.003
Age (years)				
Less than 65	123,668 (9.9%)	635 (5.8%)	0.55 (0.52–0.61)	<0.001
65–69	345,897 (27.9%)	2,041 (18.7%)	0.60 (0.57–0.63)	<0.001
70–74	312,635 (25.2%)	2,952 (27.1%)	1.10 (1.06–1.15)	<0.001
75–79	262,276 (21.1%)	2,891 (26.5%)	1.35 (1.29–1.41)	<0.001
80–84	153,474 (12.4%)	1,763 (16.2%)	1.37 (1.30–1.44)	<0.001
85 and older	57,140 (4.6%)	616 (5.6%)	1.24 (1.14–1.35)	<0.001
Unknown age	27,916 (2.2%)	292 (2.7%)	1.20 (1.06–1.34)	0.003

Table 2: Comorbidities with OR of OP group compared with non-OP group after TKA

Comorbidity	*Non-OP group (n = 1,241,186)*	*OP group (n = 10,895)*	*OR (95% CI)*	*p-value*
Alcohol abuse	12,197 (0.98%)	111 (1.02%)	1.04 (0.86–1.25)	0.696
Blood loss anemia	20,058 (1.62%)	324 (2.97%)	1.87 (1.67–2.09)	<0.001*
Chronic peptic ulcer disease	1,602 (0.13%)	44 (0.40%)	3.14 (2.32–4.24)	<0.001*
Chronic pulmonary disease	186,735 (15.04%)	2,844 (26.10%)	2.00 (1.91–2.08)	<0.001*
Coagulation deficiency	36,855 (2.97%)	526 (4.83%)	1.66 (1.52–1.81)	<0.001*
Congestive heart failure	84,479 (6.81%)	1,121 (10.29%)	1.57 (1.48–1.67)	<0.001*
Deficiency anemias	186,702 (15.04%)	3,439 (31.56%)	2.60 (2.50–2.71)	<0.001*
Depression	99,082 (7.98%)	2,012 (18.47%)	2.61 (2.49–2.74)	<0.001*
Diabetes with chronic complications	45,224 (3.64%)	582 (5.34%)	1.49 (1.37–1.62)	<0.001*
Diabetes without chronic complications	253,905 (20.46%)	2,679 (24.59%)	1.27 (1.21–1.32)	<0.001*
Drug abuse	9,365 (0.75%)	126 (1.16%)	1.54 (1.29–1.84)	<0.001*
Fluid and electrolyte disorders	151,073 (12.17%)	2,813 (25.82%)	2.51 (2.40–2.62)	<0.001*
Human immunodeficiency virus/acquired immune deficiency syndrome	9,933 (0.80%)	179 (1.64%)	2.07 (1.78–2.40)	<0.001*
Hypertension	679,933 (54.78%)	8,350 (76.64%)	2.71 (2.59–2.83)	<0.001*
Hypothyroidism	168,971 (13.61%)	3,548 (32.57%)	3.06 (2.94–3.19)	<0.001*
Liver disease	20,876 (1.68%)	420 (3.85%)	2.34 (2.12–2.59)	<0.001*
Lymphoma	7,365 (0.59%)	105 (0.96%)	1.63 (1.34–1.98)	<0.001*
Metastatic cancer	7,604 (0.61%)	207 (1.90%)	3.14 (2.73–3.61)	<0.001*
Obesity	133,464 (10.75%)	1,639 (15.04%)	1.47 (1.39–1.55)	<0.001*
Other neurological disorders	57,076 (4.6%)	1,083 (9.94%)	2.29 (2.15–2.44)	<0.001*
Paralysis	9,614 (0.77%)	134 (1.23%)	1.60 (1.34–1.89)	<0.001*
Peripheral vascular disease	97,880 (7.89%)	1,698 (15.59%)	2.16 (2.05–2.27)	<0.001*
Psychoses	35,251 (2.84%)	672 (6.17%)	2.25 (2.08–2.43)	<0.001*
Pulmonary circulation disorders	28,162 (2.27%)	524 (4.81%)	2.18 (1.99–2.38)	<0.001*
Renal failure	54,578 (4.40%)	766 (7.03%)	1.64 (1.53–1.77)	<0.001*
Rheumatoid arthritis/collagen vascular disease	59,531 (4.80%)	1,554 (14.26%)	3.30 (3.13–3.49)	<0.001*
Smoking	127,646 (10.28%)	1,405 (12.90%)	1.29 (1.22–1.37)	<0.001*
Solid tumor without metastasis	87,242 (7.03%)	1,560 (14.32%)	2.21 (2.09–2.33)	<0.001*
Valvular disease	86,551 (6.97%)	1,595 (14.61%)	2.28 (2.16–2.41)	<0.001*

*Statistically significant

Table 3: Thirty-day postoperative complications in OP and non-OP TKA patients

Postoperative complication	*Non-OP group*	*OP group*	*OR (95% CI)*	*p-value*
MI	20,449 (1.65%)	161 (1.48%)	0.85 (0.72–1.0)	0.047*
Heart failure	66,125 (5.33%)	587 (5.39%)	0.94 (0.86–1.02)	0.132
Respiratory failure	8,263 (0.67%)	85 (0.78%)	1.09 (0.87–1.36)	0.448
Deep vein thrombosis	35,333 (2.85%)	414 (3.80%)	1.20 (1.08–1.33)	0.001*
Pulmonary embolism	15,226 (1.23%)	170 (1.56%)	1.14 (0.97–1.34)	0.112
Stroke	7,984 (0.64%)	87 (0.80%)	1.06 (0.84–1.33)	0.640
Pneumonia	22,612 (1.82%)	224 (2.06%)	0.99 (0.86–1.14)	0.916
Sepsis	7,088 (0.57%	62 (0.57%)	0.74 (0.55–0.99)	0.040*
ARF	32,091 (2.59%)	237 (2.18%)	0.76 (0.66–0.86)	<0.001*
Periprosthetic infection	8,442 (0.68%)	72 (0.66%)	0.74 (0.57–0.97)	0.026*
Periprosthetic fracture	630 (0.05%)	17 (0.16%)	2.72 (1.63–4.53)	<0.001*
Surgical wound complications	8,569 (0.69%)	117 (1.07%)	1.28 (1.04–1.56)	0.017*
Vascular/neuroinjury	5,120 (0.41%)	48 (0.44%)	1.02 (0.76–1.37)	0.875
TKA revision	4,265 (0.34%)	54 (0.50%)	1.10 (0.80–1.49)	0.562

*Statistically significant

Postoperative complications at 1 year (Table 4) were found to be similar in patients with and without OP. The OP group had lower rates of PJI (OR 0.82, 95% CI 0.69–0.96, p = 0.017), and there was no difference in the rate of TKA revision (OR 1.09, 95% CI 0.94–1.27, p = 0.269) between groups. At 2-year follow-up (Table 5), there was no difference in the rate of PJI (OR 0.89, 95% CI 0.78–1.03, p = 0.113) or osteolysis/loosening (OR 1.26, 95% CI 0.8–1.98, p = 0.323) between groups. There was also no significant difference in the rates of TKA

Table 4: One-year postoperative complications in OP and non-OP TKA patients

Postoperative complication	*Non-OP group*	*OP group*	*OR (95% CI)*	*p-value*
PJI	19,730 (1.59%)	142 (1.30%)	0.82 (0.69–0.96)	0.017*
Periprosthetic fracture	1,924 (0.16%)	42 (0.39%)	2.49 (1.84–3.39)	<0.001*
TKA revision	17,142 (1.38%)	164 (1.51%)	1.09 (0.94–1.27)	0.269

*Statistically significant

Table 5: Two-year postoperative complications in OP and non-OP TKA patients

Postoperative complication	*2-year reference group*	*2-year OP group*	*OR (95% CI)*	*p-value*
Periprosthetic infection	25,470 (2.05%)	200 (1.84%)	0.89 (0.78–1.03)	0.113
Periprosthetic fracture	2,950 (0.24%)	69 (0.63%)	2.68 (2.11–3.40)	<0.001*
Osteolysis and loosening	1,724 (0.14%)	19 (0.17%)	1.26 (0.80–1.98)	0.323
TKA revision	29,047 (2.34%)	287 (2.63%)	1.13 (1.00–1.27)	0.043*

*Statistically significant

revision between the groups (OR 1.13, 95% CI 1.00–1.27, p = 0.043).

DISCUSSION

In this study, the comorbidities and postoperative complications in TKA patients with OP were elucidated. First, the OP group consisted mostly of females, smokers, and older patients, which agrees with other studies that risk factors for OP include advanced age, female gender, and tobacco use.[21] The OP group was also found to have a higher rate of rheumatoid arthritis, collagen vascular diseases, chronic peptic ulcer disease, and hypothyroidism. In patients with rheumatoid arthritis and collagen vascular diseases, the chronic systemic inflammatory processes from the disease and long-term glucocorticoid use likely increase the risk of developing OP in these patients.[22,23] The association between OP and chronic peptic ulcer disease may be explained by the long-term use of proton pump inhibitors, which has been associated with an increased incidence in hip fractures and decrease in BMD[24-26] thought to be secondary to decreased calcium absorption from pharmacologic hypochlorhydria.[27] Likewise, the association between hypothyroidism and OP is most likely explained by the treatment of hypothyroidism with levothyroxine. While untreated hypothyroidism has been associated with increased risk of bone fracture,[28] studies do not demonstrate a decrease in BMD in patients with untreated hypothyroidism causing an elevation in thyroid-stimulating hormone.[29,30] However, patients treated with exogenous thyroid hormone have decreased BMD.[30,31] These proposed theories are plausible explanations for the strong associations observed between OP and rheumatoid arthritis and collagen vascular disease, chronic peptic ulcer disease, and hypothyroidism, but we did not have access to specific patient treatment regimens in our database study.

Postoperative complications in patients with OP were also evaluated. The incidence of periprosthetic fractures following TKA in literature ranges from 0.3 to 2.5% after primary surgery and from 1.6 to 38% after revision surgery.[14-17] Our study found that Medicare patients with OP undergoing TKA demonstrated a higher risk of postoperative periprosthetic fractures in the immediate and short-term postoperative period. While the association of increased periprosthetic fracture risk and OP, advanced age, rheumatoid arthritis, and long-term corticosteroid use has been previously described,[15,16,18,32] our study validated that OP is a risk factor for periprosthetic fracture in the Medicare population, which had a 161% increase in TKA volume from 1991 to 2010.[33] With decreased BMD, periprosthetic fractures are likely in this patient population. However, given the increased porosity of cancellous bone in OP patients, there could potentially be deeper cement penetration and improved interdigitation which would result in less aseptic loosening. Thus, our study demonstrated that there was no difference in the risk of loosening or TKA revision between the two groups.

With regard to immediate postoperative complications, patients with OP had higher rate of surgical wound complications and deep vein thrombosis. This is likely explained by the higher number of comorbidities in the OP group, such as tobacco use. Meanwhile, patients with OP had a lower risk of MI, ARF, and PJI. The decreased risk of MI is likely explained by the predominance of females in the OP group which confers less risk of MI when compared with male patients.[34] Similarly, female gender has been shown to have a decreased risk of PJI which may explain the decreased risk of PJI in the OP group.[35] However, other risk factors for PJI include congestive heart failure, obesity, diabetes, peripheral vascular disease, smoking and rheumatoid arthritis,[35] which were more prevalent in the OP group. Because OP patients may be on long-term immunosuppressants, such as steroids and are known to be at higher risk for PJI, these patients may have been monitored more closely or may have been placed on longer postoperative antibiotics. Unfortunately,

antibiotic duration could not be monitored in this database study. Likewise, the OP group exhibited comorbidities, such as diabetes mellitus, obesity, and increased age that increase the risk of ARF in the geriatric population after TKA.[36] However, since OP patients presented with these chronic comorbidities, such as renal failure prior to surgery, they may have been monitored closely and were given adequate fluid resuscitation to prevent ARF.

There were limitations to this study. Since this study evaluated data from the Medicare Standard Analytical Files, there was an extremely large sample size but the data obtained have several limitations. The dataset is a collection of billing and coding-level data which does not provide specific descriptive characteristics of patients with postoperative complications that may have allowed us to elucidate other risk factors for these postoperative complications other than OP. Additionally, we assume that the ICD-9 and CPT codes were accurately and consistently recorded for the correct complication and procedure for each study patient. However, we have no way to validate this assumption, and any inaccuracy in the data would translate to inaccuracy in our conclusions. However, in 2012, Bozic et al[37] demonstrated reasonable concordance when administratively coded comorbidities and complications were compared with the clinical record, and calculated the specificity and sensitivity of the administrative record compared with the clinical record. They found the specificity of the studied comorbidities and complications to be 91 to 100% while the sensitivity was much lower, suggesting that billing and coding-level data are accurate but likely incomplete. Despite these limitations, we do not feel that the conclusions overreach the data as OP Medicare patients had similar comorbidities and postoperative complications as those in other institutional studies.

In conclusion, the associations between certain comorbidities and postoperative complications in Medicare patients with OP demonstrated in this study are valuable to the surgeon. A diagnosis of hypothyroidism, inflammatory arthropathy, or chronic peptic ulcer disease in a patient without a diagnosis of OP could alert a surgeon to the possibility of undiagnosed OP. Furthermore, surgeons can better counsel OP patients regarding the risk of postoperative complications after TKA based on the findings of this study.

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