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Return to Cycling After Total Joint Arthroplasty

Adam S. Driesman, MD [a], Roseann M. Johnson, BS [a], Charlie C. Yang, MD [a], Todd M. Miner, MD [a], Douglas A. Dennis, MD [a, b, c, d], Jason M. Jennings, MD, DPT [a, b, *]

[a] Colorado Joint Replacement, Denver, Colorado
[b] Department of Mechanical and Materials Engineering, University of Denver, Denver, Colorado
[c] Department of Orthopaedics, University of Colorado School of Medicine, Denver, Colorado
[d] Department of Biomedical Engineering, University of Tennessee, Knoxville, Tennessee

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ABSTRACT

Background: As total joint arthroplasty (TJA) candidates become younger, patients' expectations continue to expand. We surveyed our patient population to determine rates of return to cycling after TJA so that we could provide more accurate counseling on performance and safety.

Methods: At our single institution, an online survey was generated and sent out to patients who had at least 3 months of follow-up. Patients were split into 4 categories based on surgery type: single total hip arthroplasty (THA), single total knee arthroplasty (TKA), multiple TJA, and revision TJA.

Results: A total of 1,029 surveys fit the inclusion criteria. The average age of the patient population was 69 years, with an average of 4.08 years from their time of most recent TJA surgery (maximum follow-up of 18.61 years). Nearly all those who were able to bike prior to surgery were able to return to cycling, with only 6% not being able to do so. There were 41.8% who returned to cycling less than 3 months after surgery. Most cyclists were able to return to their previous level. Patients who had a revision TJA had significantly lower rates of returning to cycling in comparison to single TKA, single THA, and multi-TJA (37.3%, 60.3%, 61.9%, and 60.3%, respectively, $P < .005$). Patients who never returned to cycling had higher revision rates in comparison to those who were able to get back on a bike (14.4 versus 9.2%, $P = .01$).

Conclusions: A large proportion of patients who had prior cycling experience were able to return to bike riding within 3 to 6 months after TJA. Individuals who had revision TJA had lower rates of return to cycling in comparison to single TKA, single THA, and multi-TJA. Returning to cycling did not result in higher rates of revision.

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Many individuals continue to seek out total joint arthroplasty (TJA) to provide pain relief in the hopes that it will improve their mobility and allow them to return to recreational activity. This is ever more present today as more arthroplasty candidates are demographically younger, and therefore more active. This has been demonstrated in cross-sectional studies, where approximately 40% of total knee arthroplasty (TKA) procedures are performed on patients aged less than 65 years [1]. This younger population will continue to have high preoperative expectations and is more likely to desire to return to sports postoperatively [2,3].

While physicians agree that physical activity is beneficial to general well-being, there have been prior concerns that too much impact can decrease the lifespan of prosthetic implants, and can result in increased fractures, dislocations, and need for revision surgery [4]. Much of this concern is theoretical and has not been

Investigation performed at Colorado Joint Replacement, Denver, CO, USA.

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Authors' information: Adam S. Driesman is currently a fellow at Colorado Joint Replacement, and will be practicing at Orthopedic Specialty Group in Fairfield, Connecticut next year.

* Address correspondence to: Jason M. Jennings, MD, DPT, 2535 S Downing St Suite 100, Denver, CO 80210.

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fully elucidated in the literature. While earlier studies reporting increased failures of total hip arthroplasty (THA) were correlated with increased activity levels [5], with the advent of improved modern polyethylene, these concerns have been lessened, with some studies demonstrating no association whatsoever [6,7].

Still, there are little data or consensus regarding recommendations for activities after TJA, with many instructions varying as they come from surgeon opinion rather than data [8,9]. For example, surveys of arthroplasty surgeons show that they are more in favor of sport participation after THA than TKA without data to support their recommendations [10]. At this time, the American Association of Hip and Knee Surgeons created a 3 tier system postoperative activities, dividing sports into low-impact, intermediate-impact, and high-impact [11–13]. While road and stationary cycling is considered a low-impact activity that individuals can resume based on their recommendations, this has not been proven or universally accepted.

Although its safety and effect on long-term function of the prosthesis are still not known, it is clear that a large portion of the TJA patient population has been returning to cycling. It was therefore the primary goal of this study to determine what proportion of those who had prior cycling experience returned to bike riding after TJA. We also hoped to see what effect their arthroplasty had on their cycling ability and preferences. Finally, this retrospective study would examine patient expectations about returning to cycling after TJA. It was our hypothesis that most recent cyclists would be able to return to the sport without a risk of prosthetic loosening or patient health.

Methods

Study Design

Institutional Review Board approval was obtained before the study was initiated. There was no source of funding used for this study. This study was a single-institution retrospective survey assessment sent to all patients from a single center who had THA, TKA, unicompartmental knee arthroplasty, revision THA, or revision TKA between November 1996 and April 2023 performed by any of the 6 fellowship-trained arthroplasty surgeons. Eligible participants received the survey on February 13, 2023, and were able to complete it until April 13, 2023. There was 1 e-mail reminder that was sent out during the study period.

Inclusion and Exclusion Criteria

Patients were excluded if they had no e-mail in our institutional database or had not completed functional outcome scores preoperatively or postoperatively. Patients who did not have at least a 3-month follow-up or were non-English–speaking were also excluded from the study population. Patients were split into 4 categories based on surgery type: single THA, single knee arthroplasty (including unicompartmental knee arthroplasty and TKA), multiple TJA, and revision TJA. Of note, if a patient had a revision joint on one side and a primary joint on the other side, then they were included in the multiple TJA cohort.

Data Collection

A 17-question survey with branching logic was created and used to collect information on preoperative and postoperative participation in cycling, including duration, frequency, activity level, and limitations. Biking activity level was divided into 5 categories: Easy, Easy to Moderate, Moderate, Moderate to Challenging, and Challenging (Figure 1). A portion of this survey also included questions regarding patient expectations and surgeon education on sporting activities. Additionally, there were questions focusing on the use of stationary and electric cycling to determine their utilization before and after TJA. There was a separate independent question asking specifically how long after surgery the patient returned to biking, and therefore it is under the assumption that returning to biking as part of rehabilitation is not included in this analysis.

Easy	Short, flat terrain or low resistance
Easy to Moderate	Short to medium distance, relatively flat terrain with occasional inclines (low resistance with occasional moderate resistance)
Moderate	Medium distance with moderately uneven/graded terrain (varied resistance)
Moderate to Challenging	Medium to long distance with moderately uneven/graded terrain (varied resistance)
Challenging	Long distance, more demanding, hilly terrain (varied and intense resistance)

Fig. 1. Cycling activity choices in survey.

Demographic information is prospectively collected in our institutional arthroplasty database and was used to correlate age, sex, body mass index (BMI), primary TJA date, and laterality of TJA with the patients who completed surveys. Additionally, our institutional database collects patient-reported outcome (PRO) scores and reoperation data on our patient population, and this was linked with our survey data.

Data Analyses

To compare, cohorts were created of those who never cycled, those who cycled at least 2 years before their TJA, and those who cycled within 2 years of their first TJA. A descriptive analysis was performed for response rates. Statistical analysis was completed using Minitab version 18.0 (Minitab, State College, Pennsylvania). Demographics, activity levels, time spent cycling, and complications were compared between those who had not cycled using *Chi*-square test and analysis of variance as required. An additional analysis was performed comparing those who returned to cycling to those who did not, to detect differences in reoperation using Fisher's exact test.

Patient Characteristics

The survey was sent to 10,585 patients who have undergone at least 1 joint arthroplasty surgery, among whom 1,045 patients responded. Of those, 16 surveys were incomplete or did not have at least 3-month follow-up and therefore were excluded from our study, leaving 1,491 joints from 1,029 patients who were included in the final analysis. Of these, 332 underwent single TKA only, 237 underwent single THA, 401 underwent multiple TJA, and 59 patients underwent revision TJA. The mean age of the study population was 69 years (range, 23 to 93), and the mean follow-up since the date of the questionnaire to the most recent surgery was 4.08 years (range, 0.25 to 18.61). There was no age difference between those who were never or remote bikers, and those who had biked in the 2 years leading up to surgery (Table 1). Those who had revision TJA were more likely to have never cycled before their TJA ($P < .001$).

Comparing those who responded to those who did not respond to the survey, our study population was around the same age (69 ± 9.4 versus 69 ± 10.6, $P = .250$), more likely to be men (46.3% versus 43.2%, $P = .065$), and had a lower average BMI (28.0 ± 5.6 versus 28.9 ± 6.1, $P < .001$). Our study population was also noted to have better Harris Hip Scores (91.2 ± 11.6 versus 83.4 ± 16.6, $P < .001$), Knee Society Scores (178.6 ± 27.0 versus 167.0 ± 34.6, $P < .001$), and

Table 1
Demographics by Biking History.

Patient Characteristics	Overall (%)	Never Cycle (%)	I Used to Bike but did Not for 2 Y Leading up to My Joint Replacement Surgery (%)	Yes, I Biked Occasionally Leading up to My Surgery (%)	Yes, I Biked Regularly Leading up to My Surgery (%)	*P* Value
Procedure Type						
Multi Joint	401 (39.0)	63 (15.7)	94 (23.4)	124 (30.9)	120 (29.9)	.0001[a]
Single TKA	332 (32.3)	68 (20.5)	68 (20.5)	83 (25.0)	113 (34.0)	
Single THA	237 (23.0)	37 (15.6)	52 (21.9)	83 (35.0)	65 (27.4)	
Revision	59 (5.7)	22 (37.3)	10 (17.0)	9 (15.3)	18 (30.5)	
Procedure Type						
Multi Joint	401 (39.0)	63 (15.7)	94 (23.4)	124 (30.9)	120 (29.9)	.043
Single TKA	379 (36.8)	84 (22.2)	77 (20.3)	91 (24.0)	127 (33.5)	
Single THA	249 (24.2)	43 (17.3)	53 (21.3)	84 (33.7)	69 (27.7)	
Number of Joints Replaced						
1	629 (61.1)	127 (20.2)	131 (20.8)	175 (27.8)	196 (31.2)	.799[a]
2	350 (34.0)	54 (15.4)	83 (23.7)	110 (31.4)	103 (29.4)	
3	38 (3.7)	7 (18.4)	8 (21.1)	10 (26.3)	13 (34.2)	
4	12 (1.2)	2 (16.7)	2 (16.7)	4 (33.3)	4 (33.3)	
Revision	116 (11.3)	29 (25.0)	21 (18.0)	30 (25.9)	36 (31.0)	.231[a]
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	*P* Value
Age at time of survey		69 ± 9.4	70 ± 10.6	69 ± 9.7	69 ± 9.0	68 ± 8.8	.208[b]
Years since most recent joint replacement		4.08 ± 3.0	3.7 ± 2.9	3.9 ± 2.9	4.4 ± 3.0	4.2 ± 2.9	.032[b]

TKA, total knee arthroplasty; THA, total hip arthroplasty; SD, standard deviation.
[a] *Chi*-squared test.
[b] ANOVA.

Veterans Rand 12 Physical Component Scores (VR-12 PCS) (47.1 ± 9.6 versus 43.6 ± 11.0, $P < .001$).

Results

There were 190 patients (18.5%) who never cycled before their joint arthroplasty. There were 224 (21.8%) patients who had biked previously but not for the 2 years prior to their surgery, and the remaining 615 (59.8%) had cycling experience within the 2 years of their most recent surgery. Most of these recent cyclists bicycled between 30 minutes and 2 hours (423 or 68.8%) during a session with easy to moderate exertion (367 or 59.7%), but were only using a bike between 1 and 7 days a week (373 or 60.7%). Preoperatively, the majority of these individuals were using an outdoor bicycle (86.4%), but there was still a large percentage who were supplementing their exercise with stationary bike work (59.3%).

Postoperatively, nearly all of those who were able to bike prior to their surgery were able to return to cycling. Only 6% of individuals were able to return to the bike if they were previously using one within 2 years of their surgery. There were 41.8% of individuals who were frequently cycling before their TJA and were able to return to sport less than 3 months after surgery. By 6 months, 73.8% were able to return to cycling (Table 2). In comparison, 53.6% of individuals who were remote or never bikers before their TJA were not able to get on the bike after their surgery. Those who did took longer to return to cycling, with 21.5% riding within 3 months of their surgery and 29.2% on the bicycle by 6 months (n = 121). The majority of recent cyclists were currently cycling at a level similar to or higher than they were preoperatively (Table 3). Of note, approximately 20% of recent cyclists felt that they dropped 1 activity level after their TJA at the time of their survey.

In total, 416 individuals never returned to cycling after their TJA. While there was no difference in patient characteristics between individuals who returned to cycling in regards to the number of joints replaced, patients who had a revision TJA had significantly lower rates of returning to cycling in comparison to single TKA, single THA, and multi-TJA (37.3%, 60.3%, 61.9%, and 60.3%, respectively, $P < .005$). When directly comparing single TKA to single THA, a higher percentage of total hip patients were able to return to cycling (61.3 versus 57.0%), but this was not a statistically significant difference (Table 4). Similarly, a higher percentage of single THAs were able to return to their preoperative biking level than single TKAs (57.08 versus 52.72%). Interestingly, TKA patients returned to cycling faster, with 54% of prior TKA riders returning by 3 months after surgery and 89.4% by 6 months, while 46.2% of prior THA riders returned by 3 months and 87.7% by 6 months after surgery. Please note the addendum tables.

Overall, 116 individuals (11.3%) had reoperations after their TJA. There were no significant differences in reoperations between preoperative cycling cohorts (Table 1). Patients who never returned to cycling had higher revision rates in comparison to those who were able to get back on a bike (14.4 versus 9.2%, $P = .01$). All

Table 2
Timing of Returning Back to Cycling Post TJA.

Return to Biking Timing	Never (%)	<3 Mo (%)	3-6 Mo (%)	6 Mo-1 Y (%)	1-2 Y (%)	3-5 Y (%)	>5 Y (%)
Never (190)	133 (70.0)	31 (16.3)	5 (2.6)	8 (4.2)	3 (1.6)	3 (1.6)	7 (3.7)
I used to bike but did not for the 2 y leading up to my joint replacement surgery. (224)[a]	89 (39.9)	58 (26.0)	27 (12.1)	22 (9.9)	15 (6.7)	7 (3.1)	5 (2.2)
Yes, I biked occasionally leading up to my surgery. (299)[b]	32 (10.9)	86 (29.2)	89 (30.2)	55 (18.6)	23 (7.8)	7 (2.4)	3 (1.0)
Yes, I biked regularly leading up to my surgery. (316)	5 (1.6)	171 (54.1)	108 (34.2)	23 (7.3)	4 (1.3)	1 (0.3)	4 (1.3)
Total (1,029)[a,b]	259 (25.2)	346 (33.6)	229 (22.2)	108 (10.5)	45 (4.4)	18 (1.7)	19 (1.9)
Total that bike prior to TJA (615)[b]	37 (6.0)	257 (41.8)	197 (32.0)	78 (12.7)	27 (4.4)	8 (1.3)	7 (1.1)

TJA, total joint arthroplasty.
[a] One patient missing data.
[b] Four patients missing data.

Table 3
Analysis is Looking at the Cycling Level Presurgery Compared to Postsurgery, Just for Patients That Cycled Prior to Their TJA.

Biking Activity Level Change	Easy: Short, Flat Terrain or Low Resistance (%)	Easy to Moderate: Short to Medium Distance, Relatively Flat Terrain with Occasional Inclines (Low Resistance with Occasional Moderate Resistance) (%)	Moderate: Medium Distance with Moderately Uneven/ Graded Terrain (Varied Resistance) (%)	Moderate to Challenging: Medium to Long Distance with Moderately Uneven/ Graded Terrain (Varied Resistance) (%)	Challenging: Long Distance, More Demanding, Hilly Terrain (Varied and Intense Resistance) (%)	Did Not Return (%)
(Pre) Easy: short, flat terrain or low resistance[b]	45 (43.7)	13 (12.6)	7 (6.8)	3 (2.9)	0	35 (34.0)
(Pre) Easy to Moderate: short to medium distance, relatively flat terrain with occasional inclines (low resistance with occasional moderate resistance)[a]	11 (5.6)	104 (52.5)	17 (8.6)	4 (2.0)	4 (2.0)	58 (29.3)
(Pre) Moderate: medium distance with moderately uneven/ graded terrain (varied resistance)[b]	8 (4.9)	38 (23.0)	80 (48.5)	17 (10.3)	3 (1.8)	19 (11.5)
(Pre) Moderate to Challenging: medium to long distance with moderately uneven/graded terrain (varied resistance)[c]	1 (1.3)	10 (12.5)	17 (21.3)	38 (47.5)	5 (6.3)	9 (11.3)
(Pre) Challenging: Long distance, more demanding, hilly terrain (varied and intense resistance)	2 (3.3)	2 (3.3)	8 (13.1)	13 (21.3)	32 (52.5)	4 (6.6)

TJA, total joint arthroplasty.
[a] Three patients missing data.
[b] One patient missing data.
[c] Two patients missing data.

patients in our cohort had improvements in their PRO scores. It was noted that patients who never cycled before surgery had the worst VR-12 PCS scores in comparison to remote, occasional, and recent cyclists (32.2 ± 8.7, 32.8 ± 9.1, 35.8 ± 9.1, and 38.2 ± 9.6, respectively, $P < .001$). While recent cyclists had the best PROs, it is interesting to note that there was no significant difference in change in VR-12 PCS scores from preoperative to postoperative between all the cohorts, all improving close to 12 points ($P = .852$).

There were 67.3% of our patients who stated that they discussed return-to-sport expectations with their surgeon preoperatively. While a third stated that cycling was not discussed, an additional third stated they were told they could return to cycling at their previous level. There were 10.8% who were told they should use a stationary bike, and 8% were told they should bike with caution. There were 62.7% of the patient population who had their own expectation that they could return without any limitation, but nearly a fourth of the patients did not think they would be able to return to cycling.

Table 4
Patient Characteristics of Those Who Returned Back to Cycling.

Patient Characteristics	Returned to Cycling, N = 607 (%)	Never Returned to Cycling, N = 416 (%)	*P* Value
Procedure Type			
Multi Joint	240 (60.3)	158 (39.7)	.005[a]
Single TKA	199 (60.3)	131 (39.7)	
Single THA	146 (61.9)	90 (38.1)	
Revision	22 (37.3)	37 (62.7)	
Procedure Type			
Multi Joint	240 (60.3)	158 (39.7)	.502[a]
Single TKA	215 (57.0)	162 (43.0)	
Single THA	152 (61.3)	96 (38.7)	
Number of Joints Replaced			
1	367 (58.6)	259 (41.4)	.379[a]
2	208 (60.0)	139 (40.1)	
3	22 (57.9)	16 (42.1)	
4	10 (83.3)	2 (16.7)	
Requiring Reoperation	56 (9.2)	60 (14.4)	.010[b]

TKA, total knee arthroplasty; THA, total hip arthroplasty.
[a] *Chi*-squared test.
[b] Fisher's exact test.

Discussion

In this single-center retrospective survey assessment, the majority of recent cyclists were able to return to bicycling without any significant increase in reoperations or joint function as measured by PRO scores. There were 94% of recent cyclists who had returned by the time of survey implementation, and the majority had returned to prior levels. Of note, approximately 20% have dropped an endurance level in comparison to their function before their TJA. It should also be noted that 73.8% of recent cyclists were able to return to cycling by 6 months postoperatively. This is consistent with other studies in the literature. A recent study by Arshi et al. found that most patients frequently returned to sport 1 to 6 months following TJA, with a minority of patients requiring more than 6 months [14]. This, however, has been found to be sport-specific, with studies showing that the mean time to return to golf was 4.4 months following TJA [15], where physically intensive sports such as jogging or skiing may require greater time [16,17]. This study, therefore, supplements the literature and will give providers more realistic expectations to provide during patient counseling.

Interestingly, we found that those individuals who never returned to cycling had higher reoperation rates. This supports the notion that low-impact sports have no effect on implant longevity in the short term. With our average short-term follow-up, however, longer-term studies would be needed to conclusively state that low-impact activities such as cycling do not affect implant longevity. This runs contradictory to earlier works concerned with implant failure and increased physical activity [18] rather supporting the durability of newer polyethylene-bearing surfaces. It could be hypothesized that patients who did not return to cycling had a slower recovery with less activity, therefore being less satisfied with their total joint and more likely to seek out revision

surgery. Studies have demonstrated that patient-specific factors, such as BMI, are the main determinants of postoperative activity [19]. These same patient-specific factors, which were not controlled for in this study, could also correlate with higher revision surgeries in the cohort who were unable to return to cycling.

This study demonstrated that patients who underwent THA were not only more likely to return to cycling but were also more likely to return to a similar intensity level. This is similar to other previous studies performed. It is known that arthroplasty surgeons are more likely to favor sports participation in their THA patient population [10,11]. Other observation studies also noted that THA patients were more likely to reach higher activity levels in comparison to TKA [20,21]. Interestingly, however, it was found in this survey study that TKA patients were able to return to cycling quicker than THA patients. This contradicts previous studies, where 90% of THA patients were able to returning to sport by 6 to 12 months in comparison to 88% of TKA patients returned at 14 months [22,23]. It could be hypothesized that the TKA patients at our center were encouraged to use a stationary bike postoperatively to improve knee motion, thereby resulting in higher utilization in the early postoperative period.

There is a lack of consensus regarding sports activities after TJA. In a study of surgeons, trainees, and consultants at the Mayo Clinic, 3.8% of providers would not recommend cycling after TJA [24]. In a survey of surgeons of the British Medical Society, 4.8% of surgeons would educate patients not to ride a bike [25]. In our study, we found that more patients expected they would be able to return to cycling with minimal limitations, but still, there were close to 23% of patients who did not think they would return to cycling if they did not discuss it with physicians. When they did discuss expectations with physicians, only 11% of patients did not think they would be able to return to cycling. Current recommendations by the American Association of Hip and Knee Surgeons emphasize the importance of physical activity. They attempt to provide patients feedback on sports after TJA by categorizing low-impact, intermediate-impact, and high-impact sports [13]. These results support their recommendations, showing that bicycling is a great way to maintain physical activity without risking implant longevity.

This study is not without potential limitations and therefore should be addressed. While a large population was able to be captured using a relatively short but comprehensive surgery, nearly 90% of patients at this institution did not fill out a survey and therefore could not be included in this study. This response rate appears to be similar to other similar works in the literature [14,17]. It can be hypothesized that this low response rate could be secondary to survey fatigue, as this institution is inactive in many prospective and retrospective trials. There may also be a low response rate in this arthroplasty population due to technological limitations. These factors, in addition to recall and volunteer bias, could affect these results. The survey was sent out to every patient who ever had a joint replaced at our institution if they had an e-mail on file, and therefore it would not be surprising that the patients who responded were not representative of the population in total and may be more active than the general patient population. While we asked questions regarding perceived exertion and activity levels, there were no specific questions regarding distances traveled on a bike, thus limiting our conclusions and our ability to fully counsel our patients. Furthermore, these results might not be generalizable to other populations, as Colorado has a large cycling community.

Conclusions

This study successfully examined a large population of TJA patients to determine the rates of cycling after surgery and linked their responses to functional outcome scores. It demonstrated that those who were cycling before TJA were able to return to cycling within 6 months after surgery with no detriment to their final outcome. Most individuals were able to return to their baseline cycling function, but around 20% of individuals were less active by the time of survey completion. Individuals who underwent revision TJA had lower rates of return to cycling in comparison to single TKA, single THA, and multi-TJA. Physicians should be able to use these data to better counsel their patients before TJA.

CRediT authorship contribution statement

Adam S. Driesman: Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Roseann M. Johnson:** Writing – review & editing, Supervision, Formal analysis, Data curation, Conceptualization. **Charlie C. Yang:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Todd M. Miner:** Writing – review & editing, Supervision, Resources, Methodology, Investigation, Conceptualization. **Douglas A. Dennis:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Conceptualization. **Jason M. Jennings:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization.

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Appendix

Appendix Table 1
Single THA Activity Return.

Single THA Biking Activity Change	Easy: Short, Flat Terrain or Low Resistance (%)	Easy to Moderate: Short to Medium Distance, Relatively Flat Terrain with Occasional Inclines (Low Resistance with Occasional Moderate Resistance) (%)	Moderate: Medium Distance with Moderately Uneven/ Graded Terrain (Varied Resistance) (%)	Moderate to Challenging: Medium to Long Distance with Moderately Uneven/ Graded Terrain (Varied Resistance) (%)	Challenging: Long Distance, More Demanding, Hilly Terrain (Varied and Intense Resistance) (%)	Did Not Return (%)
(Pre) Easy: short, flat terrain or low resistance[b]	16 (59.3)	3 (11.1)	2 (7.4)	0 (0.0)	0 (0.0)	6 (22.2)
(Pre) Easy to Moderate: short to medium distance, relatively flat terrain with occasional inclines (low resistance with occasional moderate resistance)[a]	3 (5.6)	33 (61.1)	3 (5.6)	1 (1.9)	0 (0.0)	14 (25.9)
(Pre) Moderate: medium distance with moderately uneven/ graded terrain (varied resistance)[b]	1 (2.8)	8 (22.2)	22 (61.1)	3 (8.3)	0 (0.0)	2 (5.6)
(Pre) Moderate to Challenging: medium to long distance with moderately uneven/graded terrain (varied resistance)[c]	0 (0.0)	1 (7.7)	2 (15.4)	7 (53.9)	2 (15.4)	1 (7.7)
(Pre) Challenging: Long distance, more demanding, hilly terrain (varied and intense resistance)	0 (0.0)	1 (6.3)	4 (25.0)	2 (12.5)	8 (50.0)	1 (6.3)

THA, total hip arthroplasty.
[a] Three patients missing data.
[b] One patient missing data.
[c] Two patients missing data.

Appendix Table 2
Single TKA Activity Return.

Single TKA Biking Activity Change	Easy: Short, Flat Terrain or Low Resistance (%)	Easy to Moderate: Short to Medium Distance, Relatively Flat Terrain with Occasional Inclines (Low Resistance with Occasional Moderate Resistance) (%)	Moderate: Medium Distance with Moderately Uneven/ Graded Terrain (Varied Resistance) (%)	Moderate to Challenging: Medium to Long Distance with Moderately Uneven/ Graded Terrain (Varied Resistance) (%)	Challenging: Long Distance, More Demanding, Hilly Terrain (Varied and Intense Resistance) (%)	Did Not Return (%)
(Pre) Easy: short, flat terrain or low resistance[b]	16 (47.1)	3 (8.8)	3 (8.8)	2 (5.9)	0 (0.0)	10 (29.4)
(Pre) Easy to Moderate: short to medium distance, relatively flat terrain with occasional inclines (low resistance with occasional moderate resistance)[a]	2 (3.6)	29 (51.8)	6 (10.7)	2 (3.6)	1 (1.8)	16 (28.6)
(Pre) Moderate: medium distance with moderately uneven/ graded terrain (varied resistance)[b]	3 (5.7)	14 (26.4)	27 (50.9)	1 (1.9)	1 (1.9)	7 (13.2)
(Pre) Moderate to Challenging: medium to long distance with moderately uneven/graded terrain (varied resistance)[c]	0 (0.0)	3 (8.8)	10 (29.4)	16 (47.1)	1 (2.9)	4 (11.8)
**(Pre) Challenging: Long distance, more demanding, hilly terrain (varied and intense resistance)	0 (0.0)	0 (0.0)	3 (20.0)	2 (13.3)	10 (66.7)	0 (0.0)

TKA, total knee arthroplasty.
[a] Three patients missing data.
[b] One patient missing data.
[c] Two patients missing data.

Appendix Table 3
Single THA Timing Return to Bike.

Single THA Return to Bike	Never (%)	<3 Mo (%)	3-6 Mo (%)	6 Mo-1 Y (%)	1-2 Y (%)	3-5 Y (%)	>5 Y (%)
Never (37)	30 (81.1)	0 (0.0)	2 (5.4)	1 (2.7)	1 (2.7)	0 (0.0)	3 (8.1)
I used to bike but did not for the 2 y leading up to my joint replacement surgery. (52)	23 (44.2)	8 (15.4)	5 (9.6)	6 (11.5)	5 (9.6)	4 (7.7)	1 (1.9)
Yes, I biked occasionally leading up to my surgery. (82)[a]	8 (9.8)	22 (26.8)	27 (32.9)	16 (19.5)	7 (8.5)	2 (2.4)	0 (0.0)
Yes, I biked regularly leading up to my surgery. (65)	2 (3.1)	30 (46.2)	27 (41.5)	5 (7.7)	1 (1.5)	0 (0.0)	0 (0.0)
Total (236)[a]	63 (26.7)	60 (25.4)	61 (25.9)	28 (11.9)	14 (5.9)	6 (2.5)	4 (1.7)

THA, total hip arthroplasty.
[a] One patient missing data.

Appendix Table 4
Single TKA Timing Return to Bike.

Single TKA Return to Bike	Never (%)	<3 Mo (%)	3-6 Mo (%)	6 Mo-1 Y (%)	1-2 Y (%)	3-5 Y (%)	>5 Y (%)
Never (68)	42 (61.8)	16 (23.5)	2 (2.9)	4 (5.9)	1 (1.5)	2 (2.9)	1 (1.5)
I used to bike but did not for the 2 y leading up to my joint replacement surgery. (68)	29 (42.7)	19 (27.9)	9 (13.2)	6 (8.8)	3 (4.4)	0 (0.0)	2 (2.9)
Yes, I biked occasionally leading up to my surgery. (81)[a]	8 (9.9)	30 (37.0)	22 (27.2)	13 (16.1)	6 (7.4)	1 (1.2)	1 (1.2)
Yes, I biked regularly leading up to my surgery. (113)	1 (0.9)	61 (54.0)	40 (35.4)	8 (7.1)	1 (0.9)	1 (0.9)	1 (0.9)
Total (330)[a]	80 (24.2)	126 (38.2)	73 (22.1)	31 (9.4)	11 (3.3)	4 (1.2)	5 (1.5)

[a] One patient missing data.