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Physical Activity After Total Joint Arthroplasty

Laura A. Vogel, BS, Giuseppe Carotenuto, BA, John J. Basti, PT, and William N. Levine, MD*

Context: Total joint arthroplasty (TJA) is a common surgical option to treat painful degenerative joint disease. However, there is currently no consensus on the appropriate intensity of physical activity after TJA or how physical activity level affects the rate of revision surgery.

Materials and Methods: A systematic review of the literature regarding physical or athletic activity after TJA was performed to determine current clinical opinion and recommendations regarding appropriate activity levels after TJA, as well as variables affecting successful surgery and improved outcomes.

Results: Many studies in the literature regarding athletic activity after TJA focus on total hip arthroplasty and total knee arthroplasty. The literature reports contradictory results regarding rates of physical activity after TJA as well as the relationship between physical activity and rates of revision surgery. The current trend in expert opinion shows more liberal recommendations for patients to engage in athletic activity after TJA.

Conclusions: Individual characteristics, lifestyle, and patient preferences must be taken into account when one considers appropriate recommendations for athletic activity after TJA. Current trends in clinical opinion favor a higher level of athletic activity after TJA, but clinicians should caution patients not to participate in contact sports or sports that create high joint loads in the replaced joint.

Keywords: total; joint; arthroplasty; activity; physical

Total joint arthroplasty (TJA) is one of the most successful treatment options for patients with painful degenerative joint disease.¹⁸ Of the various types of TJA, total hip arthroplasty (THA) and total knee arthroplasty (TKA) have become well accepted as reliable and suitable surgical procedures to relieve pain, return lower extremity function, and improve health-related quality of life.³ There are fewer studies regarding activity after total shoulder arthroplasty (TSA).⁵¹ Pain relief has historically been the primary indication for total joint replacement; there are expected and relatively predictable gains in functional activities of daily living. Worldwide, more than 500 000 total joints are implanted yearly²⁷ with approximately 300 000 knee replacements performed each year in the United States alone.²² Although pain relief has historically been the primary indication for TJA, more and more individuals are now seeking TJA to maintain an active lifestyle; specifically, patients are seeking surgical interventions to restore their ability to participate in various athletics.⁵⁴ Many patients have embraced

higher expectations for an active lifestyle, incorporating athletic activities as part of their functional goals following surgery. With the trend toward demand for higher performance, exercise, and athletic activity, clinicians have been increasingly forced to question how much athletic activity a patient can participate in after TJA and what kind of athletic activities are deemed acceptable. Defining “reasonable” levels of activity with predictable outcomes has proven to be a difficult task.

MATERIALS AND METHODS

A systematic literature review was performed using PubMed/MEDLINE, Ovid MEDLINE, and the Cochrane Library. The databases were searched from January 1980 to the time of inquiry (January 2010) for English-language articles using the following search parameters (with Boolean operators in uppercase letters): (1) *total joint arthroplasty* OR *total hip arthroplasty* OR *total knee arthroplasty* OR *total shoulder*

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arthroplasty AND (2) *physical activity* OR *exercise* OR *sports*. The reference lists of eligible studies from the search results were also examined. Search parameters were intentionally broad to include as many potential references as possible, since the literature on this topic is limited. Articles were included on the basis of the following: (1) The study presented a series of patients undergoing TJA, and (2) sports or recreational activities were examined postoperatively or loading forces or cycles were quantified during movements simulating athletic activity. Articles were excluded if the main focus or comparison was reverse TSA, resurfacing THA, unicompartmental TKA, or joints other than hip, knee, or shoulder (ie, ankle, elbow). Review articles were eligible for inclusion if they offered unique clinical perspectives. The titles, abstracts, and text of search results were examined for relevancy.

RESULTS

Of the 1073 articles returned by the search parameters, 44 were eligible for inclusion. Of those, 36 reported results from series ranging in size from 1 to 2460 patients, and 8 articles reported survey data from surgeons on their recommendations of “allowed” and “prohibited” sports after TJA. After a survey of those articles, it was apparent that the best evidence for acceptable levels of participation in sports activities following TJA is currently based on consensus statements, retrospective studies, and surveys of orthopaedic surgeons.³ There are few prospective studies, and many of the existing prospective studies lack long-term follow-up to adequately assess events such as revision surgery. Tables 1 through 4 summarize the results of the patient series studies[†] and Tables 5 through 7 summarize surgeon recommendations for activity after TJA.[‡]

DISCUSSION

Following surgery, patients should be encouraged to reestablish and maintain a physically active lifestyle. Remaining physically active allows patients to maintain their general health^{46,47} after TJA and to enhance the quality of the interface between the bone and prosthesis.⁵⁴ There is evidence that increased bone quality may improve prosthesis fixation and decrease the incidence of early loosening.^{27,54} Surgeon concerns about participation in sporting activities following TJA are generally based on the increased joint load caused by athletic activity. Jogging has been shown to increase hip joint loads to more than 500% of a patient's body weight.⁴ Higher joint load results in increased implant wear and joint debris.⁴⁸ Increased use is associated with increased joint wear⁴⁸ and leads to periprosthetic osteolysis and eventual prosthetic failure.⁵³ Thus, the questions remain regarding what is considered a “safe” athletic activity and what constitutes “excessive” and therefore

“dangerous” athletic activity that may threaten the integrity of the implant. These parameters of function continue to be widely debated since there is minimal prospective evidence or randomized controlled trials to definitively support either side.

Many studies have reported decreased athletic activity after TKA or THA.^{6,8,21} In a study by Huch et al,²¹ the majority of patients cited “precaution” as the reason for their decreased postoperative athletic activity, which is most likely influenced by surgeons counseling patients to protect the life span of their prostheses. In contrast, there have been studies in the literature reporting that patients may actually increase their sports involvement after surgery^{22,56} and that there may be little to no adverse effects of high activity on TKA or THA.⁴¹ In light of these contradictory findings and increasing patient desires to engage in a highly active lifestyle, many surgeons now promote a more liberal level of athletic activity after TJA.

Survey data from the Hip Society and Knee Society regarding recommended athletic activities after joint replacement found that the number of “not recommended” sports decreased from 1999 to 2005 while activities that were “allowed with experience” or “allowed” increased.^{16,18} However, individual surgeon opinions are not necessarily well reflected by these collective opinions; when asked if they had changed their recommendations over the same time span, most surgeons did not report changes in opinion regarding “not recommended,” “allowed,” and “allowed with experience” activities.¹⁸ Thus, the controversy regarding sports participation after total joint replacement seems to lack a clear consensus opinion. With a lack of definitive evidence on safe activity loads and the shift from paternalistic medicine to a culture of health care consumers who often have increased expectations and functional demands, sporting activities after total joint replacement remain a frequently debated topic among orthopaedic surgeons. Surgeons must remain diligent to give patients the best postoperative instructions on returning to sports based on the existing evidence, not based on anecdotes or patient desires.

Kuster²⁷ states that to recommend a certain activity after TKA or THA, factors such as wear, joint load, intensity, and type of prosthesis must be taken into account for each patient and sport in question. Though he agrees with the popular opinion that reduction of wear is one of the main factors in improving long-term results after total joint replacement, he argues that one of the most important questions to answer when dealing with a patient who wants to engage in an athletic activity is whether it is performed for exercise for physical fitness, recreation, or the patient's profession. These variables affect the risk-benefit balance for patients who want to engage in athletic activity after TJA.

Like Kuster,²⁷ Bauman et al³ argue that activity recommendations should be assessed for each patient on an individual basis. Factors to consider include the patient's general health, prosthesis type and joint replaced, preoperative involvement in physical activity or sports and the level of intensity, and the activity that a patient wants to pursue

[†]References 1, 3, 5-15, 19-21, 23-25, 29, 30, 35, 36, 38-42, 44-47, 51, 52, 55, 58.

[‡]References 16, 26, 27, 31, 33, 34, 37, 54.

Table 1. Studies of activity after total hip arthroplasty (THA).

First Author	Journal	Year	n	Sports	Finding
Arbutnot ¹	<i>J Arthroplasty</i>	2007	750	Golf	No significant change in performance and level of participation 1 year after THA. Harris hip scores higher for golfers preoperatively and postoperatively than nongolfers.
Chatterji ⁷	<i>ANZ J Surg</i>	2004	216	General	Number of active patients increased from 188 to 196 postoperatively, increased low-impact and decreased high-impact activities.
Dubs ¹²	<i>Arch Orthop Trauma Surg</i>	1983	110	General	78% of patients regularly participated in sports preoperatively compared with 56% postoperatively. Revision for loosening was 14.3% in patients with no activity versus 1.6% in active patients.
Flugsrud ¹³	<i>Acta Orthop</i>	2007	1535	General	Men with high activity level had increased risk of revision due to loosening.
Gschwend ¹⁴	<i>Acta Orthop Scand</i>	2000	100	Skiing	Loosening seen in 5 of 60 implants of nonskiers and none in skiers. Wear rate was high in very active patients.
Heisel ¹⁹	<i>J Bone Joint Surg Am</i>	2005	8	General	Serum cobalt and chromium levels were not correlated with activity level.
Kilgus ²⁵	<i>Clin Orthop Relat Res</i>	1991	688	General	Revision surgery seen more frequently in highly active patients (28%) than less active patients (6%).
Mont ³⁹	<i>Am J Sports Med</i>	1999	58	Tennis	Three patients required revision surgery after a mean of 8 years. Only 14% of patients had surgeon approval to play tennis.
Peters ⁴⁵	<i>Wilderness Environ Med</i>	2003	1	Mountaineering	Case report of 1 patient who successfully resumed professional mountaineering after THA.
Ries ⁴⁶	<i>J Arthroplasty</i>	1997	30	General, cycling	Patients were able to improve cardiovascular fitness 2 years after THA as assessed by a cycling threshold test.
Sechriest ⁵²	<i>J Arthroplasty</i>	2007	34	Walking	Average gait cycles and wear rate were not accelerated in young patients compared to older patients.
van den Bogert ⁵⁵	<i>Med Sci Sports Exerc</i>	1999	9	Walking, running, skiing	Walking, controlled alpine skiing, and cross-country skiing produce comparable magnitude loading at the hip joint. Intense alpine skiing and running produce higher joint loads.

Table 2. Studies of activity after total knee arthroplasty (TKA).

First Author	Journal	Year	n	Sports	Finding
Bonnin ⁵	<i>Knee Surg Sports Traumatol Arthrosc</i>	2010	347	General	Among patients < 75 years old, 10% regularly participated in strenuous sports after TKA.
Bradbury ⁶	<i>Am J Sports Med</i>	1998	160	General	77% of patients who participated in regular exercise the year before surgery returned to sports.
Chatterji ⁸	<i>ANZ J Surg</i>	2005	144	General	Number of active patients decreased from 122 to 108 postoperatively, increased low-impact and decreased high-impact activities.
D'Lima ¹¹	<i>Clin Orthop Relat Res</i>	2008	3	Golf, tennis, cycling, jogging	Stationary cycling generated low forces in the knee. Jogging, tennis, and the golf swing generated high peak forces.
Dahm ⁹	<i>J Arthroplasty</i>	2007	335	General	12% of patients reported participating in labor/sports "not recommended" by the Knee Society survey. Walking, stationary cycling, swimming, and dancing were common activities after TKA.
Dahm ¹⁰	<i>J Arthroplasty</i>	2008	1630	General	16% of patients report participating in labor/sports "not recommended" by the Knee Society survey.
Hamai ¹⁵	<i>J Orthop Res</i>	2008	12	Golf, cycling	Stationary cycling produced gradual rotational movements in the knee. Golf swings produced significantly larger magnitude rotational motions.
Hopper ²⁰	<i>Knee Surg Sports Traumatol Arthrosc</i>	2008	110	General	63.6% of patients returned to sports but with less frequent participation.
Jones ²⁴	<i>J Rheumatol</i>	2004	52	General	Activity level did not appear to be risk factor for revision.
Marker ³⁵	<i>Iowa Orthop J</i>	2009	355	General	Moderate correlation ($R = 0.362$) between increased knee function and activity after TKA.
Mont ⁴⁰	<i>J Arthroplasty</i>	2008	33	General	Patients who participated in high-impact sports had successful clinical and radiographic outcomes at 4 years.
Mont ⁴¹	<i>Am J Sports Med</i>	2002	46	Tennis	All patients were satisfied with their ability to return to sport. Only 21% of patients had surgeon approval to play tennis.

(continued)

Table 2. (continued)

First Author	Journal	Year	n	Sports	Finding
Mont ³⁹	<i>Clin Orthop Relat Res</i>	2007	72	General	Low- to moderate-impact sports did not affect clinical or radiographic outcomes after TKA at midterm follow-up.
Nilsdotter ⁴⁴	<i>Acta Orthop</i>	2009	102	General	Patient expectations exceeded their capabilities at 5 years after TKA.
Ries ⁴⁷	<i>J Bone Joint Surg Am</i>	1996	19	General, cycling	Patients were able to improve cardiovascular fitness 2 years after TKA as assessed by a cycling threshold test.

Table 3. Studies of activity after total hip arthroplasty (THA) and/or total knee arthroplasty (TKA).

First Author	Journal	Year	n	Sports	Finding
Bauman ³	<i>Clin J Sport Med</i>	2007	354	General	Average total hip and knee joint replacement patients maintained moderate activity levels.
Huch ²¹	<i>Ann Rheum Dis</i>	2005	809	General	Preoperative sports participation increased from 36% to 52% after THA and decreased from 42% to 34% after TKA.
Levine ²⁹	<i>Clin Orthop Relat Res</i>	2009	38	Pilates	All patients performed modified Pilates exercises with no complications at short-term follow-up.
Liebs ³⁰	<i>J Bone Joint Surg Am</i>	2010	362	Cycling	Patients had better outcomes when assigned to perform ergometer cycling after THA; no differences seen after TKA.
Naal ⁴²	<i>Clin Orthop Relat Res</i>	2010	2460	General	Patients do not typically reach health-enhancing activity levels (10 000 steps/d) after THA or TKA (average 6721 steps/d).
Wylde ⁵⁸	<i>J Bone Joint Surg Br</i>	2008	2085	General	61.4% of patients returned to sport 1 to 3 years after surgery. Most common sports were swimming, walking, and golf.

after surgery. To maintain physical fitness, an endurance activity can be performed several times per week with high-intensity effort. Since joint load influences the amount of wear on the joint prosthesis in an exponential fashion,²⁸ many

surgeons believe that only activities with low joint loads (eg, swimming, cycling, or possibly power walking) should be recommended for routine participation.²⁷ Participation in high-impact activities with high joint load greatly increases the risk

Table 4. Studies of activity after total shoulder arthroplasty.

First Author	Journal	Year	n	Sports	Finding
Jensen ²³	<i>J Shoulder Elbow Surg</i>	1998	24	Golf	Of 24 patients, 23 returned to golf, some with improved performance.
McCarty ³⁶	<i>Am J Sports Med</i>	2008	75	General	71% of patients improved sports performance and 50% increased frequency of participation after total shoulder arthroplasty. Best improvements were seen in swimming, tennis, and golf.
Schumann ⁵¹	<i>Am J Sports Med</i>	2010	100	General	89% of patients who participated in sports preoperatively were able to return to sports. Most common sports were swimming, cycling, and fitness training.

Table 5. Activity recommendations after total hip arthroplasty.

Recommended		Recommended With Experience	Not Recommended
Golf	Cycling	Weight lifting	Singles tennis
Swimming	Elliptical	Cross-country skiing	Racquetball/squash
Doubles tennis	Low-impact aerobics	Downhill skiing	Jogging/running
Stairclimber	Dancing	Ice skating/rollerblading	Snowboarding
Walking/speedwalking	Rowing	Pilates	Contact sports (football, hockey, soccer)
Hiking	Weight machines		Baseball/softball
Stationary skiing	Treadmill (walking)		High-impact aerobics
Bowling			Martial arts
			Waterskiing
			Handball

of premature wear, thus leading to an otherwise avoidable premature prosthesis failure and revision surgery (as well as the associated inherent risks of undergoing another operation).

Kilgus et al²⁵ found higher rates of THA revision in patients with high activity versus those with low activity. A Swedish THA registry reported 20% revision in younger patients

versus 5% in older patients.³² While this finding is probably related to higher activity levels in younger patients, studies have shown similar activity rates for patients of all ages who have undergone joint replacement surgery.^{49,52,59} Thus, age is not necessarily an appropriate proxy for activity level when studying TJA.

Table 6. Activity recommendations after total knee arthroplasty.

Recommended	Recommended With Experience	Not Recommended
Low-impact aerobics	Cycling	Racquetball/squash
Bowling	Hiking	Contact sports (football, hockey, soccer)
Golf	Rowing	Rock climbing
Dancing	Cross-country skiing	Jogging/running
Walking	Stationary skiing	Singles tennis
Swimming	Speed walking	Waterskiing
	Doubles tennis	Baseball/softball
	Ice skating	Handball
		Martial arts

Table 7. Activity recommendations after total shoulder arthroplasty.

Recommended	Recommended With Experience	Not Recommended
Jogging/running	Cycling	Racquetball/squash
Aerobics	Rowing	Baseball/softball
Tennis	Walking/speedwalking	Downhill skiing
Basketball	Dancing	Snowboarding
Stairclimber	Pilates	
Hiking	Golf	
Cross-country skiing	Swimming	
Ice skating/rollerblading	Elliptical	
Bowling	Fencing	

In contrast, there have been reports of a negative correlation between physical activity and lower extremity TJA revision rates. Widhalm et al⁵⁷ found lower rates of prosthesis loosening among active patients. Dubs et al¹² reported lower rates of revision surgery after THA in active patients (1.6%) than in inactive patients (14.3%). Interestingly, one study reported that 5 of 60 inactive patients showed signs of prosthesis loosening at 5 years, while no patients in the active group had signs of loosening at that time point. At 10-year follow-up,

2 patients from the active group showed signs of loosening, and there was no new loosening in the inactive group.¹⁴ This suggests that some degree of activity promotes bone density and decreases early prosthesis loosening but that too much activity leads to excessive wear and increased late prosthesis loosening. Clearly, long-term follow-up is needed for the full effects of activity on TJA. It is also worth noting that significant surgical innovation has occurred since many of the studies on revision rates; their conclusions may not be valid for current

clinical practice. In general, limiting activities to low joint loads (eg, swimming or walking) decreases excessive wear, which may then allow for a more predictable, successful functional outcome and avoidance of revision surgery.

The belief that high-impact activities and overuse lead to component failure is not universally supported.⁴¹ In one study, only 4% of active competitive tennis players (2 of 33) needed revision surgery, thus demonstrating that sports activity may not predispose highly active individuals to premature component failure or the need for revision surgery any more than it does sedentary individuals after similar procedures. Furthermore, both of those who required revision surgery had cemented TKAs, which suggests that parameters regarding the procedure itself may be a stronger correlate with a successful surgery than patient activity after the procedure. Another example involves the observation that deep knee flexion with standard TKAs has been associated with increased load and, potentially, increased failure rates^{2,43}; in contrast, newer, high-flexion TKAs with posterior stabilization are designed to more accurately replicate normal knee kinematics and allow for greater knee flexion. Argenson et al² found that patients who received a high-flexion TKA and were able to achieve postoperative knee flexion greater than 125° reported higher subjective outcomes than those with flexion less than 125°. This again suggests that details of the procedure (ie, prosthesis choice) have a high degree of interplay with other factors, such as patient activity, in determining overall patient outcomes. Further evaluation of athletic activity and newer prosthesis designs, such as high-flexion TKAs or metal-on-metal bearings, should be performed to determine if they allow a safe increase in athletic activity compared to traditional prostheses.

Some authors suggest that it is “safer” for clinicians to recommend low levels of activity after total joint replacement operations than to advocate high-risk or high-demand athletic activity.¹⁸ It is prudent to advise patients to avoid recreational and athletic activities until their quadriceps and hamstrings are sufficiently rehabilitated, to decrease early postoperative injury; ultimately, though, patients should be allowed to choose which activities they wish to participate in after TJA. Contact sports and high-impact loading sports, such as soccer, baseball, hockey, football, and basketball, have a higher risk of directly damaging the replaced joint, and patients should be appropriately counseled regarding the risks of engaging in those sports.

Many of the principles described above for lower extremity TJA also apply to upper extremity TJA, such as TSA. Schumann et al⁵¹ found that 89% of patients who participated in sports preoperatively were able to participate in sports at a similar level after TSA (Figures 1 and 2), although a significant number (36.7%) reported persistent restrictions on their sports activities after surgery. Motivation and training are important determinants in how much athletic activity patients achieve postoperatively. Patients in that study did not stop all sports activities after TSA. In comparison, other studies report that 16% to 19% of patients do not resume sports activities after



Figure 1. Forty-seven-year-old right-hand dominant man 2 years following a right total shoulder replacement. He has returned to all activities including throwing a football, mountain-biking, and swimming.
Courtesy of Columbia University Center for Shoulder, Elbow and Sports Medicine.



Figure 2. Seventy-three-year-old right-hand dominant man 2 years following a right total shoulder replacement. He has returned to playing golf without difficulty. He has no pain and no limitations.
Courtesy of Columbia University Center for Shoulder, Elbow and Sports Medicine.

TSA. It is not known if postoperative limitations were due to shoulder problems or comorbid medical conditions.^{36,50}

In summary, joint replacements relieve pain, improve function, correct physical deformity, increase social mobility, preserve an independent lifestyle, and contribute to psychological well-being.²² Arthroplasty patients often believe that their level of physical activity will increase after their surgery as their pain decreases,²² but this does not always occur.^{6,8,21} Although joint replacements are cost-effective medical treatments that provide substantial improvements in quality of life, the true relationship between athletic activity and the rate of revision surgery remains unclear.^{12,17,25} The

existing literature does not allow one to definitively draw conclusions on sports in general or high-risk activity after TJA in particular. The prevailing belief is that overuse is related to prosthesis loosening or excessive wear of component surfaces. Patients who participate in high-impact activities may be more likely to need revision surgery at long-term follow up.⁴¹

CLINICAL RECOMMENDATIONS

The following clinical recommendations are opinions based on literature reflecting clinical practice.

Subdividing TJA patients into the following 3 groups may help guide practitioners in rehabilitation plans for patients after TJA: younger patients who have joint disease as a result of traumatic injury, older patients with degenerative disease, and rheumatoid patients with systemic disease who require joint sparing procedures. The younger patients are often those who want to participate in high-level sports activity after TJA.

Patients often experience difficulty during rehabilitation and physical therapy after TKA because of significant postoperative pain, which is also often accompanied by stiffness and inflammation. Surgeons and therapists should counsel patients in that it may take as long as 3 months to significantly improve their symptoms. Sports that create high knee joint loads (ie, running) or have high-contact potential (ie, football) are not recommended for patients after TKA. Many surgeons allow patients to engage in high-risk activities such as skiing if they have previous experience, but patients should be informed of the risk of wear, loosening, periprosthetic fractures, or revision surgery (Table 6).

The shoulder is a complex joint with little stability; rehabilitation after TSA should again focus on range of motion but then transition to working on increased rotator cuff and deltoid strength. After TSA, tennis players can begin with groundstrokes at 4 to 6 months after surgery and engage in open play after 6 months. Sports that create extremely high stress in the shoulder joint (eg, gymnastics) or have high contact potential (eg, hockey) are not recommended. Throwing sports (eg, baseball) are recommended only with prior experience in the sport (Table 7).

Rehabilitation after THA generally lasts 4 to 5 months, although some patients can return to sports between 3 and 6 months after surgery.²⁶ Restrictions on sports participation after THA are less strict than after TKA, but patients should still avoid contact sports (eg, football, hockey) and high-impact activity (eg, running) (Table 5). Patients should be counseled of the details of possible complications, prosthesis failure, and revision surgery.

CONCLUSIONS

Recommendations for sports activity after TJA must take into account multiple factors, such as age, type of prosthesis, underlying diseases, comorbidities, athletic experience, and degree of rehabilitation.⁵³ Patients should realize that there is

still the possibility that other existing pathology may become symptomatic after TJA if they increase their activity level. Most important, since there are no definitive guidelines for all patients, clinicians must educate them regarding the risks of athletic activity after TJA. Counseling should include the general consensus that high-impact activities are not recommended for patients with TJA and that revision procedures have a higher rate of complications. Ultimately, patients will make decisions about sports participation that fit their lifestyles and goals.¹⁸ Clinicians should regularly communicate with them to assess their potential to regain function and decrease symptoms, according to their medical histories, intraoperative details, and performance in physical therapy.

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