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# Return to Play and Performance in Golfers After Total Knee Arthroplasty: Does Component Type Matter?

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**Background:** Golf is a popular sport among patients undergoing total knee arthroplasty (TKA). The golf swing requires significant knee rotation, which may lead to changes in golfing ability postoperatively. The type of implant used may alter the swing mechanics or place different stresses on the knee. The purpose of this study was to evaluate golf performance and subjective stability after TKA and compare outcomes between cruciate-retaining (CR) and posterior-stabilized (PS) implants.

**Hypothesis:** Patients with CR implants will experience better stability during the golf swing compared to patients with PS implants.

**Study Design:** Retrospective cohort study.

**Level of Evidence:** Level 3.

**Methods:** Patients who underwent primary TKA were identified from the medical record and sent an electronic questionnaire focusing on return to play (RTP), performance, pain, and stability during the golf swing. Knee injury and Osteoarthritis Outcome Scores (KOOS) were collected before and at multiple time points after surgery. Patients were surveyed postoperatively and asked to evaluate overall performance, pain, and stability before and after surgery. Outcomes were compared based on implant type.

**Results:** Most patients (81.5%) were able to return to golf at an average of  $5.3 \pm 3.1$  months from surgery. The average postoperative KOOS was  $74.6 \pm 12.5$  in patients able to RTP compared with  $64.4 \pm 9.5$  in those who were not ( $P < 0.05$ ). Knee pain during golf significantly improved from  $6.4 \pm 2.1$  to  $1.8 \pm 2.2$  ( $P < 0.01$ ). There were no significant differences in pain, performance, or stability between the CR and PS patients.

**Conclusion:** Most patients can successfully return to golfing after TKA. Knee replacement offers patients reliable pain relief during the golf swing and fewer physical limitations during golf, with no detriment to performance. There is no difference in performance or subjective knee stability based on component type.

**Clinical Relevance:** Understanding associated outcomes of different TKA knee systems allows for unbiased and confident recommendations of either component to golfers receiving total knee replacement.

**Keywords:** total knee arthroplasty; golf; cruciate-retaining; posterior stabilized

Total knee arthroplasty (TKA) is widely utilized in the treatment of knee osteoarthritis with the number of annual procedures expected to continually increase.<sup>7</sup> Patients expect that TKA can provide pain relief and lead to an increase in ability to participate in physical activity after surgery.<sup>14</sup> Golf is a popular sport, particularly among older

adults undergoing TKA, and a recommended avenue for continued physical activity after surgery.<sup>13</sup>

As surgery is being performed on younger, more active patients, the expectations after TKA are increasing with many patients planning to return to sports such as golf. Witjes et al<sup>20</sup> conducted a systematic review evaluating the return to sport

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after TKA and found that 94% of patients were able to return to low-impact sports. Mallon and Callaghan<sup>15</sup> were the first to evaluate golfing after TKA and found that the average time to return to play (RTP) was 20.3 weeks with the majority of patients experiencing minimal if any, pain during golf activity. Subsequent studies have produced similar results, with most patients returning to regular play within 6 months of their TKA with a decrease in pain and often an improvement in their game.<sup>8</sup>

Previous studies have suggested that there are no significant functional differences between cruciate-retaining (CR) and posterior-stabilized (PS) component designs.<sup>10,19</sup> Hamai et al<sup>4</sup> investigated 3-dimensional knee kinematics during the golf swing in both CR and PS components and found that the golf swing requires significant knee rotation, which could potentially put stress on the implant and cause knee pain.<sup>4</sup> While biomechanical studies add to our knowledge on the kinematic aspect of the golf swing, less is known about patient outcomes, perception, and performance after TKA. A greater understanding of patients' experience on the golf course after knee replacement will allow surgeons to set realistic expectations for future patients.

The purpose of this study was to evaluate pain, performance, and stability during the golf swing after TKA. The investigation also sought to detect any potential differences between CR and PS components.

## METHODS

The investigation received approval by the institutional review board before data collection. Patients who previously underwent TKA by 6 adult reconstruction fellowship-trained orthopaedic surgeons at a tertiary care medical center from December 2017 to October 2019 were identified using the Current Procedural Terminology code 27447 (TKA). All patients who underwent a unilateral, primary TKA who were a minimum of 2 months postoperative from the surgery were included in the study. Exclusion criteria included patients undergoing a unicompartmental knee arthroplasty, revision knee arthroplasty, patients who were less than 2 months from the date of surgery or patients who reported less than 1 year of golfing experience before surgery.

All participants were sent a 23-item questionnaire via an electronic, secure platform (REDCap, Vanderbilt University; Table 1). The survey first asked if the patients identified as golfers. If the answer was in the affirmative, the patient was asked to complete the survey and if not, they were excluded from further questioning. The survey questions focused on the return to golfing activity, golfing performance, pain, and stability during the golf swing before and after surgery, with all data collected retrospectively. In addition to the survey, a chart review was performed on all patients to determine demographics, type of surgery, and component implanted, specifically CR versus PS total knee components. The Knee Injury and Osteoarthritis Outcome Scores (KOOS) were

collected preoperatively and at multiple time points after surgery. Comparisons between pre- and postoperative pain, performance, and outcomes were made, including if any differences depended on component design.

## Statistical Analysis

The data were analyzed with descriptive summaries for continuous variables, and frequencies were calculated for categorical variables. Univariate comparisons were performed using an independent sample *t* test and chi-square or Fisher's exact tests for categorical variables. Statistical significance is set to  $P < 0.05$ . All analyses were performed using SAS Version 9.4 (SAS Institute Inc).

## RESULTS

### Demographics and RTP

A total of 1952 patients were identified as undergoing primary, unilateral TKA at our institution during the study period and were sent surveys through email. A total of 81 patients identified themselves as golfers and 65 of these patients completed the entire follow-up survey. Five patients were excluded for having less than 1 year of golfing experience before TKA and 6 patients had undergone unicompartmental knee arthroplasty resulting in a total of 54 patients included in the final analysis. Patients filled out the survey an average of  $12.6 \pm 6.3$  months after the date of surgery.

A total of 44 of 54 (81.5%) patients who underwent TKA were successfully able to return to golf, with an average time to RTP of  $5.3 \pm 3.1$  months. There were no significant demographic differences between those who were able to RTP and those who were not. Golfers who returned to play did play significantly more rounds per month preoperatively, but there were no differences in performance or pain medication use between groups before surgery (Table 2).

Before surgery, there was no difference in KOOS between groups; however, the average postoperative KOOS was  $74.6 \pm 12.5$  in patients able to RTP compared with  $64.4 \pm 9.5$  in those who were not ( $P < 0.05$ ). Additionally, those who returned to play had a significantly better KOOS at their 1-month visit (Table 3).

### Pain and Performance After RTP

In the 44 patients who were able to successfully RTP, pain scores significantly improved from  $6.4 \pm 2.1$  to  $1.8 \pm 2.2$  ( $P < 0.01$ ) on the visual analogue scale (VAS). Additionally, 88.6% of patients reported that their golfing performance was limited by their knee before surgery, compared with 22.7% postoperatively ( $P < 0.01$ ). The percentage of patients taking anti-inflammatory pain medication surrounding golf rounds improved from 86.3% to 29.5% after surgery ( $P < 0.01$ ).

The proportion of patients who stated that their performance improved or stayed the same after surgery was 84.1%. There were no significant differences in handicap or driving distance after the surgery (Table 4).

Table 1. Patient satisfaction survey

Question	Possible Answer
What is your age?	
Which knee did you have surgery on?	Left Right Both
How many years have you been playing golf?	
How many rounds of golf do you play per month?	
Have you resumed golfing activity after the surgery?	Yes No
How long after surgery did you resume golfing activities?	
Since the surgery have you golfed more frequently, the same amount or less frequently?	More frequently Same amount Less frequently
Was your golf activity been limited by your knee before surgery?	Yes No
Has your golf activity been limited by your knee after surgery?	Yes No
What was your handicap before the surgery?	
What was your handicap after the surgery?	
What was your average estimated driving distance before the surgery?	
What was your average estimated driving distance after the surgery?	
Do you feel that your overall golf performance has improved, stayed the same or worsened since the surgery?	Improved Stayed the same Worsened
Rate the pain in your knee during the golf swing before the surgery	1-10
Rate the pain in your knee during the golf swing after the surgery	1-10
Does your knee ever feel unstable while golfing after your surgery?	Yes No
Does your knee ever feel as if it is giving out on you during golf after your surgery?	Yes No
On a scale of 1-10, how stable would you rate your knee during the golf swing after surgery?	1-10
Did you require anti-inflammatory pain medication (ibuprofen, Motrin, Aleve) during golf rounds before your surgery?	Yes No
Did you require anti-inflammatory pain medication (ibuprofen, Motrin, Aleve) during golf rounds after your surgery?	Yes No
Rate your overall satisfaction with your knee surgery	1-10

Table 2. Preoperative comparison between patients who were able to successfully return to golf and patients who were not able to return to play

Variable	No Return (N = 10)	Return to Play (N = 44)	<i>P</i> <sup>a</sup>
Age, y	66.2 ± 5.8	66.6 ± 7.3	0.88
Sex, % male	70.0	81.8	0.40
Body mass index	31.9 ± 5.5	32.3 ± 6.3	0.86
Golfing experience, y	30.5 ± 13.6	36.2 ± 15.7	0.30
Golf rounds per month	3.4 ± 1.9	5.7 ± 3.6	<b>&lt;0.01</b>
Handicap	16.2 ± 7.5	18.9 ± 9.7	0.44
Driving distance, m	172.3 ± 61.2	182.0 ± 50.6	0.60
NSAID use, % of patients	80.0	86.4	0.61

NSAID, nonsteroidal anti-inflammatory drug.

<sup>a</sup>Boldfaced *P* value indicates statistical significance.

Table 3. Comparison of knee injury and osteoarthritis outcome scores in patients who returned and did not return to golf

Time Point	No Return (N = 10)	Return to Play (N = 44)	<i>P</i> <sup>a</sup>
Preoperative	56.9 ± 13.8	58.5 ± 15.2	0.78
One-month postoperative	63.5 ± 9.2	73.2 ± 13.3	<b>0.03</b>
Three-month postoperative	66.5 ± 11.7	74.7 ± 4.7	0.26
Average postoperative	64.4 ± 9.5	74.6 ± 12.5	<b>0.02</b>

<sup>a</sup>Boldfaced *P* values indicate statistical significance.

Table 4. Pain and performance before and after surgery in golfers who returned to play

	Before	After	<i>P</i> <sup>a</sup>
Handicap	18.9 ± 9.7	18.7 ± 10.2	0.68
Driving distance, m	182.0 ± 50.7	183.3 ± 50.0	0.69
Performance limited by pain, %	88.6	22.7	<b>&lt;0.01</b>
Pain medication use, %	86.3	29.5	<b>&lt;0.01</b>
Pain, VAS	6.4 ± 2.1	1.8 ± 2.2	<b>&lt;0.01</b>

VAS, visual analogue scale.

<sup>a</sup>Boldfaced *P* values indicate statistical significance.

## CR Versus PS

Overall, 19 patients received a PS implant while 35 received a CR implant. The PS group had a higher preoperative body mass

index compared with the CR group; otherwise, there were no significant demographic or performance differences between groups (Table 5). In patients who returned to play after surgery,

Table 5. Preoperative comparison between patients who received CR components and patients who received PS components

Variable	PS (N = 19)	CR (N = 35)	P
Age, y	65.4 ± 5.5	67.1 ± 7.75	0.40
Sex, % male	79.9	80.0	0.93
BMI, kg/m <sup>2</sup>	34.7 ± 5.9	31.9 ± 6.0	0.03
Active golf years	36.6 ± 14.2	32.5 ± 17.5	0.35
Monthly golf rounds	5.31 ± 2.9	5.3 ± 4.32	0.99
Golf limitations, %	82.4%	92.6%	0.30
Handicap	19.1 ± 12.0	18.8 ± 8.2	0.92
Driving distance, m	178.6 ± 53.1	184.1 ± 50.0	0.73
VAS pain score	6.2 ± 2.0	6.4 ± 2.1	0.73
Use pain medication, %	85.7%	84.2%	0.88
Return to play	89.5%	77.1%	0.47

BMI, body mass index; CR, cruciate-retaining; PS, posterior-stabilized; VAS, visual analogue scale.

Table 6. Postoperative comparison between patients who received CR components and patients who received PS components and returned to golf<sup>a</sup>

Variable	PS (N = 17)	CR (N = 27)	P
Golf limitations, %	23.5	22.2	0.92
Handicap	18.8 ± 13.5	18.7 ± 7.7	0.99
Change in handicap	−0.4 ± 3.3	−0.1 ± 3.4	0.81
Driving distance, m	182.4 ± 57.5	183.8 ± 45.8	0.93
Change in driving distance, m	3.7 ± 25.1	−0.3 ± 17.9	0.53
Pain	19.8 ± 25.5	17.2 ± 20.0	0.71
Change in pain scores	−4.2 ± 3.1	−5.1 ± 2.5	0.31
% Reporting knee giving out	17.6	11.1	0.54
Rating of knee stability (1-10)	7.7 ± 2.4	8.2 ± 2.0	0.46
Use of pain medication, %	29.4	29.6	0.99
Overall satisfaction (1-10)	8.6 ± 1.8	8.6 ± 2.0	0.98

CR, cruciate-retaining; PS, posterior-stabilized.

<sup>a</sup>Change reported as the difference between postoperative and preoperative scores.

there were no significant differences in the change in pain, performance, or KOOS between component groups (Table 6). Additionally, the proportion of patients reporting giving out during the golf swing did not differ between components,

11.1% and 17.6% for CR and PS knees, respectively ( $P > 0.05$ ). Patients rated their subjective golfing stability after surgery as  $8.2 \pm 1.9$  for CR knees and  $7.7 \pm 2.4$  for PS knees ( $P > 0.05$ ).

## DISCUSSION

Overall, the majority of patients (81.5%) were able to successfully return to golfing activity after TKA. Additionally, TKA was successful in alleviating pain and lessening the proportion of patients taking pain medication during golfing activity. There was no significant difference in performance after surgery in golfers who were successfully able to RTP. A comparison between CR and PS components demonstrated no difference in perceived stability during the golf swing.

TKA has been shown to successfully allow patients to return to a variety of recreational activities, particularly low-impact activities such as walking, golf, swimming, and cycling.<sup>20</sup> In the present cohort, 44 of 54 (81.5%) patients who underwent TKA were successfully able to return to golf, with an average time to RTP of  $5.3 \pm 3.1$  months. Pioger et al<sup>18</sup> surveyed a group of 143 golfers at least 2 years post TKA and found that all but 1 golfer had returned to golfing activity, with a median time to return of 3.7 months. Likewise, Mallon and Callaghan<sup>15</sup> reported on a group of 83 patients after TKA and found that subjects were able to return to golf at an average of approximately 3 months. The average time postoperatively of patients surveyed in this investigation was  $12.6 \pm 6.3$  months, and it is possible that with additional long-term follow-up, more golfers will return. Additionally, the average number of golf rounds per month was significantly lower before surgery in those who did not RTP; thus, return to golf may not have been a priority. While the preoperative KOOS were similar in those who were and were not able to RTP, the average overall postoperative and 1-month postoperative KOOS were significantly worse in those who did not RTP, which may explain this groups inability to return to physical activity. Multiple studies have demonstrated that a reliable predictor of postoperative athletic activity is the degree of preoperative activity, which can explain why patients playing golf more frequently before TKA had better RTP rates.<sup>6,9</sup> Patients may be counseled that they can reliably expect to RTP at an average of 4 to 6 months, with those participating in regular golfing activity before surgery more likely to successfully return to the course.

TKA is a successful procedure in alleviating knee pain.<sup>11,17</sup> In those patients who were able to RTP, pain scores during golfing activity improved from  $6.4 \pm 2.1$  to  $1.8 \pm 2.2$  ( $P < 0.01$ ) on the VAS, and the proportion of patients feeling limited by their knee during golf significantly decreased. Additionally, a lower proportion of patients reported the need for anti-inflammatory pain medications surrounding golfing activity. The reduction in VAS pain scores during golf was similar to the aforementioned study by Pioger et al,<sup>18</sup> which noted that patients in their cohort improved from  $6.13 \pm 1.82$  to  $1.27 \pm 1.48$  after TKA. Jackson et al<sup>8</sup> reported on a group of 93 golfers who were surveyed on their experience golfing after a TKA. As in our cohort, they found that patients reported significant pain relief after the procedure and many reported no knee pain during the golf swing. However, a significantly higher proportion of patients had to use a motorized golf cart rather

than walking after TKA, highlighting a potential limitation after surgery.

Golfing performance after TKA was not significantly altered compared to preoperatively, with no difference in patient-reported handicap or driving distance. In their 1993 study, Mallon and Callaghan<sup>15</sup> found that patients had a significantly worse handicap and lower driving distances after their surgeries. However, our investigation and more recent studies on golfers after TKA have found that the majority of patients experience either no change or an improvement in performance after surgery.<sup>8,18</sup> This may be due to improved postoperative mobility or physical therapy protocols, which allow patients a more reliable return to the same or improved levels of activity after TKA.

Many studies have been conducted in an attempt to evaluate for potential differences between CR and PS total knee component designs, with the general consensus finding no significant functional difference between the 2 designs.<sup>10,19</sup> Our investigation attempted to evaluate any potential differences in postoperative golf ability and perceived knee stability between component types and also found that there were no significant differences. Proponents of CR designs note increased bone preservation, more natural proprioception and kinematics, and inherent stability.<sup>1</sup> Hamai et al<sup>5</sup> noted that the CR knee provided improved sagittal plane stability during stair climbing compared with the PS counterparts, highlighting the potential for improved stability with the CR design. In contrast, a PS knee removes the risk of PCL insufficiency and can offer improved ligament balancing and more predictable kinematics.<sup>12</sup> Yagishita et al<sup>21</sup> conducted a study involving patients undergoing bilateral TKAs, 1 of each component type. They found that the PS knees offered a greater range of motion than their CR counterparts.<sup>21</sup> Knee motion is an important aspect of the golf swing. A kinematic fluoroscopic evaluation of the knee during the golf swing demonstrated that native knees undergo an average of 5 mm of anteroposterior translation and 26° of axial rotation during the full swing motion.<sup>16</sup> Comparison between skilled and unskilled golfers revealed increased knee flexion/extension excursion in skilled golfers, highlighting the importance of knee motion in proper swing mechanics.<sup>2</sup> Based on our investigation and the current literature, it does not seem that component design significantly impacts subjective knee stability after TKA and should not be a substantial consideration when choosing component type in golfers.

There were limitations to this investigation. This study was conducted via retrospective survey, which is inherently vulnerable to response and memory bias.<sup>3</sup> Additionally, we did not receive responses from all patients who underwent TKA, thus may have missed patients who may have fit the inclusion criteria. RTP is multifactorial; thus, failure to return to golf may have been due to issues unrelated to their knee surgery. The medical histories of the patients were not reviewed and could have limited successful RTP. Additionally, while we excluded patients who underwent surgery less than 2 months before the survey, it is possible that some patients are still early in their



recovery or slow to recover and plan to return in the future. Multiple providers' patients participated in the study; thus, there were likely variations in surgical technique and reasoning behind choosing component type. Finally, there was a relatively small sample size of patients, as well as a high rate of patients who responded to the initial survey questions but did not complete the full survey for unknown reasons.

## CONCLUSION

The vast majority of patients can successfully return to golfing after TKA. Knee replacement offers patients reliable pain relief during the golf swing and less physical limitations during golf, with no detriment to performance. There is no difference in performance or subjective knee stability based on component type.

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