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History of Breast Cancer Increases 90-Day Pulmonary Embolism Rates and Reimbursements After Total Hip Arthroplasty: A National Matched-Pair Analysis

Samuel Rosas, MD[a,*], **Alejandro Marquez-Lara, MD**[a], **Daniel N. Bracey, MD, PhD**[a], **Jennifer Kurowicki, MD**[b], **Martin W. Roche, MD**[c], and **Cynthia L. Emory, MD, MBA**[a]

[a]Department of Orthopedic Surgery, Wake Forest School of Medicine, Winston-Salem, North Carolina

[b]Department of Orthopaedic Surgery, Seton Hall University, School of Health and Medical Sciences, South Orange, New Jersey

[c]Department of Arthroplasty, Holy Cross Orthopedic Institute, Oakland Park, Florida

Abstract

Background: Rates of total hip arthroplasty (THA) are projected to increase in the coming decades. Multiple studies have focused on identifying risk factors for adverse events after joint arthroplasty, and recent attention has been directed toward cancer. Very limited data have been published examining the effects of history of malignancy on outcomes after THA. With a concomitant increase in breast cancer diagnosis and treatments in recent years, it is expected that orthopedic surgeons will likely see more breast cancer survivors in clinic. The purpose of this study is to examine the effects of a personal history of breast cancer on 90-day outcomes after THA.

Methods: We conducted a retrospective case-control study of the entire Medicare records. The endpoints of this study included length of stay, medical complications, surgical complications, and costs (examined here as reimbursements). Patients were matched by age and gender in order to decrease confounding. A 1:1 matching was performed.

Results: After age and demographics matching, our findings demonstrated that patients with a history of breast cancer have increased rates of pulmonary embolism (0.59% vs 0.45%, $P = .003$), increased use of chest computed tomography (1.72% vs 1.18%, $P < .001$), and higher mean 90-day reimbursements (mean $15,432 vs mean $14,701, $P = .011$) in the 90 days following surgery. Other medical and surgical complications were equally distributed in both cohorts.

Conclusion: Surgeons should be aware of the increased rate of pulmonary embolism and have a more aggressive thromboprophylaxis protocol in these patients.

*Reprint requests: Samuel Rosas, MD, Department of Orthopedic Surgery, Wake Forest School of Medicine, 1 Medical Center Boulevard, Winston-Salem, NC 27101

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Keywords

breast cancer; outcomes; total hip arthroplasty; cost; reimbursements; pulmonary embolism; Level of Evidence:III; case-control study

Total hip arthroplasty (THA) [1] rates are projected to grow in the United States in the coming years [2]. Unfortunately, with increasing utilization of these procedures, more complications are also expected, thus pre-operative risk stratification has received a great deal of attention as research has proven that risk-stratifying patients are cost-effective [3,4]. Modifiable risk factors have been a source of great attention as pre-operative interventions decrease post-operative complications, but non-modifiable risk factors continue to be a source of great concern [5–7]. Some of these non-modifiable risk factors include a history of cancer, rheumatic disease, and/or red cell dysplasia, and thus further research on these topics is required [8,9]. Epidemiological studies of the US patient population have demonstrated that the incidence of breast cancer is increasing, but the mortality is decreasing due to earlier diagnosis and advancements in treatment. Thus it is common to encounter patients in clinic with a history of cancer such as breast, prostate, or colon.

In a recent study, Karam et al [10] evaluated the outcomes of patients treated with lower extremity arthroplasty with a history of cancer at their institution. This study demonstrated that greater attention should be given to these patients, but due to sample size limitations, outcomes of each type of cancer were not described. Nonetheless, the general outcomes of patients with a history of cancer demonstrated that these patients had a greater in-hospital risk of ischemic cardiac events and deep vein thrombosis compared to patients without cancer. Thus, the purpose of this study is to examine the effects of a personal history of breast cancer on patient outcomes and costs following THA at the national level.

Materials and Methods

A population health study was conducted examining the entire Medicare files. The Medicare Standard Analytical Files provide the ability to examine all the records of the Medicare database through a standardized search. The search was conducted with International Classification of Disease 9th revision codes and Current Procedural Terminology codes as has been done in previous studies [9,11,12]. The Pearl Diver server (Warsaw, IN) was used for the query. The codes utilized to identify patients are shown in Table 1. A query for all THAs performed within the Medicare Standard Analytical Files was performed from 2005 to 2014. Two cohorts of patients were then identified based on the presence of a history of breast cancer or no history of breast cancer. Once the cohort of patients with a history of breast cancer was created, an age and demographics matched cohort was selected at random from the total number of patients without a history of cancer to match at a 1:1 ratio to patients with a history of breast cancer.

Ninety-day outcomes were tracked and analyzed, as this is the time period used in the comprehensive Care for Joint Replacement program, which is the most commonly used bundled payment program used by Medicare [3,13]. This methodology has been used before

extensively to track outcomes within the 90-day interval. Patients with incomplete data were excluded from analysis.

Cost, as depicted by Medicare reimbursements, was tracked and analyzed for the day of surgery and entire 90-day global period. These cost data represent the amount of dollars spent for the entire care provided to patients. Length of stay was also analyzed.

Statistical analysis was conducted with odds ratios (OR) with 95% confidence interval [8], Student's t-tests, and chi-squared tests. Statistical significance was set at $P < .05$. All tests were performed with SPSS Version 20 (IBM, Armonk, NY).

Results

After inclusion and exclusion criteria were applied, there were a total of 46,618 patients in the breast cancer history cohort. There were 1,162,973 THAs performed on patients without a history of breast cancer. After randomized 1:1 matching, each cohort comprised 43,902 patients. Table 2 presents the demographics of the patient cohorts. As expected, women comprised over 98% of the patient population.

Length of stay was similar in both cohorts ($P = .432$) with a mean of 3.50 days (standard deviation [SD] 0.33) for those with a history of breast cancer vs 3.64 days (SD 0.40) in those without a history of breast cancer.

Medical Outcomes

Ninety-day post-operative complication rates were similar between cohorts except for pulmonary embolism (PE) rates (0.59% in those with a history of cancer vs. 0.45% in those without; OR 1.323, 95% CI 1.09–1.59, $P = .003$). There was also an increased use of chest computed tomography (CT) imaging in the cancer history cohort (1.72% vs 1.18%, $P < .001$) and extremity ultrasound, but this was not statistically significant (OR 1.32, 95% CI 0.96–1.80, $P = .082$). Table 3 demonstrates the 90-day medical complication rates of the 2 cohorts.

Surgical Outcomes

The rates of surgical complications were similar in both cohorts as evidenced by 90-day osteomyelitis, mechanical complications, dislocation, prosthetic joint infection, prosthetic joint fracture, and peri-prosthetic joint fractures ($P > .05$ for all). Table 4 demonstrates the rates of these complications and the statistical comparisons of both groups of patients.

Reimbursement Comparison

Mean day of surgery reimbursement analysis demonstrated that there was no difference in costs between both cohorts: mean reimbursement was $13,532 (SD $1986) for those with a history of breast cancer and mean reimbursement was $12,801 (SD$1492) for patients without breast cancer.

Contrary to the day of surgery reimbursements, global period reimbursements were significantly higher for patients with a history of breast cancer at a mean of $15,432 (SD

$633) compared to those without $14,701 (SD $516) ($P = .011$). Table 5 demonstrates day of surgery and 90-day global reimbursement analysis.

Discussion

The purpose of this study is to evaluate the 90-day outcomes of THA in patients with a history of breast cancer vs those without such history at a population level. All Medicare patient records from 2005 to 2014 were analyzed, providing a representative sample to study.

Limited literature is available in regards to the effects of active or a history of breast cancer on joint reconstruction. Furthermore, the increased survival rates of cancer patients suggest that more cancer survivors will require joint arthroplasty, highlighting the importance of conducting research in this topic [14].

Karam et al studied the effects of active malignancy or a history of various cancers on the outcomes after hip and knee reconstruction. Although their series included 2211 patients, the authors did not examine each type of cancer separately, limiting the interpretation of their findings, and encouraging our group to pursue research in this topic. The authors found that a history of a malignancy increased the rates of deep vein thrombosis and ischemic heart disease within the 90 days after hip and knee arthroplasty, which is in line with our findings of increased incidence of PE rates in patients with a history of breast cancer (0.59% vs 0.45%). Cancer has been shown in multiple studies to increase thromboembolic events as it causes a pro-thrombotic environment within the endothelium of patients with the disease [15,16]. Furthermore, chemotherapy and surgical management of cancer have also been shown to increase the pro-coagulation cascade [17,18]. Various unknown factors remain to be elucidated as the duration of this pro-inflammatory state, if it is clinically significant in all patients, and how to diminish it. Our findings of increased use of chest CT demonstrate that many patients required this imaging modality, which may have been drivers of increased costs within the 90-day post-operative period. Furthermore, the increased rates of PE also cause a greater use of in-hospital services such as medicine consults, medications, laboratory, and imaging examinations [19,20]. The increased rate of PE further highlights what has been previously shown in the literature, that patients with a history of cancer should have increased thrombotic protection during the post-operative period.

Our analysis demonstrated that surgical complications such as infections were not increased in those with a history of breast cancer. Pulido et al [21] reported similar findings in their study of 7739 patients, where their model failed to identify a history of malignancy as a risk factor for prosthetic joint infection. Another large sample size study by Bozic et al [22] also failed to identify malignancy as a factor for increased prosthetic joint infection in the Medicare population. Both studies support our findings that there is no increased risk of prosthetic joint infection in patients with a history of breast cancer vs in those without (0.49% vs 0.51%, $P = .633$).

The literature currently lacks studies that examine the effects of cancer on costs following lower extremity arthroplasty. Certain risk factors have been identified that increase the risks

of a costlier hospitalization, such as obesity, discharge to an inpatient rehabilitation facility, congestive heart failure, hepatitis C, and cirrhosis [11,12]. These reported costs were similar to our reported costs with reimbursements nearing $13,000 for Medicare reimbursements after THA [23,24]. Nonetheless, our findings of increased 90-day reimbursements may help further risk-stratify these patients so that they are not included in standard bundled payment plans as greater resource utilization appears to be present with the cohort of a positive history of cancer. Exclusion from a standard bundled payment program should be considered as has been done for hip fractures [25].

Limitations

Our study is not without limitations as it is of a retrospective nature and does not account for individual patient factors such as implant choice, surgical technique, radiation treatment, post-operative rehabilitation, and thromboprophylaxis protocol. Another limitation of this study is that we did not account for time from cancer remission to THA, which may or may not affect the outcomes after surgery. Nonetheless, large database studies have been proven to be effective at providing outcomes data, especially as they can help identify risk factors for diseases that are not commonly studied in relationship with arthroplasty [26]. Because of the lack of information in the literature regarding the effects of a history of malignancy on outcomes after THA, it is important that such studies be performed that allow for further hypothesis development that may be better tested with prospective studies.

Conclusion

In conclusion, our study demonstrated that a history of breast cancer increases the rates of PE, chest CT utilization, and 90-day reimbursements. Other surgical and medical complications were not significantly greater in this study of over 40,000 patients per cohort. Surgeons should pay careful attention to thromboprophylaxis in patients with a history of breast cancer.

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Table 1

Codes Utilized for the Query.

Code Description	ICD 9th Revision Code
Total hip arthroplasty	81.51
Osteoarthritis	715.00–715.99
Pulmonary embolism	415.1
Acute post-operative anemia	285.1
Acute myocardial infarction	410
Deep venous thrombosis	453.4
Pneumonia	480–486
Pulmonary insufficiency	518.5
Post-operative bleeding	998.11, 998.12
Cardiac complication	997.1
Peripheral vascular complication	997.2
Urinary complication	997.5
Osteomyelitis	730
Mechanical complication of orthopedic device	996.4
Unspecified mechanical complication of internal orthopedic device	996.40
Mechanical loosening of prosthetic joint	996.41
Dislocation of prosthetic joint	996.42
Broken prosthetic joint implant	996.43
Peri-prosthetic fracture around prosthetic joint	996.44
Other mechanical complication of prosthetic joint implant	996.47
Other mechanical complication of other internal orthopedic device implant and graft	996.49
Infection of orthopedic device	996.66
Other complications due to other internal prosthetic device	996.79
Intubation	Procedure code: 96.xx
Transfusion of blood	Procedure code: 99.x
Diagnostic ultrasound of peripheral vascular system	Procedure code: 8877
Chest computed tomography	CPT codes: 71250, 71260, 71270, 71275

CPT, Current Procedural Terminology; ICD-9, International Classification of Disease 9th revision.

Table 2

Demographic Characteristics of the Matched Cohorts.

	Percent of Cohort
Age	
64 and under	3.7%
65–69	20.9%
70–74	22.3%
75–79	23.0%
80–84	18.0%
85 and over	11.2%
Unknown	0.9%
Gender	
Female	98.38%
Male	0.69%
Unknown	0.93%
Total sample size	43,902

Table 3

Ninety-Day Medical Complication Rates and Statistical Analysis.

Medical Complications	History of Breast Cancer	No History of Breast Cancer	Odds Ratio	95% Confidence Interval	*P* Value
Pulmonary embolism	0.59%	0.45%	1.323	1.09–1.59	.003
Acute post-operative anemia	3.59%	3.54%	1.015	0.945–1.09	.16
Acute myocardial infarction	0.16%	0.19%	0.845	0.61–1.15	.296
Deep venous thrombosis	1.23%	1.24%	0.987	0.876–1.113	.831
Pneumonia	0.74%	0.80%	0.917	0.788–1.067	.263
Pulmonary insufficiency	0.04%	0.03%	1.2	0.60–2.381	.601
Post-operative bleeding	0.67%	0.70%	0.951	0.810–1.117	.539
Cardiac complication	0.06%	0.09%	0.737	0.452–1.200	.218
Peripheral vascular complication	0.06%	0.07%	0.781	0.463–1.318	.354
Urinary complication	0.04%	0.04%	1.118	0.581–2.151	.739
Intubation	0.20%	0.19%	1.024	0.759–1.381	.879
Transfusion of blood	2.00%	2.02%	0.986	0.897–1.084	.773
Peripheral vascular ultrasound	0.21%	0.16%	1.32	0.965–1.805	.082
Chest computed tomography	1.72%	1.18%	1.46	1.305–1.634	<.001

Table 4

Ninety-Day Surgical Complications.

Surgical Complications	History of Breast Cancer	No History of Breast Cancer	Odds Ratio	95% Confidence Interval	*P* Value
Osteomyelitis non-specific site	0.04%	0.03%	1.584	0.769–3.263	.209
Mechanical complication of orthopedic device	1.61%	1.62%	0.993	0.894–1.103	.894
Unspecified mechanical complication of internal orthopedic device	0.07%	0.06%	1.036	0.616–1.741	.895
Mechanical loosening of prosthetic joint	0.13%	0.11%	1.146	0.778–1.688	.49
Dislocation of prosthetic joint	0.83%	0.81%	1.028	0.888–1.191	.709
Broken prosthetic joint implant	0.03%	0.05%	0.522	0.260–1.048	.063
Peri-prosthetic fracture around prosthetic joint	0.38%	0.35%	1.105	0.888–1.376	.372
Other mechanical complication of prosthetic joint implant	0.10%	0.13%	0.818	0.552–1.213	.317
Other mechanical complication of other internal orthopedic device	0.07%	0.08%	0.941	0.581–1.525	.805
Infection of orthopedic device	0.49%	0.51%	0.956	0.793–1.152	.633

Table 5

Cost Comparison.

	History of Breast Cancer	No History of Breast Cancer	*P* Value
Day of surgery reimbursements			
Mean	$13,532	$12,802	.367
Standard deviation	$1968	$1492	
Ninety-day reimbursements			
Mean	$15,432	$14,701	.011
Standard deviation	$634	$517	