

# Sports After Knee Arthroplasty: Partial Versus Total Knee Arthroplasty

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**Abstract:** Osteoarthritis becomes more prevalent with increasing age, and currently is occurring more frequently in the “Baby Boomer” Generation (ages 44–66 years). However, many individuals may be reluctant to undergo arthroplasty procedures because potential activity limitations. Thus, physicians must consider each patient’s history and desired activity level after treatment. Osteoarthritis treatments include nonoperative measures such as weight reduction, injections, and nonsteroidal anti-inflammatory drugs, as well as operative options, including partial and total knee arthroplasty. Each treatment type will vary in its impact on activity levels. If arthroplasty is required, patients must be cautioned to minimize component overload, which may result in polyethylene wear and loosening; however, cardiopulmonary fitness and general conditioning benefits of activity can be maintained.

**Keywords:** arthroplasty; knee arthroplasty; osteoarthritis; joint replacement; sports; arthritis

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## Introduction

Many patients are reluctant to consider knee arthroplasty because they are reluctant to limit their sporting activities. The group of patients aged 44 to 66 years, commonly referred to as the “Baby Boomer” generation, are experiencing increasing rates of total knee arthroplasty (TKA). For physicians treating this age group, the first goal is to assign a disease-specific diagnosis early in the course of treatment, and then explain treatment options and acceptable activity levels in a logical manner. The process is initiated by a thorough physical examination, which is often supplemented with radiographs. Nonoperative treatment continues to serve as a primary treatment option, but for patients needing arthroplasty, both partial and total arthroplasty options are available. The goals for activity recommendations after arthroplasty are to minimize polyethylene (PE) wear and loosening, while at the same time allowing maintenance of cardiopulmonary fitness, general conditioning, and the psychosocial benefits of sport.

Sporting activities often become difficult or impossible with advancing knee arthritis. Knee arthroplasty is indicated for end-stage arthritis of  $\geq 1$  knee compartment to decrease pain and improve function. As the Baby Boomer generation ages, the number of knee arthroplasties is expected to increase dramatically over the next 2 decades. This generation has been changing the perception of aging, and many boomers (unlike earlier generations) refuse to accept a decrease in activity level as they age. This suggests that the increased need for arthroplasty treatment will intensify interest in determining which sporting activities are appropriate after knee arthroplasty.

It is well known that regular exercise improves general health, reduces mortality, and contributes to physiological and psychological well-being.<sup>1,2</sup> More specifically, regular sports activity can lead to an increased bone mineral density, which may be of great importance for implant fixation and longevity.<sup>3</sup> In contrast to these beneficial effects, high levels of activity (aside from other factors) increase implant wear and, therefore, the risk of implant loosening and failure.<sup>4</sup>

## Arthritic Knee Presentations

Although arthritis presents in many forms, the most common type is degenerative joint disease (DJD) (osteoarthritis). A higher percentage of these patients may be potentially interested in sports compared with those who have systemic inflammatory arthritis because patients with inflammatory arthritis have decreased activity scores compared with their osteoarthritis counterparts.<sup>5</sup> Although osteoarthritis is caused by both mechanical and traumatic causes, the common denominator is articular cartilage wear

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resulting in progressive joint space narrowing, often presenting with osteophytic formation and malalignment. In those individuals with malalignment, maximal articular cartilage wear typically occurs in the compartment experiencing increased loading as a result of malalignment (eg, medial compartment in a varus knee). Within this group, some patients have primary osteoarthritis without prior surgery or injury, and others have secondary osteoarthritis from prior injury or surgery. The first group has a high incidence of genetic predisposition overlying other factors such as weight, activity, and baseline alignment. In patients with secondary osteoarthritis, many have had prior sporting injuries such as anterior cruciate ligament tears, meniscal tears, and articular cartilage damage, all of which may contribute to increased knee deterioration. Surgical intervention (articular and meniscal cartilage restoration surgery) leads to mixed results in its ability to delay or prevent osteoarthritis in this subgroup, and a large percentage of these patients will present with knees that have radiographs very similar to primary osteoarthritis.

### Activity Expectations in Knee Arthritis: Patient Evaluation

Evidence indicates that patient age correlates with athletic activity, with the number of sports and time of activity both declining with age.<sup>6</sup> There are also data suggesting that the number of knee compartments involved and the ligamentous stability of the knee affect the number and type of sports in which patients participate. Thus, in addition to a standard history and physical examination, a history of past, current, and desired sporting activities is essential to allow a thorough discussion and management of postoperative expectations.

Patients do not typically know the extent of their arthritis: they just know they have pain, stiffness, and possible swelling

and/or limitations of motion. The evaluation of patients presenting with possible knee arthritis begins with a standard history and a physical examination. If arthritis is suspected, early radiographic evaluation will aid in directing efficient initial treatment (Table 1). Many patients with mild-to-moderate chondrosis and/or degenerative meniscal tears will have symptoms that are similar to those with arthritis. If marked joint space narrowing is evident on standing and/or flexed knee views, then the treatment is directed at the arthritis instead of potential meniscal tears (Figures 1, 2). Likewise, in the case of predominant patellofemoral (PF) pain, a low flexion angle axial view will allow assessment of arthritis in that compartment (Figure 3). In these cases, magnetic resonance imaging (MRI) does not aid in determining the diagnosis or altering treatment planning; therefore, MRI in these patients only adds to the societal medical costs, and should be avoided. In fact, most arthritic knees will have incidental meniscal tears. Some patients will insist on arthroscopy to address these “tears” only to discover they have no improvement in pain or function.<sup>7</sup> They then progress to standard arthritic treatment after the unnecessary costs of arthroscopy. Once the diagnosis of DJD is confirmed, it is appropriate to begin standard nonoperative measures, which are well described in the literature. However, if radiographic changes are advanced, prolonged nonoperative treatment may lead to debilitation of lower extremity musculature and decreased activities such as exercise and social interaction, each of which has negative implications for the patient. In these patients with advanced radiographic changes, earlier evaluation by a surgeon with expertise in arthroplasty may be beneficial and lead to improved outcome.<sup>8,9</sup>

### Alternatives to Knee Arthroplasty

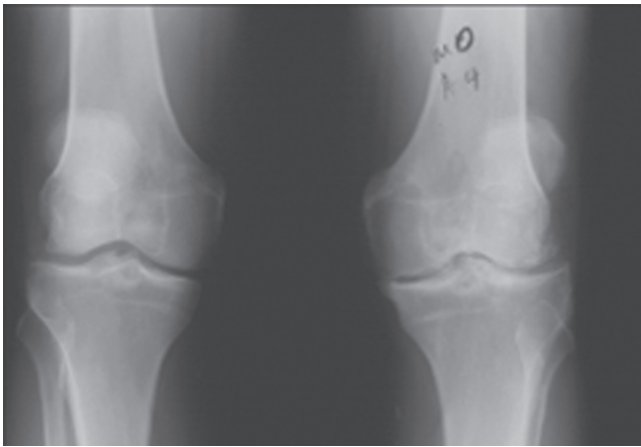
As a growing number of patients with knee arthritis are relatively young and want to remain as active as possible,

**Table 1.** Radiographs to Assess for Knee Degenerative Joint Disease

1. Standing WB anterior-posterior view: assesses TF joint space (anteriorly)
2. Standing WB flexed posterior-anterior view (also called skier or Rosenberg view): assesses TF joint space in a region of common first wear (ie, it will show DJD in many patients with moderate DJD who have “normal” anterior-posterior views)
3. Low flexion angle PF view (most commonly, the Merchant view): allows assessment of the PF joint space and patellar position. This is much more sensitive than sunrise or other high-flexion PF views
4. Lateral WB in mild flexion view: assesses patellar height, osteophytes, tilt of patella, and morphology of the trochlea (if posterior condyles are superimposed)
5. Optional hip to ankle WB anterior posterior view: assess the TF angle (degree of varus or valgus)

**Abbreviation:** DJD, degenerative joint disease; PF, patellofemoral; TF, tibiofemoral; WB, weight bearing.

**Figure 1.** Standing anteroposterior radiograph of both knees in full extension, which suggests moderate arthritis of both the medial and lateral compartments of the knee.



they may wish to explore alternatives to knee arthroplasty. For unicompartmental osteoarthritis in a knee compartment that is overloaded by malalignment, an unloading osteotomy may be a viable option (anteromedialization for PF malalignment, high tibial valgus osteotomy for the varus knee with medial compartment degeneration, and distal femoral varus osteotomy for the valgus knee with lateral compartment degeneration). Unfortunately, the more widely used cartilage restoration treatment options are predominantly indicated for focal cartilage defects (marrow stimulation, osteochondral autograft plugs). However, there are encouraging results for the cartilage restoration techniques that treat larger cartilage defect areas (autologous cultured chondrocyte implantation and osteochondral allograft), which demonstrate that it may be a semantic nuance of when a bipolar extensive loss of cartilage

is labeled as extensive chondrosis versus osteoarthritis.<sup>10</sup> Nonoperative measures are listed in Table 2.

## Knee Arthroplasty Options

Although most patients associate knee arthroplasty with a full or total knee arthroplasty (TKA), there is increased awareness of the option of partial knee arthroplasty (PKA)/unicompartmental knee arthroplasty (UKA). Partial knee arthroplasty denotes resurfacing of the medial or lateral tibiofemoral compartments or the PF compartment. This can involve just 1 compartment (unicompartmental) or 2 of the 3 compartments (bicompartamental). The goal of both options is to relieve pain and increase function. In the orthopedic community, there is an ongoing debate regarding the appropriate surgical indications for each of these procedures, and referring physicians should be alert for new evidence-based literature to aid in guiding judgments.

## Partial Knee Arthroplasty

### Tibiofemoral PKA

For patients with isolated DJD of the medial or lateral tibiofemoral compartment, PKR of that compartment can offer pain relief similar to a TKR, while at the same time retaining all the ligaments (significantly the ACL and PCL) and minimizing bone resection (Figure 4). By matching the contours of the compartment and retaining the cruciate ligaments, the complex motion of the knee is more closely approximated. Both medial and lateral compartment DJD can be treated with PKA, noting that approximately 90% are medial PKA and 10% are lateral PKA. There are clear differences in the anatomy and kinematics of the medial and lateral tibiofemo-

**Figure 2.** The same patient as Figure 1 with a standing PA flexion (40°–45°) radiograph of both knees, revealing the patient has advanced arthritis in the posterolateral compartment.



**Figure 3.** Low angle (Merchant) radiograph of both knees, revealing lateral facet arthritis on both sides.



ral compartments and surgical technique varies somewhat depending on the compartment being replaced.

### Patellofemoral PKA

Patellofemoral PKA, also referred to as “PF arthroplasty (PFA),” involves resurfacing of the PF compartment similarly to the TF PKA in that the natural contour of the knee is maintained and (in the case of the PKA) both menisci are retained (Figure 5). When evaluating patients with arthritis severe enough to consider arthroplasty, approximately 10% have DJD isolated to the PF compartment. Not only does PFA allow less bone resection, less blood loss, and a more normal motion pattern<sup>11,12</sup> of the knee than TKR, the patellar portion of the surgery can be retained if there is need to convert to a TKA in the future. Additional advantages of PKA versus TKA are listed in Table 3.

### Bicompartmental Arthroplasty

Although bicompartmental arthroplasty has a long history in Europe, it has only recently become popular in the United States. As the name implies, bicompartmental arthroplasty is used to treat 2

compartments of the knee, as opposed to the 3 compartments that are resurfaced with a TKA (Figure 6). There are 2 approaches: 1 component and 2 separate components. The 2 separate components technique has a longer history, and typically combines a PFA with a TF PKA. A newer entry into the field is a single component that has both a patellar resurfacing and a TF resurfacing area. The advantages to each are similar to unicompartmental approaches with a resurfacing approach and retention of the cruciate ligaments.

### Total Knee Arthroplasty

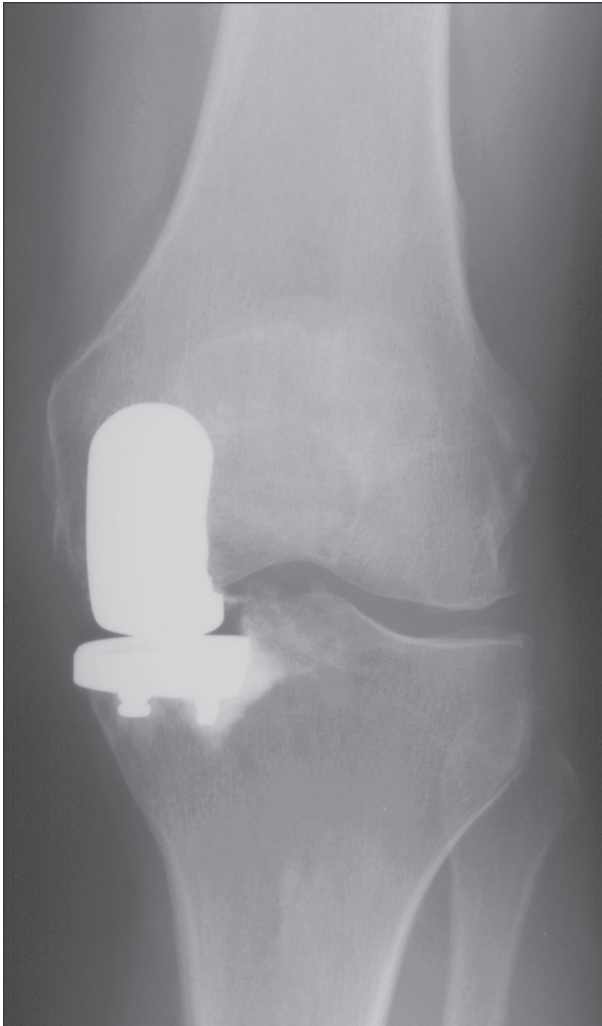
Total knee arthroplasty is the classic treatment for end-stage knee arthritis and has a long history of durability and patient satisfaction (Figure 7). With optimal implantation and patient factors, some patients who undergo TKA will have a functioning TKA after 20 years.<sup>13</sup> Although most current implants allow excellent pain relief and functional motion, patients note that the “knee is not normal.”<sup>14,15</sup> Lack of cruciate ligament function appears to be associated with reduced patient satisfaction.<sup>16,17</sup> However, there are documented advantages of TKA over PKA (Table 4).

**Table 2.** Alternatives to Knee Arthroplasty

1. Optimization of body weight (BMI)
2. Optimization of strength and endurance, often with the help of physical therapy
3. Shoe wear and inserts to decrease the load to the most painful side of the knee
4. Unloader knee bracing to decrease the load to the affected side of the knee
5. Knee injections (corticosteroid preparations and viscosupplements)
6. Oral medications (over-the-counter pain medication, anti-inflammatory, and nutraceuticals)
7. Realignment procedures
  - a. AMZ(Fulkerson AMZ) to improve patellofemoral loading for patellofemoral arthritis
  - b. High tibial osteotomy to realign and unload the tibiofemoral compartment—most commonly in a varus knee with medial compartment arthritis
  - c. Distal femoral varus osteotomy to realign and unload the tibiofemoral compartment—most commonly in a valgus knee with lateral compartment arthritis

**Abbreviations:** AMZ, anteromedialization; BMI, body mass index.

**Figure 4.** Anteroposterior radiograph of a PKA (unicondylar arthroplasty) of the medial compartment.



## Sports Participation After Knee Arthroplasty

### Total Knee Arthroplasty

Sports activity recommendations after TKA have been surveyed by several surgeons. All of the surveys have used the following criteria: activity allowed, activity allowed with experience, activity not allowed, or undecided. Healy et al<sup>18</sup> surveyed 58 members of The Knee Society in 1999, with a follow-up study in 2005 that included 70 members. Their survey attempted to identify a consensus for allowing certain sports and disallowing others. The following sports were not recommended in either survey: basketball,

**Table 3.** Advantages of PKR Compared with TKR

1. Improved kinematics (knee motion is more natural)<sup>32,33</sup>
2. Improved stairclimbing<sup>35</sup>
3. Less blood loss and bleeding complications<sup>36</sup>
4. Less bone resection (often allows conversion to a primary TKR when it fails compared to the need for a revision knee replacement when a TKR fails)<sup>37</sup>
5. Less post operative pain and faster recovery of strength and motion, and greater range of motion than TKR<sup>17,36</sup>
6. Possible overnight stay as opposed to a 2–3 day hospital stay for TKR<sup>36</sup>
7. Lower infection rate<sup>38</sup>

**Abbreviations:** PKR, partial knee replacement; TKR, total knee replacement.

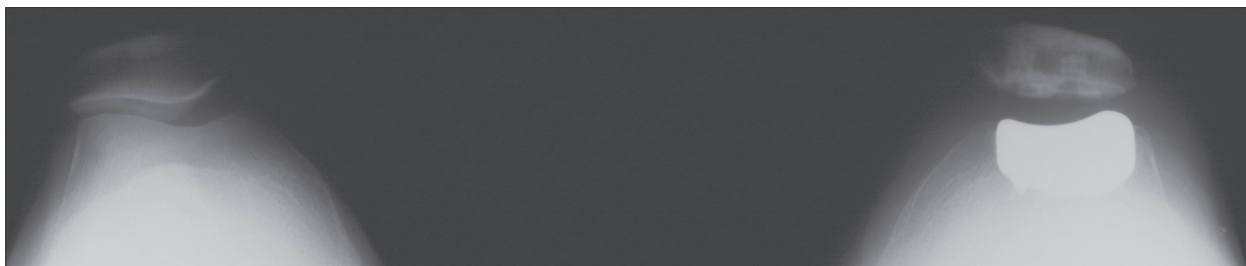
football, jogging, and soccer (presumably because they involved too much cutting and impact loads, although this was not specified). Healy et al<sup>18</sup> noted a clear trend toward liberalization of sports activity restrictions between the 1999 survey and the 2005 survey, and concluded that neither the original limitations nor the expansion of allowed sports activities were based on any scientific evidence. Instead, they represented expert opinion. A survey by Clifford and Mallon<sup>19</sup> of their patients' sports activity following arthroplasty failed to show any differences in recommended activities compared with Healthy et al.<sup>18</sup> Klein et al<sup>20</sup> surveyed 542 members of the American Association of Hip and Knee Surgeons. The authors noted a consistent surgeon position against recommending participation in so called "high-impact loading" sports, although the loads in the knee with these sports have never been studied in prosthetic joints.<sup>21,22</sup> They noted a liberalization of activity restrictions when comparing the 1999 Healy et al<sup>18</sup> report with Clifford and Mallon.<sup>19</sup> Only one study has observed patients with TKA function with more demanding "high-impact loading" sports. Mont et al<sup>23</sup> reported their series of patients with TKA who were participating in sports such as tennis, basketball, and racquetball. Of the 500 patients surveyed, they identified 33 with TKA who were participating in high-impact sports. At a mean 4-year follow-up, 32 of 33

**Table 4.** Advantages of TKA over PKA

1. More extensive base of outcome studies
2. Potentially longer survival<sup>38</sup>
3. Avoids the potential of other (nonresurfaced) compartment failures with PKA
4. More reproducible across surgeon pool<sup>38</sup>

**Abbreviations:** PKR, partial knee arthroplasty; TKR, total knee arthroplasty.



**Figure 5.** Low angle (Merchant) radiograph of a PF arthroplasty.

patients were able to tolerate a mean of 3.5 hours/week of sports associated with impact or cutting activities such as jogging, singles tennis, squash, racquetball, downhill skiing, and basketball. These patients all had good scores on the outcome scales used in the study.

### Unicompartmental Knee Arthroplasty

It is unclear whether patient activities correlate with their surgeons' activity restrictions. It is clear, however, that patients' perceptions of the success of their arthroplasty are related to the activities they perform after the arthroplasty.<sup>24-27</sup> Many surgeons maintain that patients with PKA have better kinematics than patients with TKA because of the presence of the cruciate ligaments and, at least in medial unicondylar and PF replacements, the preservation of the lateral meniscal sling. The meniscal sling is considered important in rollback of the lateral femur on the tibia, which is in turn important to high flexion. However, few studies have looked at the difference in patient function between PKA and TKA. Hopper and Leach<sup>28</sup> reported their retrospective comparison of 76 patients who had undergone TKA and 34 who had undergone PKA. The clear selection bias was that the TKA group had greater amounts of arthritis; nonetheless, using each patient as their own control, the PKA group had more patients returning to nonimpact sports compared with the TKA group (97% vs 64%). Walton et al<sup>29</sup> retrospectively reviewed their patients' results after mobile bearing medial unicondylar arthroplasty compared with a total knee cohort. One hundred fifty patients underwent PKA, and 120 underwent total knee replacement. They found significantly better modified Oxford and Grimsby scores in the unicondylar group, and also found more patients returned or increased their sports activity in the PKA group compared with the TKA group. Fisher et al<sup>30</sup> looked at the return to sports and activities in their group of mobile bearing medial PKA

patients. Although they did not compare their patients with a group of TKA patients, they noted (with a short follow-up of 18 months) that 76 patients improved from a mean University of California—Los Angeles (UCLA) score of 4.2 preoperative to 6.5 postoperative, with 93% of their patients returning to or exceeding their preoperative level of sports activity. Naal<sup>31</sup> reported on 83 patients with PKA and found that most returned to sports after PKA, but the number and extent of sporting activities diminished. Consequently, one important question remains despite these studies: will the reconstruction of these patients who return to high-impact loading activities

**Figure 6.** Anteroposterior radiograph of a medial PKA and a PF arthroplasty.

**Figure 7.** Anteroposterior radiograph of a TKA.

fail at an earlier rate than those of patients who perform only lower impact activities?

### Knee Arthroplasty Failure Mechanisms

There are several unanswered questions in the comparison of UKA versus TKA. It is not known whether failure mechanisms at high-level sports will be greater with UKA versus TKA. It is clear that the surface area for fixation is much smaller in the UKA group; however, the loads applied across this surface area are also less.

### Wear

The common concern with increased activities in patients with joint arthroplasties is failure of the joint. Failure may occur in many ways, but for those related to activity, the focus is on

material fatigue and loosening. Fortunately, material fatigue is rare with current designs. Loosening between the component and cement, or cement and bone, may occur with physical overload of these interfaces, but more common and insidious is the loosening that occurs with the immune system's response to wear debris: most commonly, the PE component (osteolysis). With each step (cycle), a microscopic amount of poly debris is released into the joint and local soft tissues. With increasing cycles, more debris is released in an arithmetic manner. However, with increasing force, the wear debris created is increased exponentially. Thus, as the force through the joint increases from walking activities (2.8 to 4.3 body weight [bw]), to jogging (8 to 10.3 bw), to running (up to 14 bw), the amount of wear debris increases dramatically. Fortunately, recent improvements in poly (increased cross-linking, improved elimination of free radicals created in cross linking) may decrease that wear. Surgeons and manufacturers have learned the importance of maintaining a minimum thickness of PE in both unicompartmental and total knee replacements. One of the major ways that poly wears is through sliding "shear" forces, and there is evidence that sliding may be greater in TKA than UKA because of the lack of one or both cruciate ligaments when the knee sustains a rapid deceleration moment such as running or jumping.<sup>32,33</sup>

### Loosening

Another concern with high-impact loading of arthroplasty components is that the force will lead to premature loosening. No previous report has shown an increased level of loosening associated with more active patients. Mont et al<sup>23</sup> did not show an increased level of loosening associated with high-impact sports.

### Conclusion

Evidence supporting that unicompartmental arthroplasty patients can participate in a higher level of sports activity than TKA patients is present, but it is relatively limited. As newer rating scales are developed that more accurately measure activity, these differences may become more apparent. Sports may be defined as a physical activity to maintain fitness, develop a physical skill and, at times, allow competition. The goal after arthroplasty is to optimize comfort and function, while minimizing the rate of implant failure. There is a balance between underuse and overuse that must be considered. Patients should first optimize strength in a structured rehabilitation program.

While advancing activities, they should not experience pain or swelling. The goal is to maintain physical fitness without arthroplasty failure. Low-impact activities are recommended such as walking, golf, swimming, bowling and biking. As some patients desire higher activity levels, intermediate activities such as doubles tennis, hiking, and cross-country skiing may be allowed on a limited basis (if the skill was present before the arthroplasty) to serve as a reward for maintaining fitness through low-impact activities. High-impact sports such as soccer, singles tennis, basketball, jogging, and racquetball require further study and are currently not recommended for UKA or TKA. Despite this, patients will continue to push the limits of their implants, and surgeons should continue to question their patients about their sports participation. Moreover, trials of higher activity are being conducted in certain centers, and it is possible that future reports will more clearly identify performance differences between TKA and UKA.

Patients should be counseled regarding the advantages of both unicompartmental and TKA. It is accurate to tell patients that recovery is shorter on average with unicompartmental arthroplasty, flexion is greater on average, and eccentric quadriceps contractions such as descending stairs and kneeling are generally easier with unicompartmental arthroplasty. All patients should be monitored with periodic radiographs to aid in detecting early evidence of arthroplasty loosening/failure, or accelerated bearing wear. With these guidelines, the hope is that patients will find an array of activities that allow them to maintain their cardiovascular fitness and a sense of well-being.

## Conflict of Interest Statement

Jack Farr, MD and William A. Jiranek, MD, FACS disclose conflicts of interest with DePuy Orthopaedics.

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