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Osteoporosis Is Common and Undertreated Prior to Total Joint Arthroplasty

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ABSTRACT

Background: Osteoporosis is common in total joint arthroplasty (TJA) patients and likely contributes to the increasing incidence of periprosthetic fracture. Despite this, the prevalence of osteoporosis in patients undergoing elective TJA is inadequately studied. We hypothesize that preoperative osteoporosis is underrecognized and undertreated in the TJA population. The purpose of this study is to report preoperative osteoporosis screening rates and prevalence prior to TJA and rates of pharmacologic osteoporosis treatment in the TJA population.

Methods: This is a retrospective case series of 200 consecutive adults (106F, 94M) aged 48-92 years who underwent elective TJA (100 total hip, 100 total knee) at a single tertiary-care center. Charts were retrospectively reviewed to determine preoperative osteoporosis risk factors, prior dual-energy X-ray absorptiometry (DXA) testing, and prior osteoporosis pharmacotherapy. Fracture risk was estimated using the Fracture Risk Assessment Tool and the National Osteoporosis Foundation criteria for screening and treatment were applied to all patients.

Results: One hundred nineteen of 200 patients (59.5%) met criteria for DXA testing. Of these 119, 21 (17.6%) had DXA testing in the 2 years prior to surgery, and 33% had osteoporosis by T-score. Forty-nine patients (24.5%) met National Osteoporosis Foundation criteria for pharmacologic osteoporosis treatment, and 11 of these 49 received a prescription for pharmacotherapy within 6 months before or after surgery.

Conclusion: One quarter of TJA patients meet criteria to receive osteoporosis medications, but only 5% receive therapy preoperatively or postoperatively. This lack of preoperative osteoporosis screening and treatment may contribute to periprosthetic fracture risk.

Total joint arthroplasty (TJA) is one of the most common orthopedic procedures at over one million surgeries annually in the United States, a number projected to increase in the future [1,2]. Osteoporosis is common in the older adults undergoing arthroplasty [3] and likely contributes to the increasing incidence of periprosthetic fracture, with rates reported to be 0.3%-5.5% after primary TJA and as high as 30% after revision arthroplasty [4,5]. Osteoporosis may also be a risk factor for aseptic loosening, which is the second most common cause of revision after total hip arthroplasty (THA) and total knee arthroplasty (TKA) [6,7]. Further, osteoporosis has been found to affect component positioning in computer-navigated TKA [8] and has been associated with increased subsidence after cementless total hip arthroplasty [9]. Optimization of bone health may help mitigate these complications and is thus an important perioperative consideration; however, it has been underemphasized to date.

The prevalence of preoperative osteoporosis in patients undergoing elective hip and knee arthroplasty is inadequately studied. The only US study was published in 2003 and found a 25% prevalence of

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Table 1
Clinical Risk Factors Included in the FRAX Tool [14].

1. Age
2. Gender
3. BMI
4. Previous fracture[a]
5. Parent fractured hip
6. Current smoking
7. Glucocorticoid use[b]
8. Rheumatoid arthritis
9. Secondary osteoporosis[c]
10. Alcohol 3 or more units/day
11. Femoral neck BMD, when available (g/cm^2)

FRAX, fracture risk assessment tool; BMI, body mass index.
[a] Previous fracture in adult life occurring spontaneously, or a fracture arising from trauma which, in a healthy individual, would not have resulted in a fracture.
[b] Equivalent to 5mg prednisolone daily currently or for >3 mo in the past.
[c] Secondary cause of osteoporosis: type 1 diabetes, osteogenesis imperfecta, untreated long-standing hyperthyroidism, hypogonadism or premature menopause, chronic malnutrition, or malabsorption and chronic liver disease.

osteoporosis in postmenopausal women undergoing THA [10]. Investigations performed in other countries have found the preoperative osteoporosis prevalence prior to TJA to range from 13%-43% [11,12].

Previous studies have used World Health Organization criteria based on dual-energy X-ray absorptiometry (DXA) scanning, with osteoporosis defined as a bone mineral density (BMD) T-score less than or equal to −2.5 and osteopenia between −1 and −2.5. However, the guidelines for osteoporosis treatment from the National Osteoporosis Foundation (NOF) have been updated to include fragility fractures and the Fracture Risk Assessment Tool (FRAX) [13]. The use of the NOF osteoporosis screening guidelines in the orthopedic setting may help identify patients at risk for osteoporosis and, if the infrastructure exists, may prompt referral to a bone health specialist or fracture liaison service.

We hypothesize that preoperative osteoporosis is common, underrecognized, and undertreated in the TJA population. Our main research questions are as follows: What is the prevalence of osteoporosis in adults undergoing elective TJA at a tertiary academic center? What percentage of patients have received DXA testing prior to TJA? What percentage of patients that meet diagnostic criteria for osteoporosis have been prescribed osteoporosis medications within 6 months before or after surgery?

Table 2
NOF Guidelines for Bone Mineral Density Screening [13].

Women	Men
All age ≥65	All age ≥70
Younger postmenopausal and women in the menopausal transition with clinical risk factors for fracture[a]	Age 50 to 69 years with clinical risk factors for fracture[a]
Age ≥50 years who have had an adult age fracture	Age ≥50 years who have had an adult age fracture
Adults with a condition (e.g,. rheumatoid arthritis) or taking a medication (e.g,. glucocorticoids in a daily dose ≥5 mg prednisone or equivalent for ≥3 mo) associated with low bone mass or bone loss	Adults with a condition (e.g,. rheumatoid arthritis) or taking a medication (e.g,. glucocorticoids in a daily dose ≥5 mg prednisone or equivalent for ≥3 mo) associated with low bone mass or bone loss

NOF, national osteoporosis foundation.
[a] Clinical risk factors found in Table 1.

Table 3
NOF Guidelines for Pharmacologic Treatment of Osteoporosis [13].

T-Score ≤2.5 at the Femoral Neck or Spine[a]
History of hip or vertebral fracture
T-score between −1 and −2.5 at the femoral neck or spine AND a 10-y risk of hip fracture ≥3% or major osteoporotic fracture ≥20%

NOF, national osteoporosis foundation.
[a] After appropriate evaluation to exclude secondary causes.

Materials and Methods

We conducted a retrospective review of 200 consecutive adults who underwent elective TJA (100 THA and 100 TKA) at a single tertiary-care center between February and September 2017. The study was granted exemption by the Institutional Review Board. Inclusion criteria were any patient over aged 40 years undergoing primary THA or TKA. Exclusion criteria included cases of acute trauma (ie, total hip arthroplasty for femoral neck fracture). If a patient had additional joint replacements within the study period, only the first surgery was included in the analysis. A sample size of 100 for each procedure was selected out of convenience as no power calculation applied to the research questions (ie, not detecting differences between groups).

Electronic medical records (EMRs) were retrospectively reviewed by the lead author for demographics, preoperative osteoporosis risk factors (Table 1), prior DXA testing, and osteoporosis pharmacotherapy (prescription within 6 months before or after surgery). The hospital system EMR and the expanded Care Everywhere Network were reviewed to include all available data. Bone mineral density data and T-scores were extracted by the lead author after independently reviewing the DXA for accuracy. Inaccurate DXA results (ie, improper default identification of bone edges and regions of interest) were not included in the analysis. The lowest T-score among average L1–L4 and proximal femur was recorded. The term “appropriately screened” was used to describe patients who were indicated for BMD testing and had undergone DXA in the 2 years prior to surgery. Previous osteoporosis medications included bisphosphonates, denosumab, raloxifene, or teriparatide. These data were used to estimate fracture risk via the FRAX calculator. The FRAX score was calculated with and without BMD when patients had prior DXA scanning. The National Osteoporosis Foundation (NOF) criteria for BMD testing (Table 2) and pharmacologic osteoporosis treatment (Table 3) were applied to all patients. Each patient was assessed and categorized as having met criteria for DXA testing or not. Similarly, each patient was categorized as having met criteria for pharmacologic treatment or not.

A FRAX major osteoporotic fracture risk of 9.3% was used as a value of interest because the United States Preventive Services Task Force recommends BMD screening in postmenopausal women younger than 65 years who have a major osteoporotic fracture risk of 9.3% or greater.

Statistical analysis was completed using Microsoft Excel. Chi-square tests were used to compare categorical values, while continuous variables were evaluated with 2-sample t tests assuming unequal variance. Ethnicity was analyzed as Caucasian versus non-Caucasian because of the low numbers in other ethnic groups. Preoperative diagnosis was analyzed as primary osteoarthritis versus other. P values less than 0.05 were considered statistically significant.

Source of Funding

There was no outside funding involved in this project.

Table 4
Demographics, Indications for Total Joint Arthroplasty, and FRAX Risk for All Subjects.

	THA (n = 100)	TKA (n = 100)	Total (n = 200)	*P* Value[a]
Sex				
Female	51	55	106	0.571
Ethnicity				
Caucasian	93	91	184	.602
African-American	6	8	14	
Hispanic	1	1	2	
Age (avg, range)	66, 42-92	68, 48-89	67, 42-92	0.192
Preoperative diagnosis				
Primary osteoarthritis	80	92	172	0.145
DDH	10	-	10	
Posttraumatic	3	4	7	
Rheumatoid arthritis	2	4	6	
Avascular necrosis	4	-	4	
SCFE	1	-	1	
Previous fracture after age 50 years	13	8	21	0.249
FRAX MOF risk (%)[b]	7.4 ± 5.7	7.3 ± 6.1	7.4 ± 5.8	0.879
FRAX hip risk (%)[a],[a]	1.1 ± 2.5	1.2 ± 3.0	1.2 ± 2.7	0.558
FRAX MOF >20%	6	6	12	1
FRAX hip >3%	33	33	66	1
T-score −1 to −2.5 with FRAX hip >3% or MOF >20%	21	18	39	0.489

THA, total hip arthroplasty; TKA, total knee arthroplasty; DDH, developmental dysplasia of the hip; SCFE, slipped capitol femoral epiphysis; MOF, major osteoporotic fracture; FRAX, fracture risk assessment tool.
[a] Comparison between THA and TKA groups.
[b] Data presented as median and standard deviation.

Results

Demographics and Indications for Arthroplasty

A total of 200 adults (106F, 94M) were included in the study (Table 4). The average age was 67 (range = 48-92) years. Ninety-two percent of patients were Caucasian. Of the 100 TKA, indications included, 92 primary osteoarthritis, 4 posttraumatic arthritis, and 4 rheumatoid arthritis. Of the 100 THA, indications included 80 primary arthritis, 10 developmental dysplasia of the hip, 4 avascular necrosis, 3 posttraumatic arthritis, 2 rheumatoid arthritis, and 1 prior slipped capital femoral epiphysis.

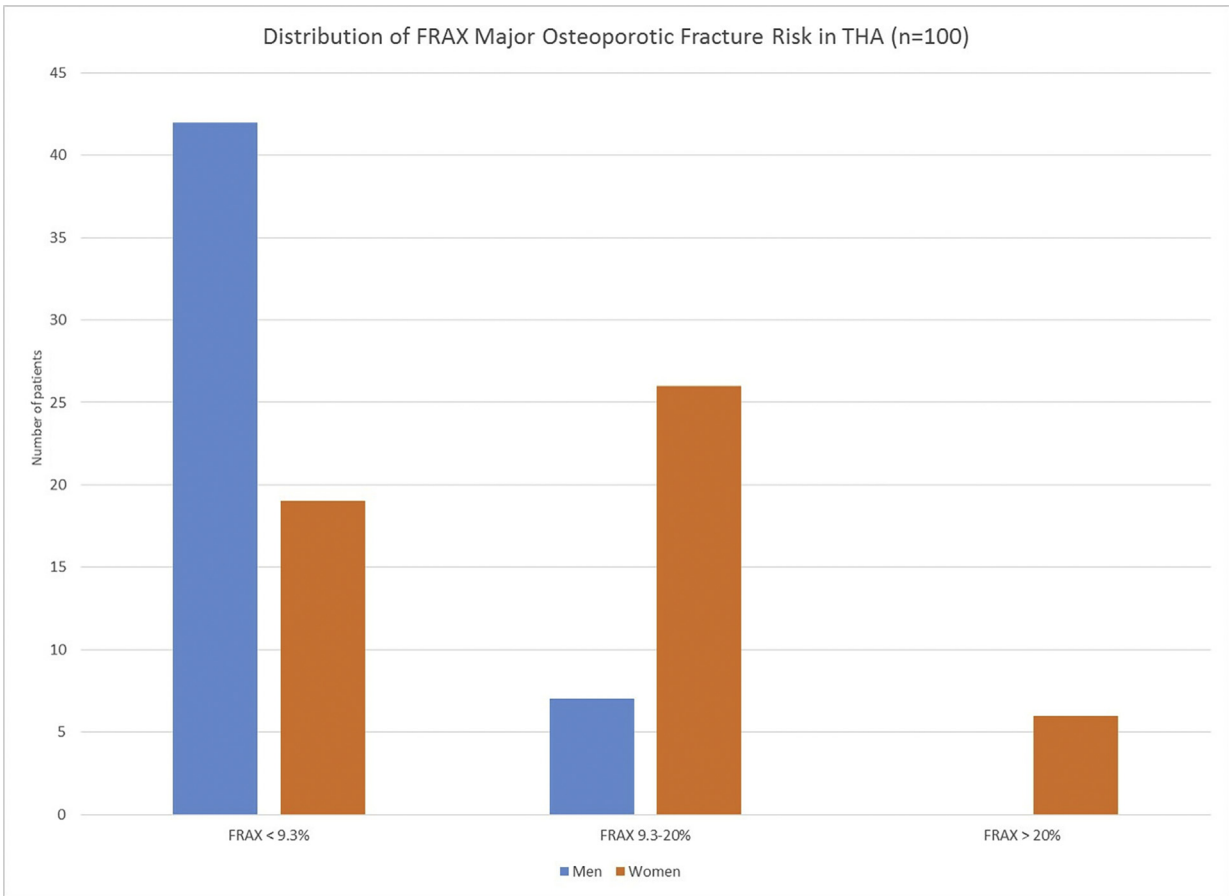

Fig. 1. Distribution of major osteoporotic fracture risk according to FRAX calculator in THA patients (n = 100). FRAX, Fracture Risk Assessment Tool; THA, total hip arthroplasty.

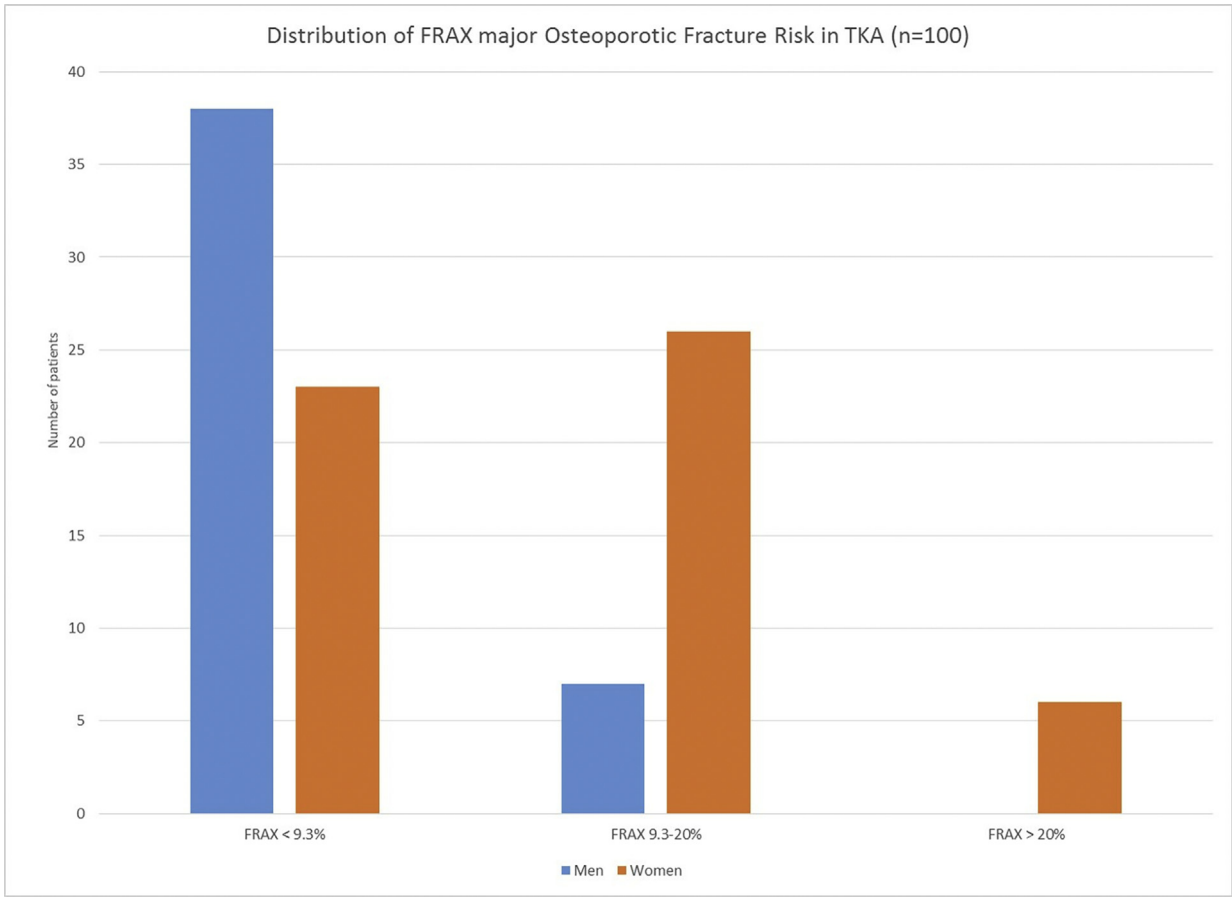

Fig. 2. Distribution of major osteoporotic fracture risk according to FRAX calculator in TKA patients (n = 100). TKA, total knee arthroplasty.

FRAX Risk

The median calculated fracture risk combining both THA and TKA groups was 1.2% (std dev = 2.7, range = 0.1-18) for hip fracture and 7.4% (5.8, 1.7-35) for major osteoporotic fracture (Table 4). There was no statistically significant difference between THA and TKA. Twelve patients (12F) had a major osteoporotic fracture risk greater than 20%, 66 (14M, 52F) between 9.3% and 20%, and 122 (80M, 42F) less than 9.3% (Figs. 1 and 2).

DXA Testing

In the THA cohort, 53 patients met NOF criteria for BMD measurement (Fig. 3). Ten patients had DXA testing in the 2 years prior to surgery. In the TKA cohort, 66 patients met NOF criteria for BMD screening (Fig. 4). Eleven patients had DXA screening in the 2 years prior to surgery.

Treatment

Overall, 49 patients met NOF criteria for osteoporosis treatment (Table 3). Thirty-four patients had T-score between −1 and −2.5 at the femoral neck, total femur or spine, and a 10-year risk of hip fracture greater than 3% or major osteoporotic fracture risk greater than 20%. Eleven patients met multiple criteria. Three patients had a history of hip or spine fracture. One patient had a T-score ≤2.5 at the femoral neck or spine. In the THA group, 26 patients met NOF criteria for receiving osteoporosis medications while 6 had been prescribed pharmacotherapy in the 6 months before or after surgery. In the TKA group, 23 patients met NOF criteria for osteoporosis medications, while 5 had been prescribed pharmacotherapy in the 6 months before or after surgery.

In the 21 patients with DXA testing in the past 2 years, 7 were osteoporotic (T-score ≤−2.5), 11 were osteopenic (T-score between −1 and −2.5), and 3 had normal bone mineral density (T-score ≥ −1).

Case Example

A 70-year-old female without significant past medical history underwent routine left TKA. At the time of surgery, she met criteria for DXA testing but did not undergo this assessment preoperatively. Unfortunately, 6 months after surgery, she had a ground level fall and sustained a periprosthetic distal femur fracture requiring open reduction internal fixation. Once she was ultimately referred to the fracture liaison service, she underwent DXA and was found to have a T-score of −3.1 at the femoral neck and trabecular bone score of 1.128, consistent with degraded bone microarchitecture. Adjusted for trabecular bone score, her FRAX risk was calculated to be 11.6% and 32% for hip and major osteoporotic fracture, respectively. Had her osteoporosis been identified and treated preoperatively, she may not have had this low-energy periprosthetic fracture and may not have required revision surgery.

Discussion

The current study finds osteoporosis to be common, underdiagnosed, and undertreated prior to TJA. Specifically, we found low

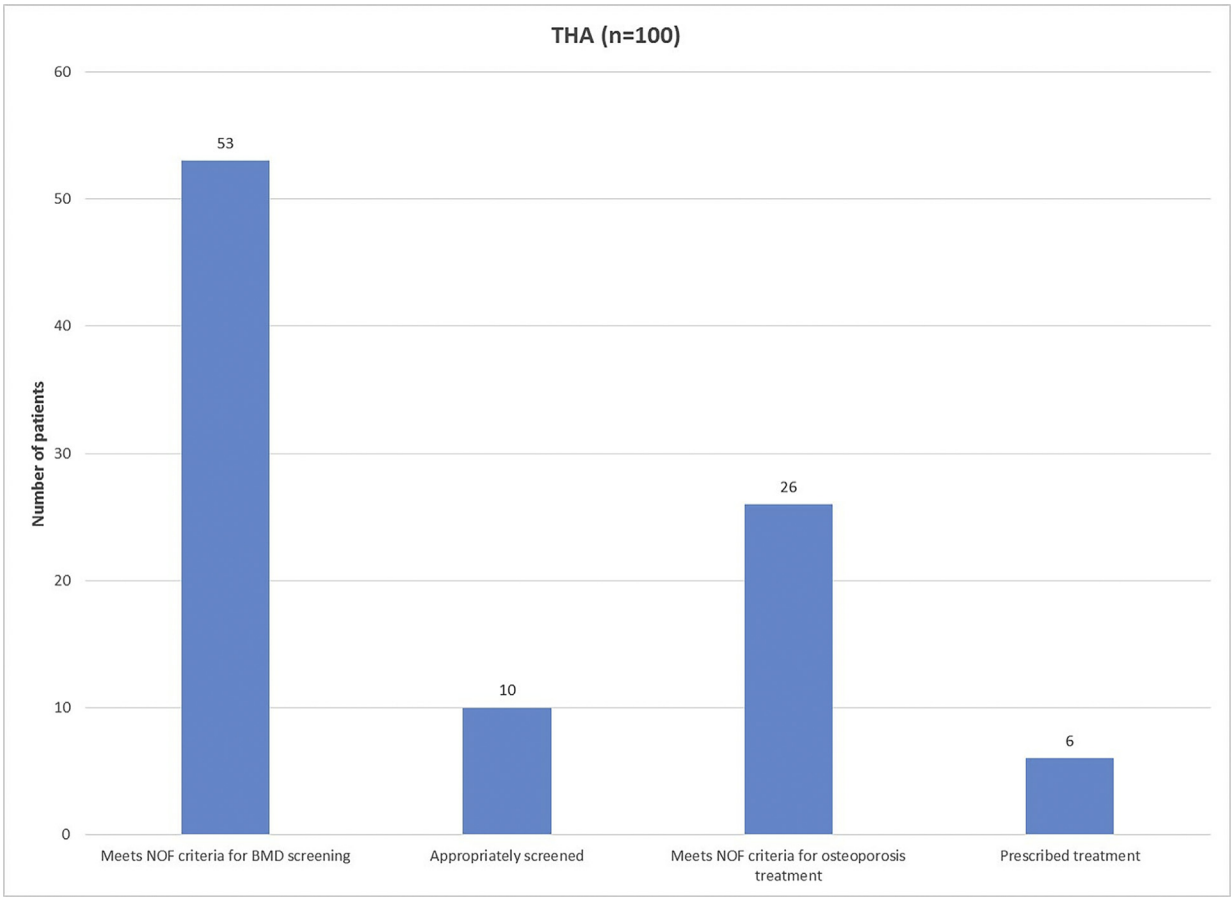

Fig. 3. Number of patients in the THA cohort meeting NOF criteria for screening and treatment compared to those that received screening and treatment. NOF, National Osteoporosis Foundation.

bone mass to be present in 86% of TJA patients with DXA. Further, 60% of TJA patients meet NOF criteria for BMD testing, but only 18% of those patients had been screened within 2 years prior to surgery. This suggests that over 80% of patients are not receiving appropriate osteoporosis screening. We also found that one-quarter of TJA patients meet NOF criteria for osteoporosis treatment, but of those patients, only 22% had received a prescription for osteoporosis medication in the 6 months before or after surgery.

The underattention to osteoporosis in the TJA population is not appropriate given that osteoporosis is common in older adults [3]. Osteoarthritis leading to elective TJA is also highly prevalent and can be comorbid with osteoporosis [15]. Moreover, osteoporosis has been associated with multiple complications in arthroplasty including altered component positioning [8], intraoperative fractures [16], subsidence [17], delayed osteointegration [9], aseptic loosening [6,7], and periprosthetic fractures [18,19]. In addition, osteoporosis may change choice of implant (ie, cemented versus uncemented femoral component in THA) [20]. Bone health should therefore be considered prior to elective arthroplasty.

This lack of osteoporosis care in orthopedic patients represents an opportunity for improvement. Although this study reflects a single patient population (academic referral center), we surmise that this generalizes to many/most orthopedic practices in the United States. This topic has been investigated in Europe and Asia, where osteoporosis has been reported in 13%-43% of patients prior to TJA [11,12]. Few studies have reported on the rates of osteoporosis treatment prior to TJA. James et al found 42% of TJA patients in the United Kingdom had osteopenia or osteoporosis, and of those with T-score–defined osteoporosis, fewer than half were on bisphosphonate therapy [21]. While more studies are needed to better define the scope of the problem, osteoporosis is clearly common in the TJA population.

Preoperative knowledge of bone status is of particular importance in arthroplasty as it may affect the surgical plan or implant choice. For example, many orthopedic surgeons cement the femoral component in THA if radiographs indicate osteoporosis or if intraoperative bone quality is poor [20]. Consistent with this, a survey of 435 orthopedic surgeons found over 60% reporting that low BMD is a reason to reconsider operation strategies; however, only 4% performed BMD measurement preoperatively [22]. Preoperative optimization of blood pressure, cholesterol, glucose, and tobacco cessation are common practice in arthroplasty. It is the authors' opinion that bone health should be similarly evaluated and optimized prior to elective orthopedic surgery.

The effect of arthroplasty on local bone is not well-known and may also increase the risk of periprosthetic fractures and other postoperative complications. We conducted a meta-analysis of studies reporting periprosthetic BMD after TKA and found ipsilateral femur decreases of 15% in the first postoperative year, which is sustained at 2 years (unpublished data). The clinical implication of this decline is unknown but seems exceptionally likely to increase periprosthetic fracture risk. This information should be taken into consideration when selecting patients and managing bone health prior to TJA. If a patient has baseline low BMD and this is expected to further decrease postoperatively, the decision to operate or what implants to use may change.

Multiple potential approaches exist to improve bone health in arthroplasty patients. As these data suggest, the majority of patients

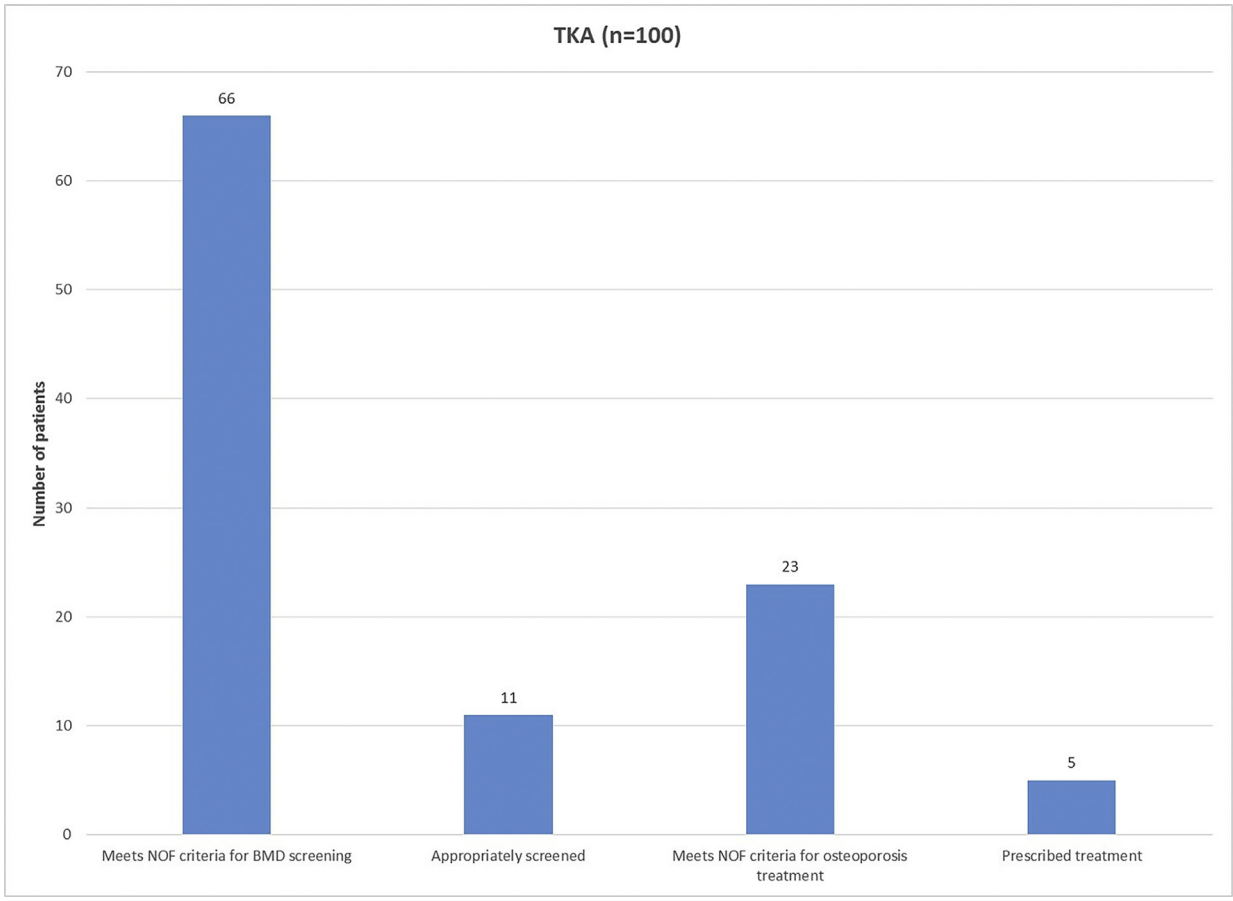

Fig. 4. Number of patients in the TKA cohort meeting NOF criteria for screening and treatment compared to those that received screening and treatment.

presenting for arthroplasty meet criteria for osteoporosis screening. If patients have not had DXA testing in the past 2 years, we recommend applying the NOF criteria to determine if such evaluation is indicated. Subsequently, for those with osteopenia or osteoporosis, we recommend referral to a bone health/fracture liaison service, primary-care provider, or further evaluation by the orthopedic clinic. In patients with a confirmed diagnosis of osteoporosis as outlined in Table 3, preoperative medical therapy should be considered for 3-6 months if elective surgery can be delayed.

Several investigations suggest improved outcomes when osteoporosis is treated preoperatively and postoperatively in TJA patients. A small study on hip resurfacing found that in women with low BMD, delaying surgery for 12 months and initiating bisphosphonate, calcium, and vitamin D therapy yielded substantial improvements in BMD, and there were no intraoperative femoral neck fractures during hip resurfacing [23]. A recent meta-analysis of 4 studies found long-term bisphosphonate use to correlate with reduced revision rates after THA and TKA [24]. Another meta-analysis of randomized controlled trials showed risedronate to be associated with significantly reduced femoral BMD loss after THA [25]. Denosumab similarly decreased BMD loss in a randomized controlled trial of cementless THA [26]. Additionally, patients on bisphosphonates have lower risk of fracture after TJA [27]. Teriparatide administration after TKA increased periprosthetic BMD [28] while denosumab given immediately postoperatively and again at 6 months decreased early migration in TKA [29]. In a randomized placebo-controlled trial of women undergoing cementless THA, postoperative zoledronic acid infusion maintained periprosthetic BMD [9]. Further work is needed to examine the cost-effectiveness and safety of postoperative anti-osteoporosis drugs.

Limitations of this study include its retrospective nature. It is important to note that this study is not powered nor designed to show causality between osteoporosis and poor outcomes. Rather, we report a high prevalence of osteoporosis, which in multiple cited studies, has been correlated to adverse outcomes. The use of the EMR may also having missing data. We queried both the hospital system EMR and the expanded Care Everywhere Network to decrease missing data, but history and medications recorded elsewhere (ie, another state) were not captured in this study. Additionally, a family history of hip fracture which is a component of the FRAX calculation that can strongly affect the calculated risk is not well-recorded in the EMR. Our cohort was 92% Caucasian and represents the population served by a tertiary referral center. Thus, these findings may not be generalizable to other ethnic populations or more community-based practices. Finally, this study was not designed to compare outcomes or costs between groups.

Conclusions

Our study finds that osteoporosis is common, underrecognized, underevaluated, and undertreated prior to TJA. Osteoporosis is correlated with poorer outcomes and increased costs after arthroplasty. Antiosteoporosis medications have been associated with improved radiologic and mechanical outcomes. Bone health screening and optimization should be considered prior to TJA. Further research is needed to examine the cost-effectiveness of

osteoporosis screening in the arthroplasty population as well as the clinical benefit of perioperative antiosteoporosis medications.

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