Arthroplasty Today 11 (2021) 68–72

Contents lists available at ScienceDirect

Arthroplasty Today

journal homepage: http://www.arthroplastytoday.org/

Original research

Does Activity Level After Primary Total Hip Arthroplasty Affect Aseptic Survival?

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ARTICLE INFO

Article history:
Received 25 March 2021
Received in revised form
21 June 2021
Accepted 17 July 2021
Available online xxx

Keywords:
Activity
Total hip arthroplasty
Survivorship
Polyethylene
Sports

ABSTRACT

Background: The purpose of this study is to evaluate survivorship and outcomes of high-activity patients compared to low-activity patients after total hip arthroplasty.
Methods: A retrospective review identified 2002 patients (2532 hip) that underwent a primary total hip arthroplasty with vitamin E–infused highly crosslinked polyethylene liner. Patients were divided into 2 groups based on their University of California Los Angeles (UCLA) activity level: low activity (LA) (UCLA $\leq$5) and high activity (HA) (UCLA $\geq$6). Outcomes included Harris Hip Score, UCLA activity score, and reoperations. A multivariate nominal regression analysis was performed to evaluate the significance of postoperative activity level on survivorship.
Results: The mean follow-up duration was 4.5 years (range, 0.3 to 9.9 years). HA group had significantly higher improvements in Harris Hip Score (HHS) ($P < .001$) and UCLA activity score ($P < .001$). Aseptic revisions were performed in 2.1% of the LA group and in 0.4% hips of the HA group ($P < .001$). After controlling for age, gender, preoperative pain, HHS, and body mass index, a higher postoperative activity level remained a significant factor for improved aseptic survivorship with an odds ratio of 4.9 (95% confidence interval, 1.1 to 21.2, $P = .03$). The all-cause 5-year survivorship was 99% for the HA group and 96% to for the LA group ($P < .001$). The aseptic 5-year survivorship was 99.6% for the HA group and 98% for the LA group ($P < .001$).
Conclusions: This study found that a higher activity level after primary THA was not deleterious to survivorship at short to midterm follow-up with modern implants.

Introduction

Total hip arthroplasty (THA) is one of the most successful procedures in all of orthopedics [1]. However, failures still occur because of infectious and aseptic causes. Aseptic failures can be related to patient factors, surgical techniques, or implant-related variables.

Polyethylene wear as a mode of failure in arthroplasty has continued to decline over the past few decades [2]. With improvements in polyethylene manufacturing, such as highly crosslinking, sterilization technique and antioxidant additives, failures for isolated polyethylene wear in THA represent only 18% of all aseptic failures [2,3]. The vast majority of THA bearing surfaces in the US in 2019 are either ceramic or metal head on polyethylene liner [4]. Assuming press-fit implants have ingrowth, there is no instability, and no infection occurs, “how long a replacement lasts” is really related to polyethene wear. Wear rates of highly cross-linked polyethene in THA have been reported at 0.003 mm/y [5].

One of the factors thought to contribute to polythene wear is the force placed across a joint and number of joint cycles. To this end, surgeons frequently have conversations with their patients on what sports they can return to after surgery and what their activity level should be. Modern arthroplasty patients are getting younger and have a high expectation of return to physical activity [6].

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https://doi.org/10.1016/j.artd.2021.07.005
2352-3441/

The study institution has previously published on the effect of patient activity level on survivorship in unicondylar knee arthroplasty (UKA) and total knee arthroplasty (TKA) [7,8]. Both studies found that a higher level of activity did not adversely affect survivorship at midterm to long-term follow-up. However, there have been other conflicting reports on adverse outcomes in more active patients after arthroplasty [9-11].

The purpose of this study is to evaluate the effect of postoperative activity level on clinical outcomes and implant survivorship after primary THA. We hypothesize that activity level will not negatively impact either clinical outcomes or survivorship.

Material and methods

A retrospective review of the institutional arthroplasty registry was performed from 2007 to 2014 on all primary THAs performed with a single manufacturer's hip system and vitamin E–infused highly crosslinked polyethylene liner. The acetabular components included the Mallory-Head RingLoc (Zimmer Biomet, Warsaw, IN) and its successor the G7 (Zimmer Biomet, Warsaw, IN). The initial query revealed 3502 THAs. Patients were excluded for declined research consent (336 THAs), lack of 2-year minimum follow-up (583 THAs), or missing postoperative University of California Los Angeles (UCLA) activity score [12] (51 THAs). Patients were included in analysis if they had a revision surgery before 2-year minimum follow-up but not clinical follow-up after 2 years. This yielded a study cohort of 2002 patients (2532 hips).

All surgeries were performed by one of 3 fellowship-trained arthroplasty surgeons using the TaperLoc stem (Zimmer Biomet, Warsaw, IN). The Mallory-Head RingLoc cup was used in 1937 hips (77%), while the G7 was used in 595 hips (23%). Biolox delta ceramic heads (CeramTec, Plochingen, Germany) were in 1784 THAs (70%), while cobalt chromium heads were used in the remaining 784 THAs (30%). All polythene liners were vitamin E–infused highly crosslinked ArComXL (Zimmer Biomet, Warsaw, IN), designed to match their respective acetabular component. The direct anterior approach was used in 69% of surgeries and a direct lateral approach in 31%.

Patient-reported postoperative UCLA activity score was used to separate patients into 2 groups. The UCLA score reported represents the most recent score in patients that did not have a revision and the UCLA score before revision in those patients that had a revision. The “low-activity” (LA) group had a UCLA score between 1 and 5, and the “high-activity” (HA) group had a UCLA score between 6 and 10. The LA group consisted of 1054 patients (1299 THAs), and the HA group had 984 patients (1231 THAs). Table 1 describes each of the scores for the UCLA and the percentage of patients in each category.

Table 1
UCLA activity scale and number of patients and percent in each category.

Level	Description	# Of patients (%)
1	Wholly inactive, dependent on others, and cannot leave residence	12 (0.5%)
2	Mostly inactive or restricted to minimum activities of daily living	111 (4.4%)
3	Sometimes participates in mild activities, such as walking, limited housework, and limited shopping	411 (16.2%)
4	Regularly participates in mild activities	515 (20.3%)
5	Sometimes participates in moderate activities such as swimming or could do unlimited housework or shopping	251 (10%)
6	Regularly participates in moderate activities	688 (27.2%)
7	Regularly participates in active events such as bicycling	201 (8%)
8	Regularly participates in active events, such as golf or bowling	217 (8.6%)
9	Sometimes participates in impact sports such as jogging, tennis, skiing, acrobatics, ballet, heavy labor, or backpacking	92 (3.6%)
10	Regularly participates in impact sports	33 (1.3%)

Table 2
Preoperative demographics and clinical scores between activity groups.

Characteristic	LA	HA	*P* value
Number of patients	1054	984	
Number of hips	1299	1231	
Gender of patients			
Male patients	377 (36%)	534 (54%)	
Female patients	677 (64%)	450 (46%)	<.001
Gender of hips			
Hips in male patients	456 (35%)	652 (53%)	
Hips in female patients	844 (65%)	579 (47%)	<.001
Mean body mass index (kg/m^2)	32.3	29.2	<.001
Mean age (y)	66	62.2	<.001
Harris Hip Score	49	54	.42
UCLA	3.7	5.3	<.001

LA = UCLA 1-5, HA = UCLA 6-10.

Patient gender, age, body mass index (BMI), UCLA activity score, and length of follow-up were recorded. Operative reports and office visit notes were reviewed. Preoperative and postoperative pain score, Harris Hip Score [13], UCLA activity score, and revisions were analyzed.

Statistical analysis

Statistical analysis was performed using Microsoft Excel (Microsoft Corporation, Redmond, WA) and MedCalc Statistical Software version 18.6 (MedCalc Software bvba, Ostend, Belgium). Unpaired t-test was used for statistical analysis of continuous variables between groups. Chi-squared and Fisher exact test compared binary variables. A multivariate nominal regression analysis was performed to evaluate the significance of postoperative activity level on aseptic survivorship while controlling for age, gender, preoperative pain, Harris Hip Score (HHS), and BMI. Kaplan-Meier survival analysis was performed with failure being defined as revision of any component.

Results

Preoperative demographic information and clinical scores between groups are listed in Table 2. The HA group had significantly more male patients, lower BMI, younger patients, and a higher preoperative UCLA score (all with $P < .001$).

Mean follow-up duration was 4.5 years (range, 0.3 to 9.9 years). Postoperative clinical scores between groups are shown in Table 3. The higher activity group had significantly higher HHS, change in HHS, UCLA activity score, and change in UCLA activity score (all $P < .001$).

Aseptic revisions were performed in 2.1% of the LA group and in 0.4% hips of the HA group ($P < .001$). Reasons and incidence of failure between groups are shown in Table 4. After controlling for age, gender, preoperative pain, preoperative HHS, and BMI, a higher postoperative activity level remained a significant factor for

Table 3
Postoperative outcomes between activity groups.

Characteristic	LA	HA	*P* value
Harris Hip Score	76.5	88.7	<.001
Change in Harris Hip Score	27.8	34.8	<.001
UCLA activity score	3.7	6.8	<.001
Change in UCLA activity score	0	1.5	<.001

LA = UCLA 1-5, HA = UCLA 6-10.

Table 4
Reason for revision between activity groups, number of hips (percent).

Characteristic	LA	HA	*P* value
Infection	17 (1.3%)	6 (0.05%)	<.001
Fracture	15 (1.2%)	3 (0.24%)	.006
Aseptic loosening	7 (0.5%)	2 (0.2%)	.11
Instability/dislocation	2 (0.15%)	0 (0%)	.5
Other	3 (0.2%)	0 (0%)	.3
Any aseptic failure	27 (2.1%)	5 (0.4%)	<.001
Total	44 (3.4%)	11 (0.9%)	<.001

LA = UCLA 1-5, HA = UCLA 6-10.

improved aseptic survivorship with an odds ratio of 4.9 (95% confidence interval [CI], 1.1 to 21.2, $P = .03$). The all-cause 5-year survivorship was 99% (95% CI, 98.7% to 99.3%) for the HA group and 96.4% (95% CI, 95.8% to 97%) for the LA group ($P < .001$) (Fig. 1). The aseptic 5-year survivorship was 99.6% (95% CI, 99.4% to 99.8%) for the HA group and 98% (95% CI, 97.5% to 98.5%) for the LA group ($P < .001$) (Fig. 2).

In the 342 patients that had a postoperative UCLA score ≥8, there were 2 revisions (0.5%). Both revisions were for periprosthetic joint infection in which the patients underwent a staged radical debridement and reimplantation.

Discussion

The findings of this study demonstrate that a higher postoperative activity level did not adversely affect clinical outcomes or implant survivorship in primary THA at short-term to midterm follow-up.

It is not well defined what constitutes a “high activity level” vs a “low activity level” with respect to arthroplasty. The authors chose to use the UCLA scale to determine the patient’s activity level as it has shown to adequately discriminate between low and highly active patients undergoing arthroplasty without floor or ceiling effects [14]. In the authors' previous publications, a UCLA activity score ≥7 denoted HA in the research on UKA while a UCLA cutoff ≥6 was used in the TKA cohort [7,8]. This discrepancy had to do with the fact that UKA patients had overall a higher activity score and a much higher percentage of patients with a score of 7 or greater. Other outcomes have been used in arthroplasty literature to define activity level. Ali et al. assessed the impact of activity level after UKA and used a Tegner level of 5 or more as high activity [15]. Robertson et al. focused on gait cycles after arthroplasty and defined highly active patients as those who complete >3 million gait cycles/y or 1 hour of activity/d [16]. Kilgus et al. defined high-impact activities as competitive tennis, jogging, horseback riding, racquetball, backpacking, handball, and heavy labor [17]. Low-impact activities consisted of swimming, golf, bowling, hiking, bicycling, skiing on nonmoguled surfaces, and recreational tennis [17]. Importantly though, patient self-reporting of activity level does not always coordinate with their actual activity level [18].

Exercise is very important in maintaining cardiovascular fitness and can reduce mortality, lead to weight loss, and improve mental health [19-23]. As such, it is important to continue regular physical activity after joint replacement. Furthermore, many patients undergo THA specifically to return to a sport [24]. Recommendations on specific sporting activities after lower extremity arthroplasty have historically lacked good research and have been guided by surgeon consensus. A 2007 survey of the members of the American Academy of Hip and Knee Surgeons found that 95% of respondents placed no limitations on walking, climbing stairs, bicycling, swimming, and golf after THA. However, surgeons consistently discouraged higher impact activities such as jogging, sprinting, and skiing. Surgeons overall were more liberal with the activity recommendations after THA than after TKA [25].

A few studies have looked at specific sporting activities after THA. In a series of 608 patients who underwent THA, Abe et al. reported that 23 patients (3.8%) jogged after their THA [26]. At a mean 5-year follow-up, those patients that jogged had no

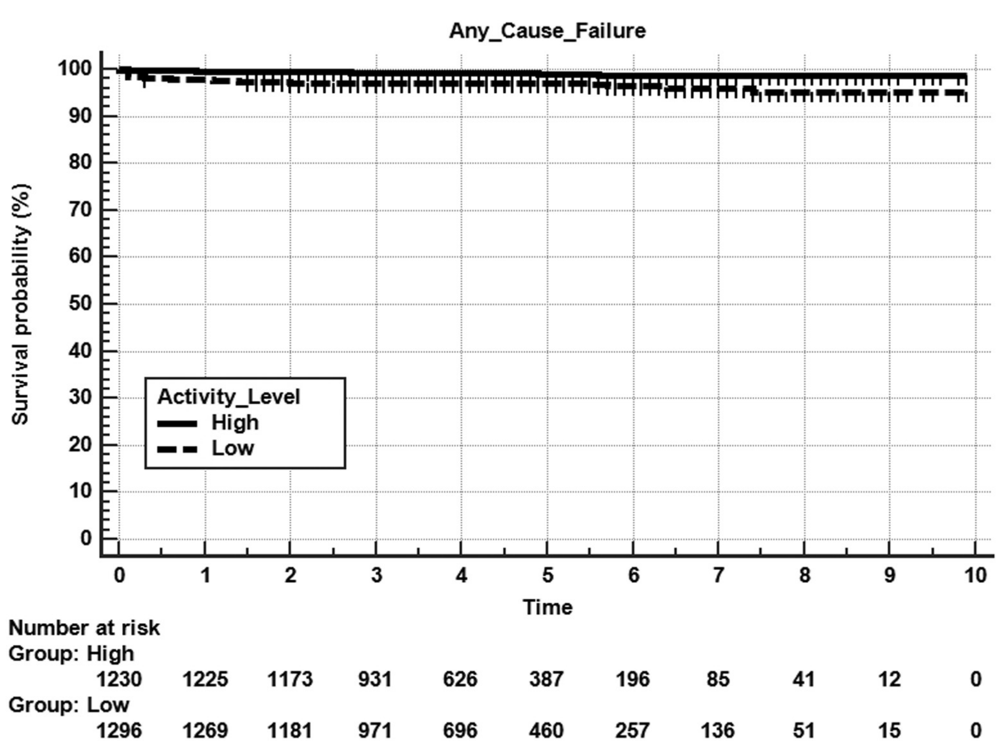

Figure 1. All-cause Kaplan-Meier survivorship between low- and high-activity groups.

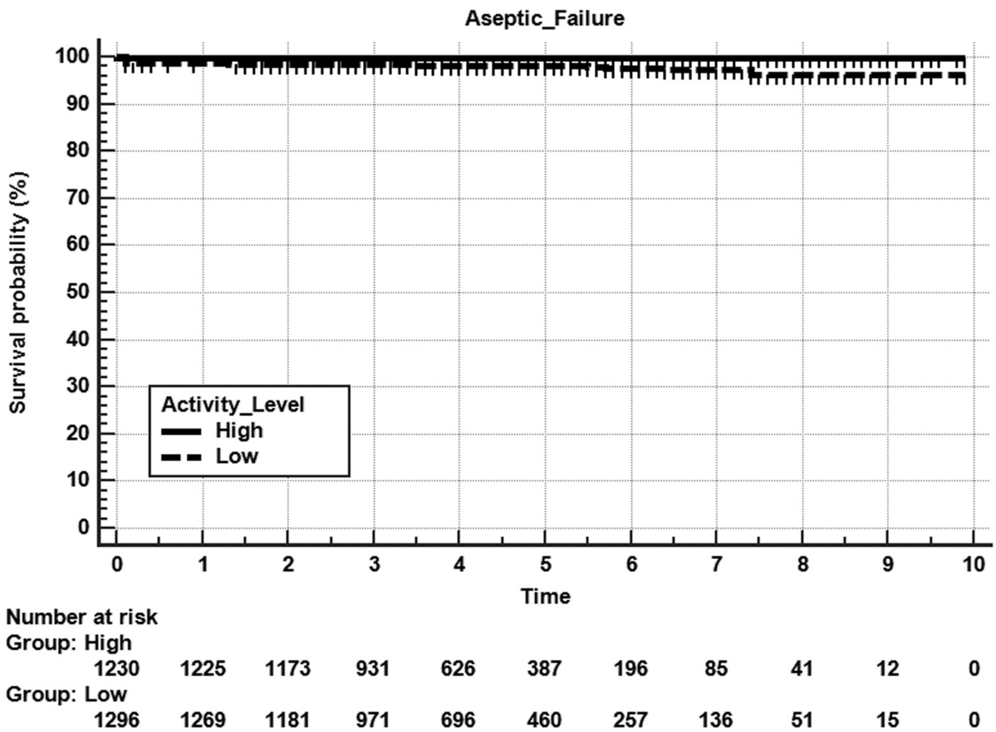

Figure 2. Aseptic Kaplan-Meier survivorship between low- and high-activity groups.

complaints of pain, no elevation in serum cobalt and chromium levels, and no radiographic loosening, component migration, or excessive wear [26]. Mont et al. surveyed 58 tennis players who had undergone THA and found that only 14% of patient's surgeons "approved" tennis activity [24]. At a mean of 8-year follow-up, 4% of the tennis players required revisions surgery [24]. In a matched cohort study with 10-year follow-up, Gschwend et al. compared a group of 50 patients who participated in alpine skiing to 50 patients who did not after THA in the 1980s [27]. Polyethylene wear rates in the skiing group averaged 2.42 mm while the nonskiing group averaged 1.16 mm at 10 years postoperatively ($P = .07$). However, even with this older generation of polyethylene, skiing did not result in increased aseptic revisions [27].

Activity level has not been the focus of much research on THA survivorship, and as such, younger age is often used a surrogate to denote more active patients. This is supported in this present study in which the high-activity group was on average 3.8 years younger than the low-activity group. Overall, THA survivorship in younger patients has been favorable. Kim and Park reported a 98% femoral component survivorship and 96% acetabular component survivorship at a mean of 17.8 years in patients who had their THA when they were younger than 30 years [28]. In an even younger cohort of patients aged <20 years at the time of index THA, Pallante et al. reported a 97.2% survivorship at 10 years [29]. The 2 aforementioned studies are on very young patients for arthroplasty. Typically, when patients are referred to as "young" in arthroplasty literature, most studies refer to <50 or 55 years of age. In a recent systematic review of patients younger than 55 years who underwent THA, Mei et al. reported an aggregate 10-year survivorship of 94.6% [30].

The general concern with higher activity level after THA is polyethylene wear. As noted previously, however, polyethylene durability has improved significantly over the past few decades [31-33]. In a registry analysis, highly crosslinked polyethylene had a 16-year cumulative revision rate of 6.2%, whereas conventional polyethylene had a revision rate of 11.7% [3]. The process of crosslinking produces free radicals that can be trapped within the polyethylene [34]. Antioxidant additives, such as vitamin E, have been added to polyethylene manufacturing to neutralize free radicals and improve polyethylene wear [31,32,34,35]. The polyethylene evaluated in this study is highly crosslinked and vitamin E infused.

This study is not without limitations. First is the limitation of determining a causal relationship between postoperative activity level and THA survivorship. Patients who have a painful or failing THA, for example, are likely going to be less active. Furthermore, some patients just are not very active even though their hip could tolerate more activity. Likewise, some patients remain active despite a painful or failing joint. We can only conclude a correlation rather than causation. Another limitation of this study is that radiographic evaluations were not performed to evaluate component position, polyethylene wear, or radiolucencies. This study is also limited by the short-term to midterm follow-up as polyethylene wear may not manifest until longer follow-up. Caution should be used to interpreting these short-term to midterm findings on long-term patient recommendations. Lastly are the inherent limitations of a retrospective study including loss to follow-up and inaccuracies in documentation. Demographic bone quality differences between groups (younger and more male patients in high-activity group) could also account for the lower aseptic failures as these patients are at lower risk for fracture. Strengths of this study include the large number of patients as well a single implant system with the same polyethylene in both cohorts.

Conclusions

This study found that a higher activity level after primary THA was not deleterious to survivorship at short-term to midterm follow-up with modern implants. Patients' activity level after THA may not need to be restricted, but longer term follow-up is needed.

Conflicts of interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: D. A. Crawford is a paid consultant for DePuy, is a unpaid consultant for SPR Therapeutics, received research support from KCI USA Inc., and is in the editorial or governing board of *American Journal of Sports Medicine*. J. B. Adams received research support from Zimmer Biomet and SPR Therapeutics and is in the editorial or governing board of the *Journal of Arthroplasty*. M. J. Morris received royalties from Total Joint Orthopedics, is a paid consultant for Total Joint Orthopedics and Zimmer Biomet, and received research support from Zimmer Biomet and SPR Therapeutics. K. R. Berend received royalties from and is a paid consultant for Zimmer Biomet; has stock or stock options in SPR Therapeutics, Elutibne, and Joint Development Corporation; and received research support from Zimmer Biomet and SPR Therapeutics. A. V. Lombardi Jr. received royalties from Zimmer Biomet and Innomed; is a paid consultant for Zimmer Biomet; has stock or stock options in SPR Therapeutics, Elutibne, and Joint Development Corporation; received research support from Zimmer Biomet and SPR Therapeutics; is in the editorial/governing board of *Journal of Arthroplasty*, *Journal of Bone and Joint Surgery—American*; *Journal of the American Academy of Orthopaedic Surgeons*; *Journal of Orthopaedics and Traumatology*; *Surgical Technology International*; *The Knee; Clinical Orthopaedics and Related Research*; and is a board member in Operation Walk USA, The Hip Society, The Knee Society; and Mount Carmel Education Foundation at New Albany.

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