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Is Post-discharge Rehabilitation Timing Associated with 90-Day Readmission in Primary Total Joint Arthroplasty?

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Abstract *Background:* Physical therapy (PT) is an accepted standard of care after total joint arthroplasty (TJA) and essential to maximizing joint functionality and minimizing complications that lead to readmission. However, evidence-based guidelines about appropriate post-discharge rehabilitative care are not well-defined in the orthopedic literature. *Purposes:* We sought to determine the average timing for receiving PT rehabilitation and to evaluate the association between PT rehabilitation timing and unplanned readmission within 90 days of a TJA patient being discharged home from acute care. *Methods:* This retrospective study examined 11,545 joint procedures using claims data for the years 2008 to 2013. Outcomes were assessed using a population-averaged approach to regression models. *Results:* The average time for initiating PT was 4 days for knee arthroplasty and 6 days for hip arthroplasty in patients discharged home from acute care. Most patients (89%) began PT consultation or supervised exercises during the first week after discharge. The type of joint surgery considerably modified the effect of rehabilitation timing on the likelihood of readmission. Later initiation of rehabilitation was associated with a higher probability of 90-day readmission in both knee and hip arthroplasty, with the effect of rehabilitation timing being more pronounced in hip rather than knee arthroplasty 2 weeks post-discharge from acute care. *Conclusions:* Timing for initiating PT may be an important modifiable factor that can affect readmission in patients discharged home from acute care after TJA. Further exploration of the role of PT timing along with other factors such as dosage and frequency among such patients is needed.

Keywords total joint arthroplasty · physical therapy · readmission

Level of Evidence: Level II, retrospective study.

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Introduction

There is an increasing demand for total hip arthroplasty (THA) and total knee arthroplasty (TKA) as a treatment for the chronic pain and activity limitations associated with arthritis [5, 11, 13, 19]. The incidence of total joint

arthroplasty (TJA) has increased not only in older (65 years and over) but also in younger (under 65 years) populations, and this trend is projected to continue over the next decade [11, 12]. However, studies examining TJA in younger populations are relatively uncommon.

Against the backdrop of increasing demand and costs for TJA, insurance providers and employers are participating in value-based payment strategies, including episode-of-care payments [6, 7, 31] in an effort to coordinate services, reduce costs, and improve value in TJA care delivery. The Centers for Medicare and Medicaid Services (CMS) has implemented a bundled payment model for TJA, under which Medicare provides a fixed payment to participant hospitals for aggregated services related to a TJA episode that begins with hospital admission and ends 90 days after discharge [3]. With increasing pressures for cost containment and quality improvement, hospitals will assume a larger burden of financial risk in episode-based payments and will confront increased accountability as payments become progressively tied to high-cost resource use outcomes such as 90-day readmission [2, 8]. The average marginal payment for readmission in 90-day episodes can range from $10,000 to $27,000 (USD) in Medicare and commercially insured populations [20, 23]. Therefore, health delivery systems have come under greater scrutiny for identifying patients at higher risk and devising care delivery approaches to improve outcomes and resource utilization.

Increase in TJA demand has led to an increase in the prevalence and total Medicare spending on post-discharge rehabilitative physical therapy (PT) [21]. PT for TKA and THA patients is an accepted standard of rehabilitative care and essential to maximizing joint function and minimizing complications that lead to readmission [9]. Exercises led by a physical therapist, whether administered individually or in groups, have demonstrated improvements in functional outcomes related to mobility in both TKA and THA [4, 15, 17, 18, 24, 26, 29].

Evidence-based clinical practice guidelines about appropriate post-discharge rehabilitative care are not defined well in North America [26, 30]. A recent study found that PT rehabilitation interventions provided by trained professionals soon after discharge were a common recommendation by experts in the USA and Canada for optimizing patient outcomes in both THA and TKA; however, there was differing consensus on the optimal timing to start post-discharge PT [30]. Since PT rehabilitation timing is an important aspect of developing best practice guidelines for post-discharge PT in TJA, we aimed to perform a population health study to better understand the role of rehabilitation timing in joint replacement patients, especially in a younger, non-Medicare population with a routine or home-health discharge after surgery. The goal was (1) to determine the average timing for receiving PT rehabilitation after discharge and (2) to evaluate the association between PT rehabilitation timing and unplanned readmission with 90 days of discharge home from the acute care setting after TJA.

Methods

This is a population-based retrospective study that used enrollment and claims data from Blue Cross and Blue Shield of Texas (BCBSTX). Our analysis cohort consisted of all members younger than 65 years of age enrolled for a minimum of 9 months in all managed care plans (except HMO) who underwent an elective, primary TJA between July 1, 2008, and October 1, 2013. We received approval from our institutional review board for performing this study. We relied heavily on Medicare guidelines to develop our inclusion and exclusion criteria (Fig. 1), since Medicare was the first payer to introduce episode-of-care-based alternative payment models. The 90-day episode of care refers to the index stay and a 90-day post discharge follow-up period. As per Medicare guidelines [3], only episodes with diagnosis-related group (DRG) codes for major joint replacement or reattachment of lower extremity (469 or 470) were included. Similarly, only unplanned readmissions to an inpatient, acute care facility in the 90-day follow-up period were included in our cohort (we excluded staged bilateral procedures).

After applying our inclusion and exclusion criteria (Fig. 1), our study cohort consisted of 11,545 TJA procedures. To prevent confounding, we excluded any TJA procedure occurring within 90 days of an index TJA admission. However, about 4.5% of patients ($n = 526$) had two primary TJA procedures (e.g., a knee and a hip replacement) within the 6-year study period. Such patients with two TJA episodes were included in our study to avoid sampling bias. Additionally, our sample had less than 2% of those with a DRG of 469 (major joint replacement or reattachment of the lower extremity with major complication or comorbidity). Only a small percentage (1%) of our sample constituted patients with an initial discharge to facilities such as inpatient rehabilitation, skilled nursing facility, or hospice. Therefore, we included only patients with a routine or home-health discharge. Generally, routine discharge involves a combination of self-care exercise regimens and clinic-based supervised rehabilitative care at an outpatient rehabilitation facility. Alternatively, home-health discharge involves home visits by trained professionals (e.g., physical therapists or occupational therapists) and self-care exercise regimens. We measured only PT services for which payments were made to qualified physical therapists or occupational therapists in the outpatient setting or at home by the insurance provider (Online Resource 1). To establish a uniform baseline for measuring PT rehabilitation timing, we evaluated index admission claims to ascertain that all episodes of care included PT evaluation and exercise led by trained professionals during the inpatient stay before discharge (more than 99% of our sample).

The primary outcome of interest for this study was any unplanned readmission to an inpatient, non-rehabilitation facility within 90-days of index discharge after a TKA or THA procedure. The primary explanatory variable of interest in our study was the week in which a trained professional initiated rehabilitation after a discharge home after TJA. We obtained this measure by calculating the days to the first PT

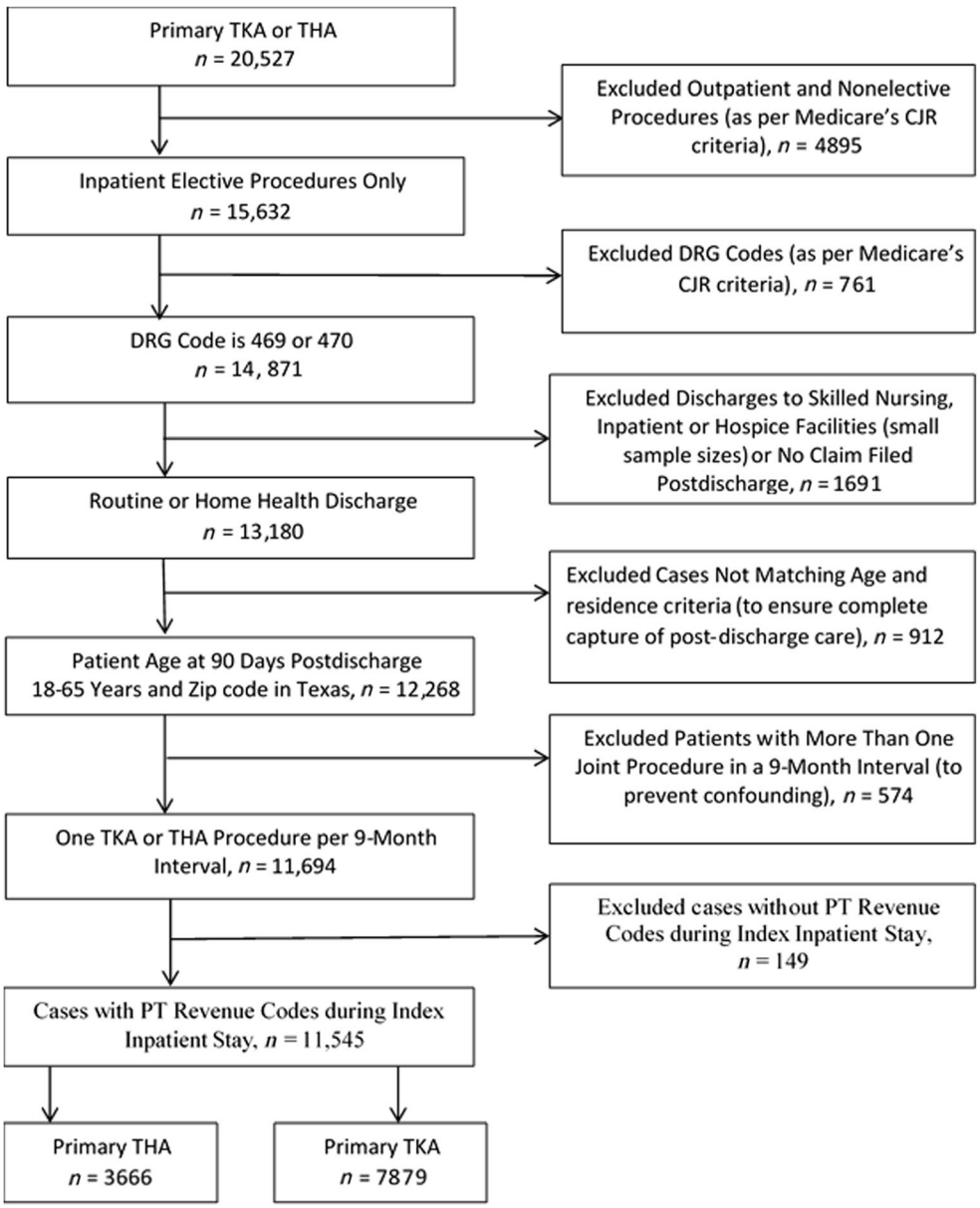

Fig. 1. Inclusion and exclusion criteria for 90-day episode of care. *CJR* comprehensive care for joint replacement model, *DRG* diagnosis related group, *THA* total hip arthroplasty, *TKA* total knee arthroplasty

evaluation or PT exercise after TJA discharge (whichever came first). We obtained incidence of rehabilitative care using Current Procedural Terminology (CPT) for PT evaluation, PT treatment, and PT exercises including home-based PT (Online Resource 1). We categorized the days to initiation of post-discharge PT rehabilitation into three categories (week 1 = less than 8 days; week 2 = 8 to 14 days; week 3+ = greater than 14 days) based on expert recommendations [30] for the optimal post-discharge timing for initiating supervised rehabilitative care.

Covariates used in the model were readmission risk factors identified in previous TJA studies [20, 22, 27, 28, 32] and included characteristics such as length of stay, age, sex, patient morbidity burden (low, moderate, and high), computer-assisted surgery, and type of discharge (routine vs. home health) (Table 1). We did not have any direct measures of patient socioeconomic status in our data. We developed residential zip code-based indicators of poverty and race as socioeconomic indicators [23], but these variables were not significant and were subsequently excluded from analysis. We used patient diagnosis codes over the 6-month admission period before the index TJA to calculate patient-morbidity burden (low to high) which is an indicator of resource use derived from the Johns Hopkins Adjusted Clinical Group® (ACG®) risk adjustment system [10]. Procedure codes used to identify joint surgery and use of computer-assisted surgery are available in Online Resource 1.

We summarized all variables using counts and percentages for categorical variables and means and standard

Table 1 Descriptive characteristics of total joint arthroplasty episodes

	All TJA ($n = 11,545$)	THA ($n = 3666$)	TKA ($n = 7879$)
	Mean (SD)	Mean (SD)	Mean (SD)
Age	56.5 (6.5)	54.9 (7.7)	57.2 (5.7)
Length of stay	2.9 (0.99)	2.8 (1.01)	3.0 (0.99)
Days to rehabilitation	4.6 (13.5)	6.3 (9.5)	4.1 (7.2)
Days to readmission	36.9 (29.5)	38.4 (28.9)	36.1(29.8)
	Count (%)	Count (%)	Count (%)
Sex			
Female	6387 (55.3)	1788 (48.8)	4599 (58.4)
Male	5158 (44.7)	1878 (51.2)	3280 (41.6)
Rehabilitation timing			
Week 1 (< 8 days)	10,234 (88.6)	3224 (88.0)	7010 (89.0)
Week 2 (8–14 days)	531 (4.6)	128 (3.5)	403 (5.1)
Week 3+ (> 14 days)	780 (6.8)	314 (8.5)	466 (5.9)
Discharge type			
Routine	5248 (45.5)	1713 (46.7)	3535 (45.0)
Home health	6297 (54.5)	1953 (53.3)	4344 (55.1)
Morbidity burden			
Low (2)	1610 (14.0)	455 (12.4)	1155 (14.7)
Moderate (3)	8148 (70.6)	2468 (67.3)	5680 (72.0)
High (4 or 5)	1787 (15.4)	743 (20.3)	1044 (13.3)
Computer-assisted surgery	761 (6.6)	122 (3.3)	639 (8.1)
Any 90-day readmission	688 (6.0)	224 (6.1)	464 (5.9)

TJA total joint arthroplasty, *THA* total hip arthroplasty, *TKA* total knee arthroplasty, *SD* standard deviation

deviation for continuous variables. We compared covariate distribution among the three PT rehabilitation initiation categories with one-way analysis of variance for continuous variables and χ^2 test of proportions for categorical variables. Our dataset included a small percentage of patients with repeated observations, so we used the population-averaged approach to general linear regression model called generalized estimating equations (GEE), with a binomial distribution and logit link to model the likelihood of readmissions in our data. We also adjusted for repeated observations in the sample by using cluster-adjusted, robust standard errors. We converted all β coefficients derived from the regression model to odds ratios (OR). We further examined whether the type of joint

Table 2 Covariate distribution of total joint arthroplasty procedures

	PT initiation less than 8 days $n = 10,234$	PT initiation 8–14 days $n = 531$	PT initiation greater than 14 days $n = 780$	
	Mean (SD)	Mean (SD)	Mean (SD)	p value[a]
Age	56.5 (6.4)	56.6 (6.6)	56 (7.1)	0.104
Length of stay	2.95(1.0)	2.96 (1.1)	2.8 (1.0)	< 0.001[b]
	Count (%)	Count (%)	Count (%)	
Computer-assisted surgery				0.099
No	9549 (93.3)	508 (95.7)	727 (93.2)	
Yes	685 (6.7)	23 (4.3)	53 (6.8)	
Discharge type				< 0.001[b]
Routine	4282 (41.8)	401 (75.5)	565 (72.4)	
Home health	5952 (58.2)	130 (24.4)	215 (27.6)	
Morbidity burden				0.591
Low (2)	1436 (14.3)	68 (12.8)	106 (13.6)	
Moderate (3)	7230 (70.6)	379 (71.5)	539 (69.1)	
High/very high (4 or 5)	1568 (15.1)	84 (15.8)	135 (17.3)	
Sex				0.120
Female	5669 (55.4)	273 (51.4)	445 (57.1)	
Male	4565 (44.6)	258 (48.6)	335 (42.9)	
Type of joint arthroplasty				< 0.001[b]
Hip	3224 (31.5)	128 (24.1)	314 (40.3)	
Knee	7010 (68.5)	403 (75.9)	466 (59.7)	

[a] one-way analysis of variance for continuous variables and χ^2 test for categorical variables
[b] p value less than 0.001
PT physical therapy, *SD* standard deviation

Table 3 Regression analysis of 90-day readmission in total joint arthroplasty

	Any 90-day readmission	
	Adjusted odds ratio (95% confidence interval)	*p* value
Rehabilitation timing		
Week 1 (< 8 days)	Ref	
Week 2 (8–14 days)	2.39 (1.34, 4.26)	0.003[a]
Week 3+ (> 14 days)	3.08 (2.14, 4.42)	< 0.001[b]
Type of joint arthroplasty		
Hip	Ref	
Knee	1.12 (0.92, 1.36)	0.256
Computer-assisted surgery		
No	Ref	
Yes	0.90 (0.65, 1.24)	0.517
Discharge type		
Routine (home)	Ref	
Home health	1.07 (0.91, 1.25)	0.441
Morbidity burden		
Low (2)	Ref	
Moderate (3)	2.24 (1.64, 3.05)	< 0.001[b]
High (4 or 5)	2.9 (2.05, 4.08)	< 0.001[b]
Length of stay	1.14 (1.05, 1.20)	< 0.001[b]
Age	0.99 (0.98, 1.00)	0.133
Sex		
Female	Ref	
Male	1.07 (0.92,1.26)	0.382
Interaction effect for rehabilitation timing and type of joint surgery		
Week 1 (< 8) × Hip (THA)	Ref	
Week 2 (8–14) × Knee (TKA)	0.78 (0.40,1.52)	0.464
Week 3+ (> 14) × Knee (TKA)	0.50 (0.31,0.83)	0.007[b]

THA total hip arthroplasty, *TKA* total knee arthroplasty
[a] *p* value less than 0.001
[b] *p* value less than 0.05

surgery modified the effect of PT rehabilitation timing on readmission by adding an interaction term between TJA and PT rehabilitation timing. We conducted all analyses using STATA®, Version 13.0 (Stata Corp, College Station, TX, USA).

We considered using propensity score matching methods to minimize confounding between episodes with an initial routine discharge versus a home health discharge, but the standardized differences in group means among several covariates was either less than or equal to 10%, which was not appreciable enough to be feasible for propensity score matching [1]. Thus, we used generalized estimating equations for our final analysis.

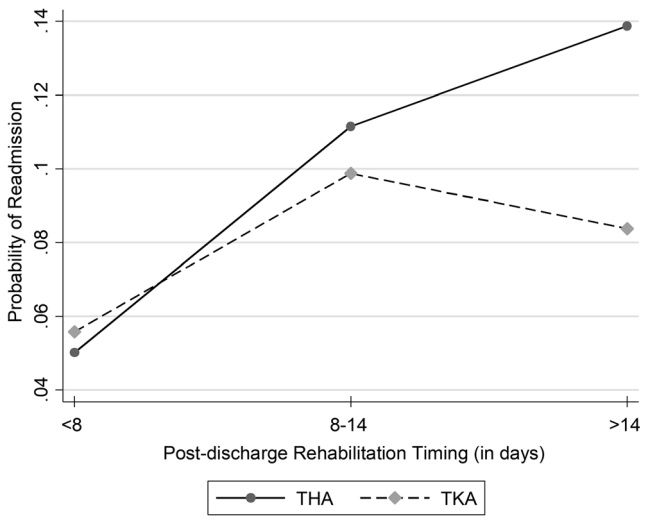

Fig. 2. Predictive margins for the interaction effect of rehabilitation timing and type of joint surgery. *THA* total hip arthroplasty, *TKA* total knee arthroplasty

Sensitivity Analysis

We reassessed our model after dropping high-complexity patients (DRG codes of 469), but our conclusions remained the same.

Results

The mean timing for initiating supervised PT rehabilitation after a home discharge for TJA was 4.6 days (Table 1). The mean age of our cohort was 56.5 years, with a slightly higher proportion (55%) of female patients than male. There were twice as many patients with knee replacements than hip replacements and a higher percentage of patients with a home-health discharge than a routine discharge. The 90-day unplanned readmission rate for TJA was 6%, and the average time to readmission was 37 days. The most common cause of readmission was joint or other post-operative infection followed by prosthesis complications (Online Resource 2).

In addition, a clear majority of patients began rehabilitative PT during the first week after discharge (Table 2). A higher proportion of TKA versus THA (60% vs. 40%, $p < 0.001$) and a higher proportion of routine versus home health (72% vs. 28%, $p < 0.001$) patients received rehabilitative PT more than 2 weeks after discharge during a care episode.

The regression model indicated that on average, after adjusting for all covariates in the model, the effect of post-discharge PT rehabilitation timing on readmission differed significantly for THA and TKA when PT initiation was more than 2 weeks after the procedure (Table 3). The marginal probabilities of the interaction effect between type of joint involvement in TJA and rehabilitation timing (Fig. 2) demonstrates this finding more clearly. The probability of readmission is very similar for both THA and TKA (less than 6%) in the first week but jumps to approximately 10 to 11% if PT services are initiated in the second week post-discharge. However, the probability of readmission further increases for THA but mostly flattens out for TKA if PT is started more than 2 weeks after discharge.

Covariates such as a prolonged length of stay and moderate or high patient morbidity burden were associated with a significantly higher likelihood of 90-day readmission after adjusting for all other variables in the model. Computer-assisted surgery and home-health discharge (vs. routine discharge) were not significant covariates in our model.

Discussion

With increasing pressures for cost containment and quality improvement, institutions are focusing on identifying risk factors for readmission, improving delivery mechanisms, and optimizing resource utilization. Little is known regarding the best practices for initiation of PT after TJA, but experts recommend early post-discharge PT to achieve improved functional outcomes after TJA.

In our study, most TJA patients received PT during the first week after being discharged home. However, approximately 8% received rehabilitative PT more than 2 weeks after surgery, a majority of them patients with routine discharge. Many patients discharged home who experience improved mobility must be self-motivated, which requires adequate social support, patient engagement, and education on post-discharge PT [9, 16]. Our findings indicate a need for improving patient follow-up for PT appointments. This may be achieved through improved health education and case management, especially in the current movement toward bundled and capitated payment systems [7]. Additionally, we found that later initiation of PT rehabilitation was associated with a higher probability of a 90-day readmission in both THA and TKA. Notably, the effect of rehabilitation timing on the likelihood of 90-day readmission was more pronounced in THA than TKA, especially 14 days or more after discharge. Other studies have suggested that post-discharge rehabilitation is beneficial after both THA and TKA but that the timing of PT can have differing effects in improving functional outcomes based on the joint involved [14, 17, 18, 25].

Our study had several limitations. Due to the nature of administrative claims data, we were unable to measure ambulatory improvement directly among patients after discharge. Moreover, even though we performed risk-adjustment to control for patient comorbidities, there may have been other unmeasured characteristics of our population that could have affected the likelihood of readmission, thereby potentially introducing bias into our results. A major assumption of our study is that all patients achieved a minimum level of function, based on the mobility and activity levels required for a home discharge. Direct home discharge from acute care (with or without a home-health component) after TJA is optimal for healthier patients who have adequate social support [16]. Our study sample consisted of younger, commercially insured patients discharged home after elective surgery, which limits the generalizability of our results among older and/or more complex patients discharged to inpatient rehabilitation facilities, skilled nursing facilities, or hospice settings. Thus, our results cannot be generalized to Medicare or Medicaid populations; an evaluation of PT timing in other populations can improve the generalizability of our study results. Also, alternative methodology in patient selection and follow-up may be required to examine whether our results are replicable in the clinical setting.

In conclusion, our findings suggest that the timing for initiating PT may be an important modifiable factor that can affect readmissions after TJA. Additionally, our findings can contribute to the best practice recommendations on the optimal timing for initiating post-discharge rehabilitation in TJA. Future studies can explore the role of specific PT modalities and dosages in terms of duration, frequency, and number of PT sessions in improving functional outcomes and reducing complications that result in readmission following TJA.

Compliance with Ethical Standards

Conflict of Interest: Shweta Pathak, PhD, MPH, Cecilia M. Ganduglia, MD, DrPH, Wenyaw Chan, PhD, John M. Swint, PhD, and Robert O. Morgan, PhD declare that they have no conflicts of interest. Samir S. Awad, MD, MPH, reports personal fees from TELA Bio, Applied Medical, Abbott Laboratories, and Pacira Pharmaceuticals, as well as grants and personal fees from Miromatrix Medical, outside the submitted work.

Human/Animal Rights: All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2013.

Informed Consent: Informed consent was waived from all patients for being included in this study.

Required Author Forms Disclosure forms provided by the authors are available with the online version of this article.

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