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Satisfaction with return to sports after unicompartmental knee arthroplasty and what type of sports are patients doing☆

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ABSTRACT

Purpose: The present study provides insight into patient satisfaction with return to sports after unicompartmental knee arthroplasty (UKA) and to what type of activities patients return. This is important because indications for UKA have expanded and younger and more active patients undergo surgery currently.

Methods: Patients who received a UKA were contacted between 12 and 24 months' post-surgery, receiving a questionnaire to evaluate postoperative satisfaction with return to sports, level of return, type of activities performed pre- and postoperatively, and (activity) outcome scores (NRS, UCLA, HAAS). Descriptive statistical analysis focused on the influence of patients' sex and age, and a regression model was fitted to assess the predictors for high satisfaction postoperatively.

Results: One hundred and sixty-four patients (179 UKAs) with a mean age of 62.3 years responded at an average follow-up of 20.2 months. Preoperatively, 132 patients (81%) participated in sports, which increased to 147 patients (90%) after UKA. Analyzing outcomes for each knee individually, satisfaction with return to sports was recorded in 83% (149/179). Return to a higher or similar level was reported in 85.4% of the cases (117/137). Most common sports after UKA were cycling (45%), swimming (38%), and stationary cycling (27%). Overall, 93.9% of patients were able to return to low impact sports, 63.9% to intermediate and 32.7% to high impact sports. Regarding activity scores, preoperative NRS score improved from 6.40 ± 2.10 to 1.33 ± 1.73 postoperatively ($p < .001$). The mean preoperative UCLA score improved from 5.93 ± 2.19 to 6.78 ± 1.92 ($p < .001$) and HAAS score from 9.13 ± 3.55 to 11.08 ± 2.83 postoperatively ($p < .001$). Regression analyses showed that male sex, preoperative UCLA score and sports participation predicted high activity scores postoperatively.

Conclusion: The vast majority of patients undergoing medial UKA returned to sports postoperatively, of which over 80% was satisfied with their restoration of sports ability. Male patients, patients aged ≥70, and patients who participated in low-impact sports preoperatively achieved the highest satisfaction rates. Regarding type of sports, male patients and patients aged ≤55 were most likely to return to high and intermediate impact sports. This study may offer valuable information to help manage patients' expectations regarding their ability to return to sports based on demographics and type of preoperative sporting activities.

Level of Evidence: Case series; Level of evidence IV.

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1. Introduction

Patients' expectations determine their assessment of the success of joint replacement surgery, and therefore strongly influence the postoperative outcome and patient satisfaction [1,2]. Several studies have emphasized the importance of meeting patients' expectations, which have been associated with greater perceived improvement after surgery, irrespective of the preoperative level of disability caused by knee osteoarthritis [3–6]. There are a number of studies on total knee arthroplasty (TKA) reporting on postoperative activity levels and sport involvement; these studies have demonstrated variable return to sport rates (36%–86%) with most patients returning to low-impact sports [7–11]. Furthermore, TKA patients tend to show a high degree of satisfaction with their ability to participate in sports postoperatively [12–16]. Although there is growing data on return to activity after unicompartmental knee arthroplasty (UKA), the evidence is insufficient to meaningfully inform patients and manage their expectations on their potential sport participation level after UKA.

Over the last two decades, UKA has become established as an effective treatment option for isolated compartment osteoarthritis (OA) [17–19]. Due to numerous technical innovations in implant design and surgical techniques, indications for UKA have expanded, which has resulted in a younger and more active population with different preoperative expectations undergoing this procedure [20–23]. One outcome of particular importance to these patients is the expectation to return to sports after surgery. To date, several studies have reported moderate to high rates of return to sports following UKA, ranging from 53% to 91% [9,24–28]. However, the focus of prior studies has been limited to rate of return to a few sports, additionally these studies reported on small patient cohorts (26 to 131 patients), of which many were included over a decade ago when patient demands and recommendations on return to activity may have been different. The state of UKA return to sport evidence thus makes it difficult to provide modern day patients with accurate and updated recommendations to best calibrate their expectations [8,29]. Moreover, there is, to our knowledge, a lack of information with regard to satisfaction with return to sports and the maximum level of sport attained after UKA.

The goals of the present study were to 1) determine postoperative satisfaction with return to sports, 2) identify the level of sporting activity after UKA and overall activity outcome scores, and 3) report common sporting activities after surgery. Special attention was paid to the influence of patients' sex and age. We hypothesized that the vast majority of patients were satisfied and able to return to a higher or similar level compared to their preoperative level. Furthermore, it could be expected that men return to sports faster and to higher impact sports compared to women, which may potentially influence satisfaction rates.

2. Methods

2.1. Study design and patient selection

After Institutional Review Board Approval, a prospective database was queried for consecutive patients who underwent UKA surgery by one of the two authors (ADP and SMS). The primary diagnosis was isolated, either medial or lateral compartment osteoarthritis, for which all patients received a cemented fixed-bearing RESTORIS MCK Onlay tibial implant (Stryker Corp., Mahwah, NJ) using a robotic-arm-assisted surgical platform (MAKO System, Stryker Corp., Mahwah, NJ) [30]. Surgical inclusion criteria for medial or lateral UKA were symptomatic unicompartmental OA, a passively correctable coronal plane deformity and a fixed flexion deformity of $<15^{\circ}$. Surgical exclusion criteria were signs of radiographic inflammatory arthritis, the presence of Kellgren Lawrence (KL) grades 3–4 in the contralateral tibiofemoral compartment or patellofemoral (PF) joint-related symptoms (anterior knee pain with prolonged sitting with the knee flexed or pain specific to stair-climbing rather than descending stairs). Degenerative changes in the PF joint were not considered to be a contra-indication, unless there was severe bone loss or grooving of the medial or lateral facet. All patients underwent the standardized rehabilitation program, and were allowed to resume their preoperative sporting activities in consultation with their surgeon and physical therapist. Patients were not encouraged to return to high impact sports as their main cardio activity, although all activities were allowed after surgery.

Patients were eligible for inclusion if they were between 12 and 24 months post-surgery at the start of the study. Informed consent was obtained via email or postal mail. Patients received a questionnaire by email or postal mail when email address was missing. Patients were considered lost-to-follow-up after three email and/or mail shipments.

2.2. Data collection

Clinical charts were reviewed for demographic data, preoperative diagnosis, and medical comorbidities. The authors derived a return to sport questionnaire (Appendix I) that was based on the work of several other prior return to sport studies for arthroplasty patients [26,27,31–33]. The questionnaire assessed the pre- and postoperative sporting activities (43 sports, walking was not considered a sport), focusing on what type of sports patients engage in and the time to return to each sport. Sports were categorized, according to the level of impact on the knee, into low, intermediate and high impact sports based on the studies by Vail [34] and Kuster [33]. Postoperative satisfaction with return to sports was recorded using a five-level Likert scale and the subjective level of return was graded as lower, similar or higher level compared to preoperative level. In addition, pre- and postoperative University of California at Los Angeles (UCLA) activity score [27,32,35], High Activity Arthroplasty Score (HAAS) [36], and Numeric Pain Rating Scale (NRS) score were collected. The UCLA activity scale has 10 descriptive levels, ranging from wholly inactive, dependent on others (level 1), to regular participation in active events, such as bicycling (level 7), and regular participation in impact sports, such as jogging or tennis (level 10). The HAAS score (scored 0 to 18, worst to best) was designed to detect subtle

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variations in physical function of highly functioning patients [36]. In the setting of bilateral UKA, patients were asked to answer the questions separately for each knee.

2.3. Statistical analysis

All statistical analyses were performed using SPSS version 24 (SPSS Inc., Armonk, NY). Descriptive analyses were performed to calculate means, standard deviations (±), frequencies, and percentages (%). Patients were divided by sex and in age groups; younger (≤55 years), middle (55–70 years), and older age (≥70 years). Mann–Whitney U and Kruskal–Wallis tests were used to compare ordinal data or when normal distribution was not followed. Furthermore, paired two-tailed t-tests were utilized to determine improvements in functional activity scores. Two ordinal regression models were fitted to assess predictors for satisfaction and high activity level postoperatively, with satisfaction and UCLA score as dependent variables [32]. These models calculate a single odds ratio (OR) and 95% confidence interval (CI) for each covariate, independent of the rank of the response category [37]. The assumptions of proportionality across threshold were tested. Summary proportional ORs and CIs were then calculated for selected independent variables, which included demographic, preoperative participation and preoperative outcome scores. Therefore, only patients who participated in sports preoperatively were included in this sub analysis. The covariates tested in all analyses included patient characteristics, such as age, sex, body mass index (BMI) and preoperative sports participation, the type of impact of preoperative sports, preoperative UCLA score, and preoperative HAAS score. In the proportional odds model for each covariate outputs included an estimate of the regression coefficient, standard error, Wald chi-square statistic, p-value, and the corresponding OR and CI. All tests were conducted using two-sided hypothesis testing with statistical significance set at $p \leq .05$.

3. Results

3.1. Demographics

In total, 251 consecutive patients (273 knees) who had undergone robotic-arm-assisted UKA between September 2015 and October 2016 were identified. Eighty-two patients (89 knees) were lost-to-follow-up, four patients (four knees) declined participation, and one patient (one knee) was excluded for severe Parkinson's disease. Consequently, 164 patients (179 knees) remained available for inclusion (139 medial UKA, 40 lateral UKA), all 15 bilateral procedures were staged. The average age at time of surgery was 62.3 ± 8.8 years (range, 33.2–87.3) and mean BMI was 27.6 ± 4.4 kg/m^2 (range, 18.3–43.4). Ninety men were included with a mean age was 62.7 ± 8.7 years and average BMI was 27.8 kg/m^2. Seventy-four women were included with a mean age of 61.9 ± 9.0 years and BMI of 27.3 ± 5.1 kg/m^2. Of all included patients, 132 patients (80.5%) participated in sports within five years prior to their knee replacement. Average follow-up was 20.2 months (range 12.0–31.0). No revision surgeries were reported during the follow-up time period, although two arthroscopic procedures (one chondroplasty of the trochlea, resection of scarring tissue and one debridement of scar tissue both at eight months postoperatively) were registered. The average age of the excluded patients was 59.7 years (range 41.4–91.1), which was significantly younger than the included patients ($p = .039$).

3.2. Return to sports and satisfaction

Of the 164 patients who responded to the return to sport questionnaire, 147 (89.6%) patients (161 UKAs) participated in sports after UKA and returned after 4.43 ± 3.54 months (range, 0.3–24.0) on average. From the initial 132 patients participating in sports preoperatively, seven patients did not return to any sports. Postoperative satisfaction of the entire cohort were scored for each individual knee, patients were either very satisfied or satisfied with their ability to participate in sports after surgery in 83.2% (n = 149). Furthermore, 8.9% (n = 16) was neither satisfied nor dissatisfied and 7.8% (n = 14) was dissatisfied (n = 14) (Table 1). Males were very satisfied or satisfied in 87.6% of the cases and females in 82.1%, which was not statistical significant ($p = .068$). Between age groups, 77.8% of the younger patients (≤55 years) reported being very satisfied or satisfied compared to

Table 1
Overall postoperative satisfaction rates after unicompartmental knee arthroplasty, and by sex and age groups[a].

	Overall (n = 179[b])	Men (n = 101[b])	Women (n = 78[b])	Age ≤ 55 (n = 27[b])	Age 55–70 (n = 123[b])	Age ≥ 70 (n = 29[b])
Very satisfied	98 (54.7%)	63 (64.9%)	35 (44.9%)	17 (63.0%)	61 (49.6%)	20 (69.0%)
Satisfied	51 (28.5%)	22 (22.7%)	29 (37.2%)	4 (14.8%)	40 (32.5%)	7 (24.1%)
Neutral	16 (8.9%)	6 (6.2%)	10 (12.8%)	2 (7.4%)	12 (9.8%)	2 (6.9%)
Dissatisfied	10 (5.6%)	6 (6.2%)	4 (5.1%)	3 (11.1%)	7 (5.7%)	0 (0.0%)
Very Dissatisfied	4 (2.2%)	4 (4.1%)	0 (0.0%)	1 (3.7%)	3 (2.4%)	0 (0.0%)
		$p = 0.068$[c]		$p = 0.123$[d]		

[a] Percentages are of the total in the given category.
[b] Number of knees within that category.
[c] Mann-Whitney U test.
[d] Kruskal-Wallis test.

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82.1% in patients aged 55 to 70 years and 93.1% in older patients (≥70 years) (Table 2). Ranked comparison showed no significant difference between age groups (p = .123). Of the patients who preoperatively participated in sports were questioned to what level they returned to compared to their preoperative level, 42.3% of the patients reported return to a higher level and 43.1% to a similar level compared to their preoperative level. No statistically significant age- or gender-related differences were noted (Table 2). However, patients who were satisfied reported to returned to an either higher or similar level more frequently than dissatisfied patients (88% vs. 70%, p = .036).

3.3. Type of sports

An increase in sports participation was noted after surgery, from 132 patients (80.5%) participating in sports preoperatively to 147 patients (89.6%) participating in at least one type of sports postoperatively (mean number of sports was 3.6 ± 3.0). The most common sports by sex and age were displayed in Table 3. After UKA, 32.7% (n = 47) of the patients participated in high impact sports, returning to singles tennis, running, and baseball most frequently (Table 4, Appendix II). Preoperatively, men participated in high impact sports more frequently than women (48.1% versus 30.2%, p = .040), comparable findings were reported postoperatively (38.8% vs. 24.2%, respectively, p = .062). Furthermore, men participated in intermediate impact sports more frequently after surgery than women (70.6% vs. 54.5%, respectively, p = .050). Concerning time to return, men return significantly faster to high and intermediate impact sports compared to females (p = .002 and p = .036, respectively). For age groups, preoperatively as well as postoperatively patients ≤55 years participated in more high impact sports in comparison to patients aged ≥70 years (p = .017).

Furthermore, satisfaction by the highest impact of preoperative sports was determined. Of the patients who participated in high impact sports preoperatively, 85.2% (46/54) were satisfied with their return to sports, independent of the type they returned to. In addition, patients who participated in intermediate or low impact sports were satisfied with their postoperative sporting activity in 86.0% (49/57) and 95.2% (20/21), respectively. No statistical difference was found (p = .413).

3.4. Validated outcome scores

The mean preoperative NRS score improved from 6.40 ± 2.10 to 1.33 ± 1.73 postoperatively (p < .001). Patients who were satisfied reported a significantly lower postoperative NRS score compared to patients that were dissatisfied (mean 3.59 ± 2.85 vs. 1.13 ± 1.40, p < .001). The mean preoperative UCLA score improved from 5.93 ± 2.19 to 6.78 ± 1.92 (p < .001), indicating that patients are able to participate regularly in active activities postoperatively. Moreover, the preoperative mean total HAAS score improved from 9.13 ± 3.55 to 11.08 ± 2.83 postoperatively (p < .001), similar findings were observed in all subdomains (Table 5).

3.5. Predictors of satisfaction and high activity scores

Patients who participated in sports preoperatively showed an increased likelihood of satisfaction with their return to sports after surgery (OR 3.60, 95% CI 1.46–8.89, p = .005), sex and age were not found predictive. In addition, 62 patients (34.6%) patients reported preoperatively a UCLA score of 7 or more, which increased to 97 patients (54.2%) at 20.2 months' follow-up. The preoperative UCLA activity score (OR 1.16, 95% CI 1.36–1.87, p < .001), male sex (OR 1.95, 95% CI 1.11–3.41, p = .020), and preoperative sports participation (OR 2.16, 95% CI 1.05–4.47, p = .037) independently predicted a postoperative UCLA score of 7 or more following UKA surgery (Table 6).

Table 2
Level of return to sports after unicompartmental knee arthroplasty.

	Higher level	Similar level	Lower level
Overall (n = 125, 137 UKAs[a])	58 (42.3%)	59 (43.1%)	20 (14.6%)
Sex			
Male (n = 86[b])	37 (43.0%)	38 (44.2%)	11 (12.8%)
Female (n = 51[b])	21 (41.2%)	21 (41.2%)	9 (17.6%)
p-Value[c]	*0.837*	*0.737*	*0.447*
Age			
Younger (≤55 y) (n = 20[b])	10 (50.0%)	6 (30.0%)	4 (20.0%)
Middle (55–70 y) (n = 95[b])	39 (41.1%)	41 (43.2%)	15 (15.8%)
Older (≥70 y) (n = 22[b])	9 (40.9%)	12 (54.5%)	1 (4.5%)
p-Value[c]	*0.763*	*0.276*	*0.307*

[a] Preoperatively, 132 patients of which 125 (137 UKAs) returned to sports postoperatively and were, therefore, eligible to answer this question for each procedure individually.
[b] Number of knees within that category.
[c] Chi-square or Fisher exact tests were used to assess differences between groups per level. A p-value ≤.05 was considered statistical significant.

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Table 3
Sporting activities after unicondylar knee arthroplasty (N = 147).

Subgroup/sport[a]	Postoperative participation		Mean time to return (months)
	N	%	
Men (n = 85[b])			
Cycling	53	62.4	3.3 (1.0–12.0)
Golf	35	41.2	2.9 (1.0–8.0)
Swimming	35	41.2	4.0 (1.0–12.0)
Weight lifting	28	32.9	3.4 (1.0–12.0)
Stationary cycling	27	31.8	2.1 (0.3–4.0)
Hiking	24	28.2	4.3 (1.0–14.0)
Downhill skiing	19	22.4	6.5 (1.0–12.0)
Low impact aerobics	16	18.8	3.2 (0.8–6.0)
Doubles tennis	12	14.1	9.2 (2.0–24.0)
Bowling	9	10.6	3.2 (3.0–4.0)
Women (n = 62[b])			
Swimming	28	45.2	5.0 (2.0–10.0)
Cycling	21	33.9	3.7 (1.0–14.0)
Yoga	20	32.3	6.8 (1.0–16.0)
Stationary cycling	18	29.0	1.7 (0.3–3.0)
Hiking	15	24.2	4.9 (1.0–12.0)
Dancing	13	21.0	4.5 (2.0–7.0)
Weight lifting	11	17.7	4.6 (1.0–22.0)
Pilates	11	17.7	4.4 (2.0–12.0)
Low impact aerobics	9	14.5	6.0 (1.0–12.0)
Spinning	9	14.5	3.2 (1.5–7.0)
Younger (≤55 y) (n = 23[b])			
Cycling	10	43.5	2.5 (1.0–5.0)
Swimming	6	26.1	3.3 (1.0–6.0)
Stationary cycling	6	26.1	1.8 (1.0–2.0)
Yoga	6	26.1	8.4 (3.0–12.0)
Golf	5	21.7	6.2 (3.0–9.0)
Middle (55–70 y) (n = 101[b])			
Cycling	60	59.4	3.6 (1.0–14.0)
Swimming	47	46.5	3.7 (1.0–10.0)
Stationary cycling	33	32.7	2.0 (0.3–4.0)
Weight lifting	31	30.7	3.6 (1.0–12.0)
Hiking	30	29.7	4.7 (1.0–14.0)
Older (≥70 y) (n = 23[b])			
Swimming	10	43.5	4.3 (1.5–9.0)
Golf	8	34.8	3.2 (2.0–6.0)
Low impact aerobics	6	26.1	1.8 (1.5–6.0)
Stationary cycling	6	26.1	1.9 (1.0–4.0)
Dancing	4	17.4	3.1 (1.5–4.0)

[a] Top 10 sports by sex and top 5 sports by age group.
[b] Number of patients.

4. Discussion

The aim of this study was to provide evidence based guidance for surgeons to inform their patients with regard to their ability to participate in sports after UKA surgery. It was showed that the vast majority of patients participated in sports post-operatively, of which over 80% was satisfied with their restoration of sports ability and returned to a higher or similar level of activity compared to preoperatively. Factors that were associated with high level of satisfaction were male gender, older age (≥70 years) and patients that participated in low-impact sports preoperatively. With regard to type of sports, men were more likely to return to high and intermediate impact sports after UKA surgery compared to women, and furthermore, they returned faster than women. Finally, patients aged 55 or less participated more frequently in high impact activities than older patients.

An increase in overall sports participation to 90% after surgery was noted in this cohort study, which was similar to the rates demonstrated by Naal [25] and Fisher [24]. Naal et al. studied a population of 83 patients who received an all-polyethylene tibial implant, of which 88% returned to at least one sport at 18 months' follow-up. A return to sports rate of 93% has been demonstrated by Fisher et al. after mobile-bearing Oxford UKA, however, only 64% of the 66 patients reviewed regularly participated in sports after surgery. Hopper et al. [9] found that 96.5% of their 26 patients returned to sports at 22 months' follow-up, excluding all patients over the age of 75. The study by Walker et al. [38] evaluated patients less than 60 years of age and found a return to sports rate of 93%, which is comparable to our results including all ages. Pietschmann et al. [26] found that 80.2% of their 131 patients, with a mean age of 65.3 years, was able to return to physical activities after surgery, which was lower than the current findings. To our knowledge, this is the largest cohort study performed, showing a high rate of return sports of 179 fixed bearing UKAs, including all ages and all levels of sporting activity.

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Table 4
Sporting activities by impact before and after unicondylar knee arthroplasty.

Subgroup/impact[a]	Preoperative participation		Postoperative participation		Mean time to return (months)[d]
	N = 132[b]	%[c]	N = 147[b]	%[c]	
Overall					
High impact	54	40.9	47	32.7	6.4 (2.0–22.0)
Intermediate impact	95	72.0	94	63.9	5.1 (1.0–24.0)
Low impact	122	92.4	138	93.9	3.8 (0.3–14.0)
Men					
High impact	38[e]	48.1	33[f]	38.8	5.8 (2.0–18.0)
Intermediate impact	53	67.1	60[f]	70.6	4.6 (1.0–24.0)
Low impact	73[e]	92.4	78	91.8	3.2 (0.3–12.0)
Women					
High impact	16[e]	30.2	15[f]	24.2	7.7 (3.0–22.0)
Intermediate impact	42	79.2	34[f]	54.5	6.1 (1.0–22.0)
Low impact	49[e]	92.5	60	96.8	4.6 (0.8–14.0)
Younger (≤55 y)					
High impact	13[e]	59.1	12[f]	52.2	7.3 (3.0–22.0)
Intermediate impact	17	77.3	15	65.2	6.4 (1.0–22.0)
Low impact	20	90.9	22	95.7	4.0 (1.0–7.5)
Middle (55–70 y)					
High impact	37[e]	41.1	32[f]	31.7	6.5 (2.5–18.0)
Intermediate impact	66	73.3	66	65.3	4.7 (1.0–10.7)
Low impact	83	92.2	96	95.0	3.9 (0.3–14.0)
Older (≥70 y)					
High impact	4[e]	20.0	3[f]	17.4	3.5 (3.0–4.0)
Intermediate impact	12	60.0	13	56.5	5.6 (1.0–24.0)
Low impact	19	95.0	20	87.0	3.4 (1.0–8.0)

[a] The top 3 sports by impact are listed in Appendix II.
[b] Number of patients.
[c] Percentage of total in the given category.
[d] Time to return is significantly shorter in men for low and intermediate impact sports ($p = .002$ and $p = .036$, respectively). No differences in time to return were observed between the age groups.
[e] Significant differences in preoperative participation between the subgroups, men vs. women: high impact ($p = .040$). Younger (≤55 y) vs. middle (55–70) vs. older (≥70 y) age: high impact ($p = .036$).
[f] Significant differences in postoperative sport participation between the specific subgroups, men vs. women: high impact ($p = .062$) and intermediate impact sports ($p = .050$). Younger (≤55 y) vs. middle (55–70) vs. older (≥70 y) age: high impact sports ($p = .039$).

A few prior studies have assessed overall satisfaction with UKA surgery, Naal et al. [25] reported that 82% of their patients considered the overall outcome of surgery to be excellent or good. A prospective study by Presti et al. [39] found that all 53 athletic patients were highly satisfied following UKA at a mean follow-up of 48 months. "Athletic" was defined as patients who participated in at least one sport before the onset of restrictive symptoms. Although these two studies were return to sport studies, satisfaction with their ability to participate in sports after surgery was not determined. Very few studies have described satisfaction level with return to sports, of which most articles reviewed patients that underwent surgery more than a decade ago when designs, surgical techniques and recommendations on return to sports may have been different [9,13,26]. An older study by Pietschmann and colleagues [26] reviewed 131 patients that underwent surgery between 1998 and 2007 and showed good-to-excellent satisfaction with their physical activity in 93%. In our study, 83.2% of the patients were satisfied with their postoperative sports participation after undergoing surgery in 2015 and 2016. This difference might be due to different techniques but possibly more important different recommendations and patient's expectations. Due to the ongoing success and development of UKA surgery, the indications have broadened to include a younger population of patients with higher expectations which can potentially

Table 5
Preoperative and postoperative patient reported outcomes[a].

	Preoperative[b]	Postoperative[b]	p-Value
	Mean (±SD)		
NRS score	6.40 ± 2.10	1.33 ± 1.73	<0.001
UCLA activity score	5.93 ± 2.19	6.78 ± 1.92	<0.001
HAAS score total	9.13 ± 3.55	11.08 ± 2.83	<0.001
Walking	3.14 ± 1.36	3.83 ± 1.23	<0.001
Running	1.09 ± 1.07	1.46 ± 1.12	0.002
Stair climbing	1.67 ± 0.76	2.01 ± 0.74	<0.001
Activity level	3.27 ± 1.41	3.73 ± 1.25	0.001

[a] Statistically significant improvement was observed in Numeric Pain Rating Scale (NRS) score, University of California at Los Angeles (UCLA) activity score, and total High Activity Arthroplasty Score (HAAS) and all its subdomains, and using paired 2-tailed independent t-tests.
[b] All 164 patients (179 knees) were included.

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Table 6
Overall predictors of postoperative UCLA activity score of ≥7.

Predictor	Odds Ratio	95% CI	p-Value[a]
Sex[b]	1.95	1.11–3.41	0.020
Preoperative UCLA score	1.61	1.36–1.87	<0.001
Preoperative sports participation[c]	2.16	1.05–4.47	0.037

95% CI: confidence interval.
[a] Calculated using an ordinal regression model.
[b] Female sex was baseline, male sex was a significant predictor.
[c] No preoperative sports participation was baseline; preoperative sports participation was independent of level of impact.

influence satisfaction [2,6,40]. A recent study showed that patients who expected some degree of pain interference with life 12 months post-surgery had a 1.3 times greater risk of not returned to desired activity compared to patients who expected no pain interference [41]. This shows the need for adequate preoperative counseling.

The goal of this study was to provide insight in to what extent satisfaction with postoperative sports participation was achieved in UKA patients, which could possibly be helpful in managing the expectations of future patients. In this study, patients were asked to subjectively rate their level of return to activity and 85.4% reported to have returned to a higher or similar level and 14.6% to a lower level. No differences were found between sexes or age groups. To our knowledge, limited data are available on subjective levels of return to sports after UKA. Walker et al. [27] demonstrated that 67% of their 45 patients reported an improvement of their sports ability, while 24% stated no difference, and 9% reported impairment at a mean follow-up of three years. Ho et al. [13] found that 17% of their patients did better and 56% returned to the same level compared to baseline. This was a small retrospective cohort study of 36 patients with a follow-up of 3.8 years, which has the potential for recall bias when historical self-reported information is elicited approximately four years after surgery.

With regard to our second objective, this study evaluated the postoperative sporting endeavors after UKA surgery (Table 5). The most common sports were cycling, swimming, stationary cycling, golf, and hiking, similar activities were described by Naal [25] and Hopper [9]. Recently, a systematic review was published assessing type of activities by impact after UKA, and found a decrease in high impact activities and an increase in low impact sports postoperatively [8]. A similar trend was noted in this study, but the overall return to high impact sports was 32.7%, which was higher than the 4% reported by Witjes et al. [8] In our cohort, men were significantly more likely to return to higher impact sports sooner after surgery compared to women. Furthermore, it was found that 85% of the patients who participated in high impact sports preoperatively, were satisfied with their postoperative sporting activity independent of the type they returned to. In this study, patients were not encouraged to return to high impact sports as their main cardio activity; however, it would be interesting to evaluate the impact of preoperative instructions on the postoperative outcome, and especially how it influences satisfaction. High impact sports after UKA remain controversial, as it puts increased stress on the prosthesis and the implant-bone interface, possibly leading to failure. Therefore, it can be argued that these patients may benefit from cementless fixation, as the reported incidence of fixation failure in cementless UKA is lower than cemented UKA [42,43]. For patients who wish to return to high impact sports, cementless fixation may ultimately be the preferable fixation method as it potentially lowers the stress at the implant-bone interface.

Moreover, the results of this study showed significant improvement in pain scores after UKA surgery. Presti et al. [39] demonstrated that 22.6% of the patients reported pain during physical activity, but felt that their knee was stable. Correspondingly, Hopper et al. [9] found that of those 24.1% of patients that experienced pain during sport, no patients felt that their knee was unstable. UKA has proven to relieve pain successfully in daily life and creates the ability to return to physical activity, although pain during sporting activities may still be experienced.

Significant improvement in UCLA scores were observed following UKA, which is consistent with the two studies performed by Walker et al. [27,38] The authors showed that, after medial and lateral UKA, patients reported an average UCLA score of 6.8 and 6.7, respectively. Furthermore, 62% of the medial UKA patients and 66% of the lateral UKA patients were very active postoperatively, achieving UCLA scores equal or more than 7. In this current study, 54.2% of the patients returned to high activity levels, this difference may be explained by the younger patient population in both studies by Walker et al. [38] The authors included patients 60 years or younger in the medial UKA study and the mean age of patients in the lateral UKA study was 60 years. Age could potentially influence to what extent patients are able to reach high activity levels postoperatively. In addition, Pietschmann et al. [26] found a significant difference in postoperative UCLA scores between patients who were preoperatively active and inactive. Based on these studies, predictive factors of high activity levels were assessed in our cohort, showing male sex, preoperative sports participation, and preoperative UCLA score to be predictive for postoperative UCLA score of 7 or more. These findings corresponded with the total joint literature. Williams et al. [32] found that male sex and preoperative UCLA score predicted high activity scores after TKA and total hip arthroplasty. However, they identified age as a predictor as well, which was not confirmed in this study, possibly due to the age distribution, as more than 68% of our patients fitted within the age range of 55–70 years.

This study has several limitations. One of the main limitations of this study was the retrospective data collection, in addition to the concern for recall bias. Ideally, a prospective study would have improved the strength of our results. Furthermore, the number of patients that were lost to follow-up was relatively high, which potentially influences the outcomes. It could be argued that non-responders were dissatisfied with the outcome or have consulted another provider regarding their knee. Therefore, this data needs to be interpreted with caution. On the contrary, descriptive analysis showed that these patients were younger than the

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included patients, which could suggest that they are possibly more active. Based on the study by Walker et al. [38] which included patients 60 years or younger, our rate of return might have been higher. Subsequently, this is, to our knowledge, the largest UKA return to sports study performed with modern implants, including 164 patients. Another limitation was that the follow-up period was too short to report on possible risks regarding the longevity of the implant dependent on the activity. Future studies, using current UKA designs, surgical techniques, and sport recommendations, with longer follow-up are necessary to assess these risks [44]. The results of this study allow surgeons to inform UKA patients preoperatively with regard to their ability to participate in sports postoperatively, which could assist in managing patients' expectations.

5. Conclusion

The vast majority of patients undergoing medial UKA returned to one or more sports postoperatively, of which over 80% was satisfied with their restoration of sports ability and returned to a higher or similar level of activity compared to preoperatively. Male patients, patients aged 70 or above, and patients who participated in low-impact sports preoperatively achieved the highest level of satisfaction. With regard to type of sports, male patients and patients aged 55 or less were most likely to return to high and intermediate impact sports after UKA surgery. This present study may offer valuable information to help manage patients' expectations regarding their ability to return to sports postoperatively based on patient characteristics and type of preoperative sporting activities.

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