

Athletic Participation After Hip and Knee Arthroplasty

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Abstract

The issue of athletic participation after hip and knee arthroplasty has become more relevant in recent years, with an increase in the number of young and active patients receiving joint replacements. This article reviews patient-, surgery-, implant-, and sports-related factors, and discusses currently available guidelines that should be considered by the physician when counseling patients regarding a return to athletic activity after total joint arthroplasty. Current evidence regarding appropriate athletic participation after total hip arthroplasty, resurfacing hip arthroplasty, total knee arthroplasty, and unicondylar knee arthroplasty is reviewed.

The indications for hip and knee arthroplasty are expanding to include younger and more active patients. Several epidemiologic studies have produced data that show individuals who participate in athletics are at greater risk for developing osteoarthritis (OA) of the hip and knee.¹⁻⁵ Many of these active patients expect to continue to

participate in athletic activities following joint replacement surgery. “Direct to consumer” advertisements using athletes to market joint replacement implants, further perpetuates the concept that sporting activities are possible following joint arthroplasty. Surgeons treating these patients must be aware of the literature regarding athletic participation after arthroplasty so that they may appropriately counsel their patients. The purpose of this article is to review the experience of athletic participation after hip and knee arthroplasty, with emphasis on patient participation in athletics and the impact of athletic participation on arthroplasty outcomes, as well as to establish guidelines to assist surgeons in counseling post-arthroplasty patients regarding participation.

Activity After Hip and Knee Arthroplasty

The benefits of athletic activity following total joint arthroplasty (TJA) are undeniable. In addition to the psychological satisfaction that patients derive from athletic activity, there are the benefits of improved muscle strength, coordination, balance, endurance, and proprioception, all of which contribute to better body control and may prevent injury from simple falls and other minor trauma. Furthermore, studies have shown that cardiovascular fitness is positively affected by exercise after both hip and knee arthroplasty, with significant improvements shown for exercise duration, maximum workload, and peak oxygen consumption 2 years postoperatively.^{6,7}

Studies also support the conclusion that TJA may allow people to return to high levels of activity and recreational exercise. Moreover, individuals who were relatively sedentary prior to joint arthroplasty sometimes begin to participate in activity after a joint replacement.^{8,9} A study by Visuri and Honkanen⁸ showed that patients significantly increased their participation in low-impact activities, such as exercise walking, cycling, swimming, and cross-country skiing, after total hip arthroplasty (THA), while Diduch and colleagues⁹

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demonstrated that patients nearly tripled their activity scores after total knee arthroplasty (TKA).

Athletic activities may pose, however, special risks to an arthroplasty patient. These include acute injuries, such as periprosthetic fractures and dislocations, as well as more incipient problems that arise from repetitive loading and wear of the joint, such as osteolysis, a leading cause of aseptic loosening. Consequently, high-impact activities have traditionally been prohibited by surgeons after TJA, unlike low-impact activities, which are typically encouraged for maintenance of general health.^{10,11}

When counseling patients who desire to participate in athletic activities after hip or knee arthroplasty, the surgeon should consider that joint wear is a direct function of overall use.¹² While general recommendations and guidelines can be helpful when counseling patients regarding safe athletic participation following arthroplasty, ultimately, each case has to be evaluated on an individual basis. In order to make appropriate recommendations to maximize the chance of a long-term, pain-free, complication-free prosthetic joint in an athletic patient, one must appropriately consider and address patient-, surgery-, implant-, and sports-related factors.

Patient Factors

The most important determinant of the likelihood of sport participation after both THA and TKA is preoperative participation in the sport itself.^{13,14} Bradbury and coworkers¹⁴ reported that no preoperatively sedentary patients took up athletics after TKA, while 65% of those who participated in athletics preoperatively returned to athletics after their knee replacement. The investigators also noted that participation in athletics the year before surgery was specifically predictive of a return to athletic activity after TKA.

Surgical Factors

Surgical factors may have an effect on the patient's ability to participate in athletics and the risk of complications with that participation. For example, in hip arthroplasty, two important surgeon-controlled factors are the type of surgical approach and the amount of soft-tissue dissection. Anterolateral and direct lateral approaches require partial detachment of the abductors from the greater trochanter, which may result in temporary or permanent postoperative abductor weakness. This factor may affect athletic participation, because the abductor muscles are important in many sporting activities. On the other hand, the low rate of dislocations after anterolateral and direct lateral approaches^{15,16} makes these techniques an attractive option for hip arthroplasty in patients who plan to return to athletics.

The posterior surgical approach to the hip may result in higher dislocation rates than the anterior approaches, according to early studies. However, recent reports have shown that a capsular repair can reduce the risk of dislocation from anywhere between 4% to 6% without such repair to less than 1% with this repair.^{17,18} A 2006 systematic review of the

literature further found that reported dislocation rates after a posterior approach with repair of the capsule and external rotators were comparable to those after anterolateral and direct lateral approaches.¹⁹ The direct anterior approach is considered muscle sparing, but may require special equipment and may be unfamiliar to many surgeons. Unfamiliar or difficult approaches may compromise the surgeon's ability to place components in proper position and orientation, and this too can lead to increased risk of postoperative instability with athletic participation. When selecting a surgical approach, the most important goals are achieving appropriate component alignment, orientation, and sizing. These factors should not be compromised for the sake of performing a particular approach.

To date, no studies have shown improved ability to participate in athletics following any specific approach for hip or knee arthroplasty, and no differences in long-term outcomes have been documented when comparing newer "minimally invasive" arthroplasty approaches with more traditional approaches. However, it is possible that surgical techniques that avoid or minimize compromise of musculotendinous anatomy may afford some patients increased ability to participate in athletic activity after TJA. As well, when certain muscle groups, such as the abductors, are particularly necessary for a sport, an approach that avoids those groups may be advisable for patients wishing to participate in that sport.

Implant Factors

During the first generation of total joint replacement, catastrophic implant failure was a major concern. The later introduction of stronger, biocompatible metal alloys, such as cobalt-chrome and titanium, minimized this particular complication. Furthermore, advances in preparation, sterilization, and storage of polyethylene have significantly lowered the rates of volumetric wear and osteolysis.²⁰⁻²²

Studies have shown greater risk of failure of cemented acetabular components in younger, more active individuals, and this particular fixation method should be avoided in this patient population. Excellent fixation with low aseptic loosening rates has been reported for press-fit acetabular components, as well as press-fit femoral components.²³⁻²⁷ Introduction of new, biologically active metals brings promise of even better ingrowth potential in uncemented hip and knee arthroplasties.

There has been a renewed interest in using alternative bearings in order to lower rates of wear and aseptic loosening. These include metal-on-metal (MOM), ceramic, and highly cross-linked polyethylene implants. However, MOM bearings generate ionically-charged debris particles, which remain a concern, especially with recent reports of these ions being able to cross the placenta in females of childbearing age.^{28,29} Ceramic-on-ceramic bearings have also demonstrated excellent wear rates, but there were early reports of catastrophic fracture and failure that could occur on high im-

impact loading during athletic participation.³⁰⁻³³ Highly cross-linked polyethylene has shown low wear rates as well, but also carries an increased fracture risk, secondary to increased brittleness, compared with conventional polyethylene.³⁴⁻³⁷ These alternative bearings may lead to improved longevity and function of hip and knee prostheses in younger, more active individuals, but lower wear must be balanced against fracture risk that may be present with participation in impact athletics. Thus, the choice of which bearing surface to use should be tailored to each individual patient and their desired athletic activity and level of participation.

Sport Factors

Surgeons must also carefully consider the demands of a particular sport when counseling patients about athletic participation after TJA. The type (impact vs torsional) and magnitude of load that is imparted to the prosthetic joint by the athletic activity, the frequency of repetitive motion, and the risk of fall and heavy contact all influence implant survival in the athletic individual. Patients should be counseled regarding these risks before returning to a particular sport.

Athletics After Total Hip Arthroplasty

There is sufficient literature to suggest that safe and fulfilling participation in a number of athletic activities is possible after THA. Several studies have found no negative effects from high activity levels and athletic participation on clinical outcomes or durability of components.³⁸⁻⁴² Cornell and Ranawat³⁸ reported survival of all-cemented total hip implants in patients younger than 50 years at 10-year follow-up. They reported only two revisions for aseptic loosening in 101 hips and concluded that high activity levels do not negatively impact clinical outcomes of THA. Ritter and Meding³⁹ analyzed their patients with a minimum 3-year follow-up and found that low-impact activities, such as walking, golf, and bowling, had no negative effect on the outcomes of hip arthroplasty. Furthermore, several studies have shown lower rates of radiographic and clinical loosening requiring revision in active patients, compared with their more sedentary counterparts.⁴⁰⁻⁴² Although these results may seem surprising in light of the basic science evidence that wear is related to use,¹² proponents of athletics after hip arthroplasty argue that adequate loading of bone with exercise is beneficial for longevity of well-fixed ingrown components and that benefits to the musculoskeletal systems in terms of improvement in strength, endurance, and proprioception outweigh the negative effects of increased joint surface wear.⁴³

Those who argue against overly aggressive participation in athletic and high-impact activities after hip arthroplasty cite increased wear rates, leading to revision for aseptic loosening, and a potential for trauma, resulting in fracture or dislocation. In the frequently cited study by Kilgus and associates,⁴⁴ worse long-term results and higher revision rates were recorded in the more active patient group. The negative effects of increased activity were not observed in total hip

patients until about 10-years post-surgery. Another study also reported significantly higher revision rates in younger patients, when compared with their older, more sedentary counterparts and attributed this difference to higher levels of activity in the younger group.⁴⁵

Although periprosthetic fracture rates are increasing, there are few published reports of trauma resulting in periprosthetic fractures and dislocations, or either alone, as a result of athletic participation after hip arthroplasty.⁴⁶ However, patients participating in high risk or contact athletics should be counseled about the potential consequences of periprosthetic fractures or dislocations.

While no consensus has developed to date, three separate surveys of arthroplasty surgeons have recommended relatively similar guidelines for a return to athletics after THA.^{11,47,48} A number of sporting and recreational activities were classified as “allowed-recommended,” “allowed with previous experience,” “not allowed-recommended,” and “no conclusion.” Athletic activities can also be classified by level of impact: high, intermediate, or low. Generally, low impact activities are permitted after THA, intermediate impact activities are allowed with limitations and with previous experience, and high impact athletic are discouraged (Table 1).

Athletics After Hip Resurfacing Arthroplasty

Hip resurfacing arthroplasty is a procedure that is rapidly gaining popularity among orthopaedic surgeons and is being performed with increasing frequency in younger patients with hip arthritis. The proposed advantages of hip resurfacing over a THA include preservation of bone stock, more normal and natural load transfer in the proximal femur, and a low-wear MOM articulation. MOM articulation has advantages and disadvantages reported in the hip arthroplasty literature. Potential benefits include very low wear rates and improved stability due to the use of large femoral heads, which have led to an increase in the utilization of this bearing surface. However, production of ionically charged debris particles in MOM bearings and catastrophic failure with any edge loading remain concerns. The literature is conflicting regarding the issue of whether increased activity leads to greater debris production in patients with these bearings,⁴⁹⁻⁵¹ and no consensus on this topic exists.

There are no reports in the literature specifically focusing on surgeon criteria for return to athletic activity after hip resurfacing. Several recent studies have reported on patient ability to participate in athletics^{52,53} and on the effect of high activity levels on implant survivorship after hip resurfacing arthroplasty.⁵⁴⁻⁵⁶ The first report of patient participation in athletics after hip resurfacing, published in 2006, found that at 6-months follow-up all but one of 43 patients who participated in athletics preoperatively were able to return to their sport of choice after hip resurfacing. The investigators also found that the level of intensity and frequency of athletic participation was significantly increased compared

Table 1 Activity After Total Hip Arthroplasty—1999 Hip Society Survey*

Recommended-Allowed	Allowed with Experience	Not Recommended	No Conclusion
Stationary bicycling	Low-impact aerobics	High-impact aerobics	Jazz dancing
Croquet	Road bicycling	Baseball/softball	Square dancing
Ballroom dancing	Bowling	Basketball	Fencing
Golf	Canoeing	Football	Ice skating
Horseshoes	Hiking	Gymnastics	Roller/inline skating
Shooting	Horseback riding	Handball	Rowing
Shuffleboard	Cross-country skiing	Hockey	Speed walking
Swimming		Jogging	Downhill skiing
Doubles tennis		Lacrosse	Stationary skiing [†]
Walking		Racquetball	Weight lifting
		Squash	Weight machines
		Rock climbing	
		Soccer	
		Singles tennis	

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Table 2 Activity After Total Knee Arthroplasty—1999 Knee Society Survey*

Recommended-Allowed	Allowed with Experience	Not Recommended	No Conclusion
Low-impact aerobics	Road bicycling	Racquetball	Fencing
Stationary bicycling	Canoeing	Squash	Roller blade/inline skating
Bowling	Hiking	Rock climbing	Downhill skiing
Golf	Rowing	Soccer	Weight lifting
Dancing	Cross-country skiing	Singles tennis	
Horseback riding	Stationary skiing [†]	Volleyball	
Croquet	Speed walking	Football	
Walking	Tennis	Gymnastics	
Swimming	Weight machines	Lacrosse	
Shooting	Ice skating	Hockey	
Shuffleboard		Basketball	
Horseshoes		Jogging	
		Handball	

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to preoperative values.⁵² Furthermore, even patients who were not significantly active in athletics preoperatively were able to and did participate in athletics postoperatively. There were no athletics-related complications in this short-term study period. The study concluded that many activities that are prohibited or discouraged after THA are well-tolerated by patients after hip resurfacing, including soccer, singles tennis, squash, and running.⁵²

Another group assessed 112 patients at 2-years post-resurfacing and found a comparative rate of participation in athletics pre- and postoperatively, with nearly the same number of different types of athletics that patients were doing on a regular basis. About half the patients were able to return to athletics at 3 months postoperatively, and 90% were back to athletics by 6 months. Although, overall, there was a decrease in the rate of patient participation in high-impact athletics, such as jogging and tennis, half were able to return to skiing, and 22% participated in “contact athletics.” The investigators commented that the patient cohort was a particularly active group, with 26% participating

in sports at least 4-times a week prior to surgery. Seventy percent of patients reported that they were completely pain-free during sporting activities. The authors reported that there were no athletics-related complications in this relatively short follow-up period.⁵³

There are no studies specifically addressing the survival of hip resurfacing implants in patients who participate in athletics, but a number of studies exist that evaluate outcomes and implant survival in young, active patients. Daniel and colleagues⁵⁴ reported results of 446 hip resurfacings in 384 patients under the age of 55 years at a mean follow-up of 3.3 years, with maximum follow-up of 8.2 years. They noted a significant number of patients held jobs with a heavy or moderately heavy physical demand; 92% of males with unilateral implants and 87% of the overall group participated in athletics; and only 1 revision was performed in the follow-up period, for a revision rate of 0.02%. They concluded that hip resurfacing is an appropriate operation for suitably young, active patients with OA.

Similarly, Treacy and coworkers⁵⁵ looked at 130 patients

with 144 resurfaced hips at a mean age of 52 years, with a minimum 5-years follow-up. The investigators reported that 90% of patients in this group played sports at the time of last follow-up. No information on the type of sport or intensity of participation was reported. Three hips had to be revised, one due to aseptic loosening.

In 2007, Amstutz and associates⁵⁶ reported a mid-term follow-up study of outcomes in young patients (younger than 50 years at the time of operation) and compared these with older, less active patients. Implant survivorship rates and rates of revision were comparable between the two groups analyzed, with only 3% revised at 3 to 5 years. The investigators concluded that modern resurfacing performs well in young, active individuals, despite high activity levels.

Athletics After Total Knee Arthroplasty

The literature in athletic participation after TKA is even more limited, and the results are not as encouraging as those after THA. Bradbury and colleagues¹⁴ showed the factor most predictive of a return to athletics after TKA to be preoperative athletic participation, especially within 1 year prior to surgery; 77% of preoperative patients took-up athletic activity after their TKA, compared with only 35% of non-athletic patients. They also noted that while 91% of patients were able to return to low-impact athletics, only 20% were able to return to high-impact activities. Another recent study of 144 TKA patients found a decline both in the number of patients participating in athletics (85% preoperatively vs 75% postoperatively) and in the average number of activities taken up by each patient. There was a relative increase in participation in low-impact athletics and a decrease in participation in high-impact athletics. The investigators did note, however, that those patients who were able to return to athletics reported a perceived beneficial effect of the TKA on their athletic performance in their sport of choice.⁵⁷

Few studies have evaluated implant survival after TKA in athletic patients. An autopsy retrieval study by Lavernia and coworkers⁵⁸ looked at 28 polyethylene inserts in 22 patients with TKAs and reported a positive correlation between activity level and wear rate of the polyethylene. Specifically, it was noted that patient weight was the most predictive factor for volumetric wear, while patient activity level, as measured by UCLA (University of California, Los Angeles) score, was the most important predictor of poly creep and deformation. Another study⁵⁹ compared 26 patients who required revision of their TKA implants with 26 matched controls who did not, specifically inquiring about their activity level after the primary TKA. Most patients reported low or low-to-moderate activity levels. The investigators did not find an increased activity level in patients needing revision, and concluded that low-impact physical activity after TKA is not a risk factor for needing revision. Interestingly, they also noted that patients who reported reduction in their usual activity levels after their primary TKA were more likely to require

a revision surgery than those who maintained or increased their activity levels.

One of the largest series evaluating implant survival in young (less than 55 years of age), active patients reported that 87% of a total of 114 total knee implants were not revised and were asymptomatic at an average 8-year follow-up.⁹ Revisions were performed for infection (two cases), tibiofemoral instability (one case), patellar problems (three cases), and excessive poly wear (one case). When patellar revision was excluded, the 18-year rate of implant survival increased to 94%. All patients had good or excellent outcome scores. The patients in this study were, as a group, very active, with 60% walking an average of 2 miles per day, and many partaking in activities, such as golf, aerobics, hiking, and hunting. About 25% of the patients participated in what was considered very high-level activities, such as farming, construction, cycling, tennis, and downhill skiing.

In 1995, Mayo Clinic surgeons were surveyed regarding their preferences for allowing a return to athletics after TKA.¹¹ The survey revealed that most surgeons allowed a return to only no-impact or low-impact activities. In 1999, Healy and associates⁶⁰ surveyed the members of the Knee Society in order to develop consensus guidelines for athletic participation after TKA, and classified sports as “recommended-allowed,” “allowed with experience,” “not allowed,” and “no conclusion.” Similar to their THA recommendations, high-impact athletics were discouraged after TKA, while intermediate activities were allowed if patients had previous experience in their sport of choice. Low-impact activities were generally encouraged after TKA for maintenance of cardiovascular health (Table 2).

Athletics After Unicondylar Knee Arthroplasty

Unicondylar knee arthroplasty (UKA) is a procedure that preserves normal anatomy of all but one compartment of the knee joint and requires intact and functioning cruciate and collateral ligaments. Athletic participation after this procedure has been assessed in several studies. Fisher and colleagues⁶¹ reported an average 1.5-year follow-up of 76 patients who underwent UKA. They found that 93% of patients returned to their regular activities after appropriate rehabilitation, with improvement of the UCLA activity level score from 4.2 to 6.5. For many patients, these activities included participation in athletics, such as swimming, golf, dancing, bowling, cycling, hiking, jogging, gym, and squash.

Another recent study reported similar results, with 95% of 83 patients reporting a return to preoperative activity level at 1.5 years of follow-up. Most activities were of low or moderate impact, and there was an overall decrease in the average number of athletics in which each patient participated. Nevertheless, 90% of patients reported that surgery maintained or improved their ability to participate in athletics and that they were satisfied with this aspect of their surgery.⁵³

Comparing athletic participation after total versus unicompartmental knee replacement, Walton and coworkers⁶² assessed 120 TKA and 150 UKA patients, all treated for OA, at a minimum 1-year of follow-up. Noting same average age and preoperative level of athletic participation, the investigators reported that more patients were able to return to athletics after UKA than after TKA. Of those patients who returned to athletics, more UKA patients were able to maintain their preoperative level of athletic participation, compared with their TKA counterparts.

Athletic Activity After Total Joint Arthroplasty: Total Hip Arthroplasty Versus Total Knee Arthroplasty

Direct comparison of athletic participation after hip versus knee arthroplasty has been reported in only one study. Huch and associates⁶³ assessed athletic participation of 809 patients 5 years after hip or knee arthroplasty for OA. Although equivalent numbers of patients in each group participated in sporting activities prior to the onset of their symptoms, a significantly greater number of THA patients were able to return to athletics after their surgery. THA patients also were able to participate in athletics more frequently and for longer periods of time. THA patients were particularly more active in biking, hiking, swimming, and skiing (both downhill and cross-country), compared with the TKA patients. Furthermore, the investigators found that the TKA group reported more pain, and cited pain in the replaced joint as the reason for decreased athletic participation about twice as often as THA patients, while precaution was cited more frequently by THA patients as a reason for avoidance of athletic participation. Other reasons cited by patients for decreased athletic participation were advancing age, worries about wearing out the “artificial joint,” and surgeon advice. Even after controlling for confounding variables, such as gender, a higher rate of athletic participation was found for hip arthroplasty patients, and the investigators concluded with regard to post-arthroplasty athletic participation that THA patients had significantly better results than TKA patients.

Direct comparisons between THA and TKA patients also have been made for participation in golf and tennis. Mallon and Callaghan^{64,65} analyzed patient ability to return to golf after TJA and found that total hip patients generally fared better than their total knee counterparts. Overall, both THA and TKA patients had mild discomfort while playing golf. Mont and colleagues^{66,67} looked extensively at a return to tennis after TKA and THA for members of the United States Tennis Association, with the study group consisting of former or current competitive tennis players. The investigators reported on 33 patients with 46 TKA implants and 58 patients with 75 THA implants, both at a mean follow-up of 7 years. Compared with TKA patients, THA patients had slightly increased playing ability, but, otherwise, the two groups were comparable in terms of pain relief, satisfaction, and revision rates (4% in each group). However, these were

high-level athletes, and the results may not apply to more recreational players.

Overall Recommendations

In a 2005 review article, Clifford and Mallon¹⁰ provided their guidelines, based on the available literature, on athletic and exercise participation after TJA, with some differentiation between total knee and total hip patients. “Low-impact” activities are encouraged for all patients, as they help improve general health and cardiovascular fitness. These activities, which include golf, swimming, walking, stationary bike, treadmill, and elliptical machines, focus on conditioning and flexibility, rather than heavy loading for strengthening.

Activities classified as “potentially low impact,” such as bicycling, speed walking, cross-country skiing, dancing, Pilates, and rowing, require patients to have good balance and proprioception, and patients participating in these activities should be monitored by their surgeon regularly. For this class of activities, emphasis should be on a high number of repetitions with minimal resistance.¹⁰

Activities that have been deemed as “intermediate impact” include tennis, hiking, downhill skiing and snowboarding, weightlifting, ice skating and rollerblading, and low-impact aerobics. These may be allowed for a select group of patients. Excellent physical condition and previous experience with these sports are required to minimize risk of injury and accelerated implant wear. Orthotics and braces may be of some use in helping reduce impact and torsional loads on replaced joints.¹⁰

Finally, most TJA patients should be strongly discouraged from participation in very high-impact athletics, including those with high risk of contact. This class includes such sports as racquetball, running, high-impact aerobics, most ball sports, martial arts, and rock climbing. There is likely a higher risk of injury and need for revision with these activities. Nevertheless, with the advent of newer implants and the inclusion of younger patients in the arthroplasty population, it is very likely that more and more patients with total joint replacements will be participating in these athletics. Patients should be counseled appropriately, as the effect of high-impact athletic participation remains to be determined.

Summary

Patients should be encouraged to be active after TJA, and this may include participation in athletic activity. Patient and surgeon should consider the patient’s general health, previous athletic experience, surgical approach, implant characteristics, and the demands of a particular sport when determining whether participation in that sport is advisable.

Disclosure Statement

None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

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