



## Current knowledge in orthopaedic surgery on recommending sport activities after total hip and knee replacement

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**The increasing number of younger patients with total hip arthroplasty and total knee arthroplasty sets higher demands on the postoperative quality of life. When it comes to athletic activity, recommendations and guidelines for sports remain unclear.**

**We have reviewed published literature to determine the extent to which patients resume their athletic activities postoperatively, and what would be the best choice. Golf and double tennis remain the most recommended activities. No-impact, low power sports like swimming and bicycling are generally allowed. Jogging is not considered as a factor for short-term implant failure, but a long-term analysis is needed. Contact and high-impact sports like football or basketball are not recommended. There are no recommendations regarding alpinism and field hockey.**

**Keywords :** hip arthroplasty ; knee arthroplasty ; quality of life ; sport.

### INTRODUCTION

The number of patients with total hip arthroplasty (THA) and total knee arthroplasty (TKA) has significantly increased in the last 30 years (28,29,33). The main goals of arthroplasty are to regain normal joint function, eliminate pain, correct the deformity and to improve overall mobilization (14). Even though new joint functions, implant survival and postoperative quality of life are constantly being

re-evaluated, recommendations and guidelines for sport and daily activities after hip or knee replacement remain unclear. (36).

Historically, the main indication for total joint arthroplasty was pain (10). Since the 1990s a steady increase has been noted in both the number and the prevalence of THA and TKA in Europe and the United States. Until 2002, the rate of primary THA doubled, whereas the corresponding rate of primary TKA tripled (16). Overall, the data suggests that between the year 2015 and 2030 the number of THA will increase 174% and number of TKA will increase 673% (14,16,17).

Nowadays, the main age of patients undergoing arthroplasty is 61.7 years (42 to 71.5), (18) but,

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according to new trends, future target group will be in the 45 to 54 years age category (17). Since the age limit for THA and TKA is decreasing, patients have higher expectations regarding an active lifestyle and desired physical activity after the surgery. Their functional goals include performing athletic, professional and daily activities, such as cycling, driving, specific activities needed for playing with grandchildren, religious activities, crouching or kneeling, as well as sexual activities (4,5,31,35).

Nonetheless, patients are often insufficiently informed about their abilities after the operation and, therefore, are unaware of the dangers regarding some of recreational or sport activities (5).

On the other hand, there are only few articles published on the analysis of preferred sports and amount of practicing sport activities after THA and TKA. Current consensus on recommendations published by the American Association for Hip and Knee Surgeons is based on experts' opinions from questionnaires and currently serves as a guideline overview for orthopaedic surgeons (33).

The aim of this review is to compare the experts' opinion with the evidence-based summaries that explored patients' ability to return to their athletic and daily activities postoperatively.

## METHODS

We evaluated Consensus Guidelines based on survey members from The Hip Society, The Knee Society, The American Association of Hip and Knee Surgeons and The British Hip Society and compared them with studies that examined to what extent patients participate in athletic activities after THA and/or TKA.

The electronic database MEDLINE was searched for further literature. We reviewed the titles and abstracts in search for suitable studies. Inclusion criteria were: a) patients who underwent THA and/or TKA surgery; b) who were active in sports and resumed their sporting activities postoperatively; c) patients who were included in specific activities such as walking, jogging, swimming, tennis and golf. We singled out 19 studies which met our criteria. We did not exclude articles based on duration of the follow-up period. Review articles

have been read and analysed, but not included in the results.

## RESULTS

### *Opinion of Orthopaedic Surgeons*

McGrory et al. evaluated the work of 28 orthopedic surgeons and 15 doctors in Mayo Clinic in 1995 and their view on playing sports after joint arthroplasty. Sports recommended after THA/TKA by the authors were non-contact sports: golf, swimming, cycling, sailing, bowling, scuba diving and cross-country skiing for TKA. Hiking, volleyball, singles and double tennis, aerobics accounted for intermediate activities. Jogging and contact sports were not recommended: handball, hockey, waterskiing, karate, soccer, baseball, basketball and football. (24).

In 1999 and 2005, Healy et al. evaluated opinion of the members of the Hip Society and the Knee Society in 43 sporting activities. In 2007, new recommendations for THA were presented from Klein in 37 specific activities and for both THA/TKA in 15 activities from Swanson. Both authors surveyed members of the Hip Society and The American Association of Hip and Knee Surgeons. The number of Healy's not recommended sports after THA decreased from 12 to 4 and after TKA from 12 to 5. The number of recommended sports grew from 13 to total 22 after THA, and from 18 to 19 after TKA. 13 activities were reclassified in Klein's study to allowed and allowed with experience from the initial Healy's study (12,15). Swanson evaluated the amount of practicing certain activities in his study in 2009. In 2016 Bradley et al. underwent a survey about 22 sporting activities amongs the members of the British Hip Society (3). Experts' recommendations after THA in a 10-year interval are presented in the Table 1. Only sports that have been evaluated in at least 2 surveys are presented.

All studies agreed that walking, stationary cycling, ballroom dancing, golf, bowling and swimming are recommendable activities after joint arthroplasty. Basketball, football, running, baseball, gymnastics, handball, hockey and soccer were not

Table I. — Experts' recommendations for sports activity after total hip arthroplasty (THA); A : allowed; E : allowed with experience; N : not recommended; U : undecided; / : no data for particular year.

SPORT	Experts' recommendations after THA			SPORT	Experts' recommendations after THA		
	McGrory, 1995	Healy, 2005	Bradley, 2016		McGrory 1995	Healy, 2005	Bradley, 2016
<b>Aerobics low impact</b>	E	/	A	<b>Ice skating</b>	E	E	E
<b>Ballroom Dancing</b>	/	A	A	<b>Racquetball</b>	N	U	/
<b>Baseball</b>	N	U	/	<b>Roller skating</b>	/	E	E
<b>Basketball</b>	N	N	N	<b>Rowing</b>	/	E	A
<b>Bowling</b>	A	A	A	<b>Running</b>	N	N	N
<b>Cross country skiing</b>	E	E	/	<b>Singles tennis</b>	E	U	/
<b>Cycling</b>	A	A	A	<b>Soccer</b>	N	N	N
<b>Doubles tennis</b>	E	E	/	<b>Speed walking</b>	E	A	/
<b>Football</b>	N	N	N	<b>Squash</b>	/	U	E
<b>Golf</b>	A	A	A	<b>Swimming</b>	A	A	A
<b>Handball</b>	N	U	N	<b>Volleyball</b>	E	U	/
<b>Hiking</b>	E	A	A	<b>Walking</b>	/	A	A
<b>Hockey</b>	N	U	/	<b>Weight lifting</b>	/	E	E

recommended. It is noted that surgeons were more liberal in recommending activities following THA than TKA. Double tennis, rowing and stationary skiing are allowed after THA but after TKA only with experience. Weight lifting and weight machines are allowed with experience after THA but remain undecided for TKA. Roller skating is undecided after TKA while ice skating is allowed with experience, and both sports are allowed with experience after THA. Volleyball is not allowed after TKA, but has no clear conclusion after THA.

In general, with years surgeons showed greater tolerance and acceptance in granting their patients an ability to return to activities that were formerly not allowed or not defined. In addition, surgeons with the high rate of revision procedures were more liberal in recommending more demanding activities. It is important to state that respondents reported their recommendations had no scientific evidence. Responds to all of these surveys were based on subjective opinions and experience of the surgeons (33).

#### *Returning to sports after arthroplasty*

After TKA, up to 88% of patients who regularly practiced sports continued with their activities, but these results were noted after only one year of follow-up (5). After a five year follow-up, Huch et al. also indicates a decrease of 12% (13) when Bradbury et al. reports that only 65% of patients regularly participated in sports (2). Vielgut et al. with a mean follow-up of 10 years showed that 70,8% patients stayed actively involved in sports (34) (Table II). Even though the number of patients performing sports after TKA is declining, the increasing age of these patients should be taken into consideration while performing certain activities (13). Dahm et al. reported activities were also limited due to other joint problems in 53% of patients (7). Interestingly, patients who underwent THA managed to improve their activity level by 16% (13).

Low-impact activities were preferable by patients, making walking the most popular postoperative activity (5). Come backs to golf and tennis were

Table II. — Returning to sports after joint arthroplasty ; TKA : total knee arthroplasty ; THA : total hip arthroplasty

Author	Number of patients	Type of operation	Mean follow-up time	% of return to sport
Dahm <i>et al.</i>	1630	TKA	5.7	11
Bradbury <i>et al.</i>	160-208	TKA	5	81
Chatterji <i>et al.</i>	144	TKA	1	85
Vielgut <i>et al.</i>	236	TKA	10	70.8
Huch <i>et al.</i>	636	THA/TKA	5	43
Dubs <i>et al.</i>	110	THA	6	55

significantly reduced, respectively 50% for golf and only 20% for tennis. Patients' worries about their artificial joint and surgeons' recommendations may have an impact on the activity type. Even 16% of the patients report participating in heavy manual labour or sports that were "not recommended" by the KS survey (7).

Nevertheless, when it comes to clinical outcomes after TKA, there seems to be no difference between the high-activity and low-activity patients. Mont *et al.* indicates that there is almost no difference in the outcome between the groups regarding the incidence of prosthesis related complications when performing low to moderate impact sports. Patients who did not participate in sports after THA even reported 14,3% to 1,6% greater incidence of a replacement due to loosening (25). When these findings are taken into consideration, it seems reasonable to allow gradual resumption of sports in younger patients.

#### Impact force

First scientific research on this topic emerged with a D'Limas research in 2005 and 2008. Tibial forces generated during daily activities and sports were measured with a custom made tibial prosthesis. They reported contact stress of in the following activities: walking on ground (2.6×body weight), treadmill (2,05×BW), cycling (1,3×BW), jogging (3.6×BW), tennis (3.6×BW during forehand stroke and 3.1×BW during backhand stroke), and golf driving swing (4.5×BW in the leading leg and 3.2×BW in the opposite leg) (8,9). The results of contact stress corresponded to the recommended level of activity. Comparison of guidelines with measured in vivo knee forces is presented in Table III.

#### Walking

Walking is listed as an allowed activity (12,15,24) that can be practiced unlimitedly (99,3%) (33) with a low-contact stress level of 2.6×BW (8). Nearly 40% of THA patients who were preoperatively unable to walk more than 10 minutes could walk after the operation more than 60 minutes (30). An increase was also noted in their walking speed, longer walking distance and more oxygen consumption (21). TKA patients also increased walking activity by using more vigorous steps, but only 16.5% achieved the guideline recommendations for walking compared to the control group used in the study (20).

#### Cycling on even surfaces (ergo meter)

Cycling was listed as an allowed activity (12,15,24) that can be practiced unlimitedly (97,8%) (33) The load placed by the body weight on the hip joint has been reduced, while knee joints were engaged with a large range of flexion. Forces generated when pedaling were even lower than walking (8). Cycling showed beneficial effect on patients after THA. Outcome parameters were significantly higher (14.7 to 9.0) in Western Ontario and McMaster Universities Osteoarthritis Index scores and overall satisfaction rate rose (92% to 80%) in the ergo meter cycling group. Results following TKA showed no significant differences between two study groups (19).

#### Jogging

Jogging was generally considered as a high-impact force activity and was not recommended in any study (12,15,24). It was estimated that knee forces can range from 7× up to 22×BW while running.

Table III. — Comparison of guidelines with measured in vivo knee forces ; A : allowed; E : allowed with experience; N : not recommended; U : undecided; /: no data for particular year; BW : body weight

SPORT	Experts' Recommendations after TKA			Measured in vivo knee forces during recreation after knee arthroplasty
	McGrory, 1995	Healy, 1999	Swanson, 2007	
Aerobics (low impact)	E	A	/	
Baseball and softball	N	N	/	
Contact sports	N	N	N	
Bicycling (road)	/	E	A	
Bicycling (stationary)	A	A	A	1,3 x BW
Bowling	A	A	/	
Golf	A	A	/	4.5 × BW in leading leg and 3.2 × BW in opposite leg
Hiking	E	E	/	
Hockey	N	N	/	
Jogging	N	N	N	3.6 × BW
Skiing (cross country)	E	E	/	
Speed walking	E	E	/	
Swimming	A	A	A	
Tennis (doubles)	E	E	A	3.6 × BW during forehand stroke and 3.1 × BW during backhand stroke
Tennis (singles)	E	N	N	
Volleyball	E	N	/	
Walking	/	A	A	2.6 × BW

Forces measured while jogging were 3.6× greater than BW (8). Most recent study performed by Abe et al. included 804 hips in 608 patients who underwent THA between 2005 and 2011 with a follow-up longer than 1 year. Only 33 patients performed jogging preoperatively and 23 continued jogging postoperatively. Analysis showed that men with history of preoperative jogging were more prone to continue jogging postoperatively. No negative influence of jogging on implant survival was noted in this group during a short-term follow up (mean 4.8 years) (1). Longer follow up period should clarify the influence of high-impact activities on newer implants.

#### Swimming

Enlisted as an allowed sport by the HS, swimming was considered as a low impact activity (6) and was often recommended during the rehabilitation period

(99,3%) (33). However, patients were not getting satisfactory information about which swimming styles to use and for what period of time. The main concern of most patients was if they could swim breaststroke after THA. Singh et al. recommend a frog kick technique for swimming breaststroke because it employs all the targeted muscles needed for hip rehabilitation (quadriceps, hamstrings, adductors, abductors, gluteus maximums), and stimulates patients to use hip flexion, external rotation, abduction and adduction with knee flexion and extension while swimming. Authors also found no reported cases of dislocated hip prosthesis in the literature. The ideal time for starting swimming after THA would be after 6 weeks postoperatively (32).

#### Tennis

Tennis was not recommended after joint replacement (15,33) due to sudden changes in the

joint position and high loads on a replaced joint ( $3.6\times BW$  during forehand stroke and  $3.1\times BW$  during backhand stroke) (8). It was discouraged by 60.6% after TKA, and 50% after THA (12). Unlike single tennis, all authors considered allowing double tennis. (12,15,24). Despite these recommendations, all active tennis players continued playing tennis after TKA and THA. Patients had increased mobility on the field but they lost their speed during the game. Only 12% of TKA patients felt pain while playing, and 16% of THA patients. Losing speed is questionable whether it can be associated with postoperative treatment, or aging during a 7-8 year follow up period (25,27). Patients were generally satisfied in the both studies (26).

### Golf

Golf has also been placed on a recommended list of all activities in each study (12,15,24), but after impact forces were measured, it showed that a golf swing derives contact force  $4.5\times BW$  in the leading leg and  $3.2\times BW$  in the opposite leg. Impact force that occurs while swinging is even higher than the peak load while jogging (8). Mallon et Callaghan followed amateur golfers after THA and TKA. All patients resumed playing golf. Patients denied pain while playing golf while 41% of THA patients and 35% of TKA patients stated they felt moderate to severe pain after participating in golf. Also, it is interesting that nearly 90% of patients used a golf car (22). Difference between right and left TKA in golf players was evidenced. Right-hand dominant patients had higher pain in the left knee because higher force was brought to the opposite leg while hitting the ball (23).

## DISCUSSION

Guidelines recommend returning to low and intermediate-impact sports, and discourage practicing high-impact and contact sports (12,15,24,33). Consensus guidelines were based on experts' opinions and experience without evidence-based conclusions, so it remains unclear whether patients should practice high-impact sports postoperatively (36).

When it comes to jogging, studies are in contrary with some general recommendations. Dubs et al. endorse resuming sports after THA, including jogging, which is considered a high-impact activity ( $3.6\times BW$ ) and is not recommended. No negative impacts occurred on implant survival during short-term jogging. It is also noted that patients who did not participate in athletic activities had a greater revision rate (1,11,25). Since implant survival has not been reduced in active patients, our study suggests that new recommendations on jogging should be considered. A long-term prospective study should measure loading cycles (number of steps) and approved mileage compatible with implant survival.

Recommendations are different for single and double tennis due to different gaming styles. Single tennis is not allowed by any association (12,14,24), whereas double tennis is allowed even unlimitedly (33). Players run less in double tennis and the number of sudden joint movements is reduced as well. Loads that occurred during forehand ( $3.6\times BW$ ) and backhand stroke ( $3.1\times BW$ ) on the implant remain the same (8,9). Mont et al. proved active tennis players were capable of resuming their sporting activities, after both TKA and THA. The number of swings in tennis combined with the amount of running per match seemed to provide good clinical outcomes in patients (26,27,33). Although 7-8 years was a short follow-up period for monitoring durability of the prosthesis in active tennis players, it was enough to conclude that active tennis players can resume playing their tennis again. Recommendations on double and single tennis should also be reconsidered.

Similar accounts for golf, which remained high on the recommended scale of sports, even though new studies suggested that golf swings generated a greater impact force (leading leg  $4.5\times BW$ , opposite leg  $3.2\times BW$ ) on the joints than jogging itself. Mallon also reported amateur golfers were fully capable to play again after TKA and THA. No negative influence was noted on the implant survival during short-term golf as well (22,23). However, the generated peak force is higher than in jogging and tennis, the repetition of loading cycles is significantly smaller. Number of swings per golf game seems to correlate well with implant survival.

Recommendations for golf have been proven to be accurate so far.

Each patient should be approached individually, and the full assessment of their abilities should be made before making a decision on their postoperative activities. Age and previous experience in sports are contributing factors as well. If patients have already participated in sporting activities, they were more motivated and eager to return to their old lifestyle. The indication for hip or knee arthroplasty was also important. In addition, patients should be aware of the limitations that an artificial joint could potentially bring. Implants are constantly improving, as well as the surgeon's technique, so it is likely that one day they will reach the strength and flexibility needed to meet the patients' needs. Since patients with joint arthroplasty are getting younger, eventually they will form a large group of active athletes. In that case, a long-term prospective study should determine guidelines for each sport and activity individually.

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