Robotic Arm–Assisted Knee Surgery: An Economic Analysis

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ABSTRACT

OBJECTIVES: Previous studies on Medicare populations have shown improved outcomes and decreased 90-day episode-of-care costs with robotic arm–assisted total knee arthroplasty (RATKA). The purpose of this study was to evaluate expenditures and utilization following RATKA in the population younger than 65 years.

STUDY DESIGN: This is a retrospective longitudinal analysis of a commercial claims data set.

METHODS: TKA procedures were identified using the OptumInsight Inc database. The procedures were stratified in 2 groups: the RATKA and manual TKA (MTKA) cohorts. Propensity score matching was performed at 1:5. Utilization and associated costs were analyzed for 90 days following the index procedure. A total of 357 RATKA and 1785 MTKA procedures were included in this analysis.

RESULTS: Within 90 days post surgery, patients who had RATKA were less likely to utilize inpatient services (2.24% vs 4.37%; $P = .0444$) and skilled nursing facilities (1.68% vs 6.05%; $P < .0001$). No patients in the RATKA group went to inpatient rehabilitation, whereas 0.90% of the MTKA arm went to an inpatient rehabilitation facility. Patients who utilized home health aides in the RATKA arm utilized significantly fewer home health days (5.33 vs 6.36 days; $P = .0037$). Costs associated with overall postsurgery expenditures were $1332 less in the RATKA arm ($6857 vs $8189; $P = .0018$). The 90-day global expenditures (index plus post surgery) were $4049 less in the RATKA arm ($28,204 vs $32,253; $P < .0001$). Length of stay after surgery was nearly a day less for the RATKA arm (1.80 vs 2.72 days; $P < .0001$).

CONCLUSIONS: RATKA was associated with shorter length of stay, reduced utilization of services, and reduced 90-day payer costs compared with MTKA.

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Recently, there has been a steady increase in the number of total knee arthroplasty (TKA) procedures worldwide. In the United States, nearly 700,000 TKAs were performed in 2014, with that number expected to exceed 1.25 million annually by 2030.[1] The cost of these surgeries exceeded $25 billion for Blue Cross Blue Shield members in 2017 alone.[2] TKA is considered the gold standard treatment for severe end-stage knee osteoarthritis.[3] Arthroplasty surgeries have been shown to significantly improve the quality of life and restore the independence and mobility of severely affected individuals.[4,5] Additionally, these procedures have been shown to be extremely cost-effective.[4,5] The cost of a quality well-year produced by an uncomplicated TKA is around $5000.[4] This makes this procedure among the "least expensive" interventions in the surgical field. In spite of this surgery being sought by patients and its cost-utility ratio making it among the most cost-effective interventions, it is still one of the highest expenditures under the Medicare diagnosis-related group (DRG) payment system.[6,7] The cost of these procedures is expected to rise dramatically over time; several strategies are being planned to reduce the cost of these procedures. These include improvement in surgical techniques and reductions in the length of stay (LOS), the rehabilitation process, the infection rate, and the readmission rate and revision procedures.

Although many factors are related to the increase in TKA procedures in the United States, the expansion of indications to include younger, more active patients has underscored the importance of understanding the cost-benefit ratio in this population.[1,8-10] Several studies have reported that the growth rate in TKA utilization is increasing rapidly among patients younger than 65 years.[3,10] Approximately 0.5% to 1% of US adults have a TKA annually, with prevalence estimates varying due to payer type (private vs government). The volume of procedures performed is expected to increase substantially over the next few decades.[11,12] Current estimates also suggest that a substantial proportion of TKAs are performed among patients younger than 65 years.[11] Prior studies examining the economic impact of TKA focused almost exclusively on patient populations 65 years and older,[5,13-16] and the limited data on patients younger than 65 years have generally reported mixed

TAKEAWAY POINTS

A commercial claims data analysis comparing robotic arm–assisted total knee arthroplasty (RATKA) with manual total knee arthroplasty (MTKA) found improved outcomes among younger patients who underwent RATKA.

- Among patients who received RATKA, 2.24% utilized inpatient services within 3 months compared with 4.37% of patients who received MTKA procedures.
- Among patients who received RATKA, 1.68% had visits to skilled nursing facilities compared with 6.05% of patients who received MTKA.
- Average total spending for utilization of these postindex services was significantly lower among patients who underwent RATKA procedures ($6857 vs $8189; $P = .0037$).
- Patients who underwent RATKA had significantly lower 90-day total costs (index plus post surgery) ($28,204 vs $32,253; $P < .0001$) and a shorter index length of stay (1.80 vs 2.72 days; $P < .0001$) than patients who underwent MTKA.

results.[17] Reported cost estimates for TKA procedures range from $12,380 for government-covered insurance to $16,094 for private or commercial payers.[18] The number of TKAs is expected to exceed 1 million annually by 2030,[9] and approximately half will be performed in patients younger than 65 years.[10] It is important to understand the health and economic outcomes associated with these procedures in the younger patient population.

New technologies have the potential to reduce costs and improve outcomes. Although robotics has been used in the manufacturing arena for more than 50 years, it was not until the early 2000s that robotics was widely used in specialty surgery.[19,20] Robotic surgery has been performed in the United States since the 1980s. In 2012, more than 85% of prostate procedures were performed with robotic assistance.[21,22] The economic impact of robotic prostatectomies remains controversial, with some studies showing significant savings.[21,23,24]

An objective of this analysis is to examine whether differences in outcomes exist between robotic arm–assisted TKA (RATKA) and manual TKA (MTKA). For an MTKA, a surgeon uses x-rays of the joint to visually identify the desired location and size of the implants and positioning/alignment of the implants. After the incision is made, the patella (kneecap) is rotated to the side of the knee, and retractors are placed in the knee to allow exposure for the surgery. During the surgery, mechanical instruments such as rods are placed inside or outside the bones, and blocks are used to measure and assess the angle and resection depth of the bone cuts. The bone cuts are done with a handheld powered saw, which is typically guided by a cutting block that has been pinned to the bone. This technique requires the surgeon to be able to visualize the edges of the bone while making the cuts to avoid inadvertently cutting into the soft tissues outside the bone. The surgeon then uses trial implants to assess the cuts and make any alterations necessary before the final implants are placed and the wound is closed. The patella is also typically resurfaced.

In RATKA, CT scan images are used instead of x-rays. The CT image is uploaded to the robotic software system to construct a 3-dimensional (3D) model of the joint and establish a plan for the surgery. At the start of the procedure, optical tracking markers are placed in the bone. These markers, together with the 3D model, inform the robotic arm where the bony anatomy of the knee and the robotic arm are in space. The powered saw is attached to the robotic arm, and during bone cutting, the surgeon controls the robotic arm, which guides bone cuts within a haptic boundary defined by the 3D model. This is designed to help protect ligaments and prevent damage to soft tissues during bone cutting. The 3D model and optical trackers also provide real-time visualization and feedback to the surgeon to position the implant in the precise location necessary to ensure the desired leg alignment and balance soft tissue. This reduces the amount of exposure because direct visualization is no longer needed. Trialing and final implant placement are the same as with manual surgery.

Length of robotic arm–assisted surgery has been shown to increase slightly during the learning curve of the surgeon and staff, but surgeons have been shown to be back to manual operative times in as few as 7 cases, as Kayani and colleagues found in their study.[25] They also found that even in the learning phase, RATKA was associated with improved accuracy of implant positioning and limb alignment to plan, with no additional risk of complications compared with conventional MTKA.[25]

In knee arthroplasty, the additional cost of robotic technology has the potential to decrease the cost per case. Cool et al published findings on the effect of using robotic-assisted technology on Medicare fee-for-service populations.[26] They reported decreased costs for a 90-day episode of care (EOC) with RATKA. In that study, RATKA was associated with decreases in LOS, the need for rehabilitation after surgery, and the readmission rate. A limitation of these findings is that the study sample was composed of Medicare patients; consequently, it is unclear if similar patterns exist in commercially insured patient populations receiving the same procedures. Given the cost pressures that commercial payers are likely to face with a substantially larger pool of eligible patients seeking TKA, it is imperative to examine economic outcomes in this patient population. Thus, the objective of this study is to evaluate the cost of a 90-day EOC with RATKA in the population younger than 65 years. A secondary objective is to investigate individual factors affecting cost.

METHODS

Study Design and Data Sources

A retrospective, longitudinal claims analysis was conducted to evaluate 90-day EOC costs for patients undergoing a TKA. This study analyzed 90-day EOC costs for patients who underwent RATKA and MTKA procedures and were aged 18 to 64 years. Data utilized in this analysis were obtained from the OptumInsight Inc database, which is composed of medical claims representing roughly 25 million patients from a large, private, US-based health plan.

Medical claims were identified for health plan members who underwent an MTKA or a RATKA between January 1, 2016, and

December 31, 2017. Expenditures and utilization associated with visits that occurred during the 90-day postindex period in the categories of inpatient (including inpatient rehabilitation), outpatient, emergency department (ED), physician, pharmacy, skilled nursing facility (SNF), home health, and outpatient rehabilitation were collected and analyzed. Expenditures were also collected for the primary inpatient TKA procedure (referred to as the index procedure) and compared. Costs were defined as the total payments (allowed amounts) made to providers for services rendered during admission for the primary TKA or during the 90-day postindex period (including any patient liability such as co-pays). The primary outcome of interest was 90-day EOC costs; other outcomes of interest included index facility costs, LOS, discharge destination, and 90-day readmission rates.

Study Population

Commercial health plan members (aged 18-64 years) who received a TKA procedure in an inpatient setting during the study period were eligible for inclusion. Primary TKA procedures were identified by *International Classification of Diseases, Tenth Revision* coding and the assignment of DRG 469 or 470 (**eAppendix** [available at **ajmc.com**]). Eligible patients had continuous health plan enrollment during the 60 days prior to index and for the 90 days following the index procedure. Additional exclusion criteria applied to members who (1) had a bilateral procedure within 90 days of the index procedure, identified by DRG assignment of 469 or 470; (2) experienced in-hospital all-cause mortality in the 90-day postindex period; and (3) had coordination of benefits payment for their index procedure.

The TKA claims were divided into 2 cohorts: RATKA and MTKA. RATKA cases were required to have received (1) a preoperative CT scan within 60 days of the RATKA procedure and (2) a robotic arm–assisted procedure at index (eAppendix). The MTKA cohort was identified by the absence of both a CT scan and robotic assistance.

Following the identification of the 2 study cohorts, outlier index costs were identified and removed based on the gamma distributed extreme value method,[27-29] using a cutoff value of Zk = 0.01. After the removal of index cost outliers (which represented < 1% of cases), 1:5 propensity score matching (PSM) between the RATKA and MTKA cohorts was conducted to minimize the difference in baseline characteristics between the 2 cohorts. PSM was performed using the nearest neighbor method and included the following covariates: (1) demographics (sex, age, and high-cost comorbidities [chronic obstructive pulmonary disease, coronary artery disease, diabetes, hypertension, obesity, and smoking]), (2) geographic and demographic variations (relying on Census Bureau divisions and on the ratio of non-Caucasian population to total population per zip code), and (3) academic status of hospitals at which the index procedures were performed. After PSM, a total of 2142 patients were selected for inclusion in the analysis: 357 RATKA and 1785 MTKA.

Ninety-Day EOC

The primary outcome of interest was 90-day EOC costs, which include the admission cost of the index procedure and any costs incurred by the health plan in the following places of service: inpatient (including inpatient rehabilitation), outpatient, ED, physician, pharmacy, SNF, or home health. Secondary outcomes included index facility costs, LOS (inpatient and SNF settings), discharge destinations, and readmissions. The rate of readmission and inpatient costs were evaluated for patients who experienced an inpatient stay during the 90-day postindex period.

Statistical Analysis

A generalized linear model was used to compare cohort differences in EOC costs. A 2-part model was created to test the likelihood of having utilization and the likelihood of costs in the postoperative health care setting. The first part of the model utilized a binomial regression, testing the probability of utilization in the 90-day postindex period. The second part of the model utilized a gamma distribution and log link function, analyzing cohort cost differences among those with costs. Additionally, a negative binomial regression was used to test differences in utilization rates among those with utilization when a variable's variance exceeded the mean; otherwise, a Poisson regression was utilized. Pearson's χ^2 and Fisher's exact tests were used to test differences among dichotomous and categorical variables. For analyzing cohort differences within continuous variables, the Mann-Whitney U test was utilized. All statistical analyses were performed using SAS Enterprise Guide 7.1 software (SAS Institute Inc).

RESULTS

Table 1 presents the member demographics of each cohort. The 2 cohorts did not differ statistically in terms of demographic characteristics, such as age, gender, minority population (used as a proxy for race), geography, or high-cost comorbidities.

Utilization and Cost Findings

Within the 90 days following the index stay, patients who underwent RATKA were less likely than patients who underwent MTKA to utilize inpatient (2.24% vs 4.37%, respectively; $P = .0444$) and SNF (1.68% vs 6.05%; $P < .0001$) services. However, patients who underwent RATKA were more likely to utilize physician services (99.72% vs 98.54%; $P = .0373$). We found no significant differences in the percentage of patients who utilized outpatient (46.22% vs 47.56%; $P = .6510$), ED (8.96% vs 8.96%; $P = .9584$), home health (66.95% vs 69.19%; $P = .3088$), outpatient rehabilitation (91.88% vs 90.20%; $P = .3149$), and pharmacy (50.98% vs 55.80%; $P = .1021$) services. The overall LOS was significantly lower for those in the RATKA arm (1.80 vs 2.72 days; $P < .0001$) (**Table 2**).

When reviewing the overall utilization, patients who utilized home health in the RATKA arm utilized significantly fewer days of home health than those in the MTKA arm (5.33 vs 6.36 days; $P = .0037$). Additionally, although inpatient admissions and the associated costs were lower in the RATKA arm, these findings were not significant (admissions: 2.24% vs 3.87%; $P = .1323$; costs: $13,328 vs $24,874; $P = .4223$).

TABLE 1. Demographic and Comorbidity Profile for Matched Study Cohorts

Characteristics	RATKA (n = 357)	MTKA (n = 1785)	Difference (% points)	*P*
Age in years				
35-44	1.96%	1.57%	0.39%	.5937
45-54	21.29%	20.34%	0.95%	.6840
55-64	76.75%	78.10%	−1.35%	.5764
Sex				
Male	49.58%	51.65%	−2.07%	.4744
Race				
High (≥ 60% nonwhite)	3.36%	2.58%	0.78%	.4046
Low (< 15% nonwhite)	52.38%	53.00%	−0.62%	.8314
Medium	44.26%	44.43%	−0.17%	.9535
Division				
East North Central	5.04%	5.04%	0.00%	>.9999
East South Central	4.20%	3.75%	0.45%	.6870
Mid-Atlantic	21.85%	20.95%	0.90%	.7048
Mountain	8.12%	8.57%	−0.45%	.7816
New England	19.61%	20.11%	−0.50%	.8280
Pacific	4.48%	5.15%	−0.67%	.5962
South Atlantic	10.64%	10.48%	0.16%	.9247
West North Central	2.24%	2.24%	0.00%	>.9999
West South Central	23.81%	23.70%	0.11%	.9638
High-cost comorbidities				
Chronic obstructive pulmonary disease	1.40%	0.73%	0.67%	.2040
Diabetes	9.52%	9.02%	0.50%	.7624
Coronary artery disease	7.00%	4.99%	2.01%	.1212
Smoking	5.88%	5.32%	0.56%	.6694
Obesity	26.05%	27.00%	−0.95%	.7109
Hypertension	46.78%	47.23%	−0.45%	.8769

MTKA, manual total knee arthroplasty; RATKA, robotic arm–assisted total knee arthroplasty.

TABLE 2. Index LOS, Index Facility Costs, and Total EOC Costs[a]

	RATKA	MTKA	Difference	*P*
LOS				
Average LOS in days	1.80	2.72	−0.92	<.0001[b]
Costs				
Index facility costs	$21,347	$24,069	−$2722	.0001[b]
Total EOC costs (index + 90-day postindex)	$28,204	$32,253	−$4049	<.0001[b]

EOC, episode of care; LOS, length of stay; MTKA, manual total knee arthroplasty; RATKA, robotic arm–assisted total knee arthroplasty.

[a]Nonparametric test used due to nonnormality.

[b]Indicates statistically significant *P* values < .05.

TABLE 3. Average Post 90-Day Pay Amounts for Those Utilizing Services[a]

	RATKA	MTKA	Difference	*P*[b]
Inpatient	$13,328	$24,289	−$10,961	.5444
Outpatient	$1818	$2148	−$330	.6113
ED	$7033	$4179	$2854	.0104[c]
SNF	$6269	$7849	−$1580	.3341
Home health	$2009	$2038	−$29	.7522
Outpatient rehabilitation costs	$2272	$2494	−$222	.0194[c]
Physician costs	$1253	$1139	$115	.2170
Pharmacy costs	$588	$843	−$254	.0057[c]
Postindex costs	$6857	$8189	−$1332	.0018[c]

ED, emergency department; MTKA, manual total knee arthroplasty; RATKA, robotic arm–assisted total knee arthroplasty; SNF, skilled nursing facility.

[a]This table includes data only for those who had utilization in the listed service categories.

[b]Nonparametric test was used due to nonnormality.

[c]Indicates statistically significant *P* values < .05.

Cost associated with the utilization of services was substantially lower in the RATKA arm, with the overall postindex cost $1332 less per case in the RATKA arm ($6857 vs $8189; *P* = .0018) (**Table 3**). Cost was also significantly less in the RATKA arm for outpatient rehabilitation ($2272 vs $2494; *P* = .0194) and pharmacy ($588 vs $843; *P* = .0057) among those who used them. The 90-day EOC cost was $4049 less per case in the RATKA arm ($28,204 vs $32,253; *P* < .0001), with an index savings of $2722 contributing to this finding ($21,347 vs $24,069; *P* = .0002) (Table 2).

DISCUSSION

Economic outcomes for TKA in patients younger than 65 years are receiving increasing attention, given the impact that this group will have on overall health expenditures over time. As more advanced surgical techniques emerge, the tolerance of payers to reimburse these procedures may be challenged. Although several studies report favorable outcomes among older populations for RATKA vs MTKA,[26,30] limited data exist directly comparing outcomes in younger patient populations. To our knowledge, this is the first study that directly compares outcomes of RATKA and MTKA in patients younger than 65 years. Results of our study demonstrated favorable outcomes for utilization of inpatient services, SNF, inpatient rehabilitation, home health services, costs associated with the utilization of those services, and LOS for the RATKA group relative to the MTKA group 90 days following surgery.

Cool et al demonstrated that RATKA had lower costs for the 90-day EOC in the Medicare fee-for-service population.[26] They showed a significant decrease in the index LOS and 90-day EOC costs and readmission rates in their cohort. In the current study, we utilized a commercial payer database to study the utilization and economic trends of a younger commercially insured population during a 90-day EOC that was subject to payment models other than fixed DRG rates.

In our study group, much like in the Medicare fee-for-service data set reported by Cool et al, the patients who were treated with robotic-assisted technology stayed in the hospital after the surgery nearly 1 day less (1.80 vs 2.72 days; $P < .0001$) than the manual group. This early discharge may result from a combination of factors. Kayani et al reported reduced time to hospital discharge, less pain, and fewer physical therapy sessions in a RATKA cohort compared with an MTKA group.[31,32] Several additional publications reported greater soft tissue protection using robotic arm assistance relative to MTKA.[33,34] In addition, factors such as more accurate balancing of the knee[35] or expectations of faster recovery based on patients' perception of the technology's benefit could influence the early discharge seen in the RATKA cohort. Regardless of the specific reason for earlier discharge, it is beneficial for payers, hospitals, and patients. Studies evaluating early hospital discharge after total joint arthroplasty have not shown an increase in readmissions.[31,32,36,37]

Our data showed that the RATKA cohort was less likely to go to an SNF than the MTKA cohort (1.68% vs 6.05%; $P < .0001$). When reviewing the overall utilization of services post discharge, patients who utilized home health in the RATKA cohort utilized significantly fewer days (5.33 vs 6.36 days; $P = .0037$). Cost was also significantly less for outpatient rehabilitation ($2272 vs $2494; $P = .0194$) and pharmacy ($588 vs $843; $P = .0057$) among RATKA patients who utilized them. Kayani et al also showed reduced analgesia usage in addition to reduced pain, LOS, and physical therapy.[31,32] They discussed how the haptic boundaries established by the robotic arm prevent saw blade (used for bone preparation during TKA) action outside the stereotactic window. This also enables the surgeon to modify bone resections, which can result in changes to soft-tissue releases, and implant alignment, therefore reducing the physical damage during the procedure.[32-35]

The average costs per case for the 90-day EOC in this study were also significantly lower in the RATKA cohort by more than $4049 per event ($32,253 vs $28,204; $P < .0001$). The costs for the index procedure were more than $2722 lower in the robotic group compared with the manual group ($21,346 vs $24,069; $P < .0002$) (Table 2). The savings observed were largely attributable to a decrease in LOS and lower utilization of SNF and rehabilitation services after discharge.

Robotic devices have been utilized in orthopedic surgery for more than 20 years.[19,20] With the recent advent of bundled payments and value-based reimbursement, the cost of such technology has received significant attention. This data set included a different cohort of patients (younger and likely healthier) and many different payment and contracting arrangements for the individual cases. The payer liability for procedures in the commercial arena can be governed by models that are quite different from those used by Medicare, including per diems with device carve-outs and even percentage-of-charges arrangements. Although the favorable postindex and readmission trends found by Cool et al accrue to the benefit of CMS as a payer, findings such as LOS reduction during the index stay may also benefit providers and patients. It may be of note that CMS benefits from LOS reduction only if the LOS reaches a short-stay threshold that generates a lower payment. In the commercial payer environment, reimbursement is commensurate with efficiency. Payment is less for less resource consumption, even in DRG-like payment structures.

The robotic-assisted technology in this analysis required a preoperative CT scan. Although this may raise concerns about additional cost, analyses similar to the current study have found that the added cost of the CT scan is outweighed by the decreases seen in postacute utilization of services and their associated costs.[26,30] The use of advanced imaging techniques prior to robotic-assisted hip and knee arthroplasty may allow for enhanced surgical planning. For the last 30 years, most surgical planning has been done using either acrylic templates or digital 2D images. A 3D analysis based on a CT scan provides the surgeon with information about the patient's anatomy, both preoperatively and intraoperatively, that was not previously available. Studies have also shown more accurate sizing prediction with CT-based planning. This may also allow the potential for sites to reduce inventory and decrease the number of trays used in surgery, potentially inducing a more efficient and economical process.[38,39]

Our cost analysis did not evaluate capital expenditures, maintenance cost of robotic technology, or potential benefits to the hospital. Our objective was to analyze the economic impact of the use of the robotic system to the payer of the procedure. Several papers have examined the cost-effectiveness of robotic procedures in urology.[20,21,40,41] The results published in that field have been mixed. For a center to start doing robotic surgery, there are 3 basic costs: acquisition of the technology, maintenance, and per-case cost. The revenue increase for the system observed in some of these studies included reduced inventory; faster setup per case; shorter surgical time; reduced LOS; increased caseload; and, over the long term, improved outcomes and fewer complications.[38-41]

In the current environment and with the current coding system, the use of robotic assistance in total joint surgery is not reimbursed as a separate line item to the hospital or the surgeon. Per-case costs may, in some contractual arrangements, be passed on to the payer, but in other arrangements these costs are absorbed by the hospital. The majority of costs to purchase a robotic system are typically incurred by the hospital as a capital expense and are partially reimbursed on the Medicare capital expense at the end of the year. Regarding total joint surgeries, those in value-based payment structures may benefit from less intensive postoperative care and resulting savings.

Limitations

Our study has limitations, which have been delineated by Cool et al because they used similar methodology for their paper.[26] In addition, because this study uses claims from only 2016 and 2017, the long-term impact of RATKA was not examined. Future research can examine the effects of RATKA vs MTKA on patients and whether RATKA leads to better functional outcomes along with cost savings.

CONCLUSIONS

Recently, RATKA has received significant interest as a potentially cost-effective alternative to MTKA, as increased utilization has been observed among younger, more active patients, who may have a preference to return to normal activities of daily living as soon as possible.[4,13,18,27,31] Using propensity scoring analyses to control for potential confounding, the advantages of RATKA observed in this study included reductions in LOS and postacute resource utilization, including being less likely to utilize inpatient rehabilitation and SNF and using fewer home health days. We also observed considerable savings of $4049 to the commercial payer 90 days after surgery in the RATKA cohort. Our findings are in agreement with previously published literature on the use of robotic TKA. RATKA was associated with less resource consumption and lower 90-day EOC costs. These findings may be pertinent to both payers and providers. ■

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eAppendix. Coding Used to Identify RATKA and MTKA Procedures

Coding	**Description**
ICD-10: Total Knee Arthroplasty	
0SRD0J9	Replacement of Left Knee Joint with Synthetic Substitute, Cemented, Open Approach
0SRD0JA	Replacement of Left Knee Joint with Synthetic Substitute, Uncemented, Open Approach
0SRD0JZ	Replacement of Left Knee Joint with Synthetic Substitute, Open Approach
0SRC0J9	Replacement of Right Knee Joint with Synthetic Substitute, Cemented, Open Approach
0SRC0JA	Replacement of Right Knee Joint with Synthetic Substitute, Uncemented, Open Approach
0SRC0JZ	Replacement of Right Knee Joint with Synthetic Substitute, Open Approach
ICD-10: Robotic Arm-Assisted	
8E0Y0CZ	Robotic Assisted Procedure of Lower Extremity, Open Approach
DRG Group	
469	Major Joint Replacement or Reattachment of Lower Extremity With MCC
470	Major Joint Replacement or Reattachment of Lower Extremity Without MCC
CPT Codes: CT Scan	
73700	Computed Tomography, Lower Extremity; Without Contrast Material
73701	Computed Tomography, Lower Extremity; With Contrast Material(s)
73702	Computed Tomography, Lower Extremity; Without Contrast Material, Followed by Contrast Material(s) and Further Sections