Sports activities five years after total knee or hip arthroplasty. The
Ulm Osteoarthritis Study.
(Extended report)
Klaus Huch¹, Kay Astrid Claudia Müller¹, Til Stürmer²,
Hermann Brenner³, Wolfhart Puhl¹, Klaus-Peter Günther⁴

¹ Department of Orthopaedics, University of Ulm,
Oberer Eselsberg 45, 89081 Ulm, Germany

² Division of Pharmacoepidemiology and Pharmacoeconomics
Division of Preventive Medicine
Brigham and Women’s Hospital, Harvard Medical School
1620 Tremont Street, Suite 3030; Boston, MA 02120, USA

³ Department of Epidemiology, German Centre for Research in Aging (DZFA),
Bergheimer Str. 20, 69115 Heidelberg, Germany

⁴ Department of Orthopaedics, University of Dresden,
Fetscherstr. 74, 01307 Dresden, Germany

Correspondence / reprint requests to:
Klaus Huch, MD
Department of Orthopaedic Surgery
University of Ulm
Oberer Eselsberg 45
89081 Ulm / Germany
Phone: ++49 731 177 5107 Fax: ++49 731 177 1103
e-mail: klaus.huch@rku.de
ABSTRACT

Objective: The aim of our study is the analysis of sports activities of patients with hip or knee osteoarthritis (OA) over life-time, preoperatively and five years after arthroplasty.

Methods: In a longitudinal four-centre study 809 consecutive patients with advanced OA of the hip (420) or the knee joint (389) under the age of 76 years were recruited for total joint replacement. A completed questionnaire about sports activities at 5-year follow-up was received from 636 patients (79% of 809 patients at baseline).

Results: Although the majority of both hip patients (97%) and knee patients (94%) had performed sports activities during their life, only 36% (hip patients) and 42% (knee patients) had maintained sports activities at the time of surgery. Five years postoperatively, the proportion of patients performing sports activities increased to 52% among hip patients, but further declined to 34% among knee patients. Accordingly, the proportion of hip patients performing sports activities for more than two hours per week increased from 8 to 14%, whereas this proportion decreased from 12 to 5% among knee patients. Pain in the replaced joint was reported by 9% of the hip and over 16% of the knee patients.

Conclusion: Differences in pain five years after joint replacement might explain part of the observed difference of sports activities between hip and knee patients. General reasons for the reduction of sports activities may include the increasing age of the patients, their worries connected with an “artificial joint”, and the advice of their surgeon to be cautious.

Keywords:
Sport, osteoarthritis, arthroplasty, total hip replacement, total knee replacement
INTRODUCTION

An increasing life expectancy combined with a good general health condition can enable the elderly to participate in diverse sports activities. Since osteoarthritis of the hip or knee can significantly impair the function of the joint, arthroplasty surgery helps to restore the function and to reduce the associated pain. Both should allow to return to sports activities after arthroplasty.

Expert opinions about recommended or allowed sports activities after total joint replacement remain very diverse [1] and only little is known about sports activities actually performed by patients with total joint replacement. In the 1980s, Ritter et al. [2] observed a significant decrease in several activities except bicycling within 3 years after arthroplasty and recommend the “intelligent participation” in e.g. walking, golf, and bowling to avoid harm for the prosthesis. Bradbury et al [3] reviewed 160 patients including only 56 patients who participated in regular exercise in the year before surgery. 5 years after total knee replacement 77% (43 patients) had returned to sports. Of the patients not regularly involved in sports in the year before surgery only 8 patients started with sports. The three most popular sports in their study were golf (over 50% preoperatively), bowling (over 30%) and tennis (30%).

However, the level of sports activities declines with age as shown by Zahiri et al [4]. Their patients under 60 years of age were 30% more active on average than those of 60 or above. Therefore, the improved function through total joint replacement in one joint might be antagonized with time by other age related impairments, such as osteoarthritis in other joints or other comorbidity.

Several specific differences are known for knee and hip joints. Norman-Taylor et al [5] demonstrated that quality of life scores before knee arthroplasty surgery are significantly lower than those before hip joint replacement. Accordingly, the history of preoperative pain is longer for patients with osteoarthritis of their knee (about 10 years) compared to patients with osteoarthritis of their hip (about 5 years) [6] and the outcome for hip joint replacement seems to be significantly better than that for the knee joint [7].

The aim of our study was to analyze and compare life-time sports activities of patients with hip or knee osteoarthritis with the activities performed preoperatively and five years after arthroplasty in a large sample of patients undergoing hip or knee replacement due to osteoarthritis.
MATERIALS and METHODS

Study design
In the Ulm Osteoarthritis Study, a longitudinal four-centre study, 809 patients who underwent total joint replacement due to advanced osteoarthritis of the hip (n=420) or the knee joint (n=389) under the age of 76 years were consecutively recruited between January 1995 and December 1996. Details of the study design have been reported previously [6].

After written informed consent, patients were interviewed and examined by trained physicians on the day before surgery according to the protocol approved by the ethics committee of the University of Ulm. The standardized investigation included the following baseline data: demographic information, duration and severity of symptoms, drug use, previous medical history.

Between 01.07.2000 and 30.06.2001 follow-up information was obtained by a standardized mailed questionnaire from 636 patients (79% of 809 patients at baseline). Of the 809 recruited patients at baseline 56 (7%) did not respond (after several initiatives), 56 (7%) refused to be further involved in the study, 44 patients (5%) had died, and 17 (2%) could not be contacted due to an unknown address.

Questionnaire
Engagement in the following disciplines of sport was ascertained both in the baseline and the follow-up questionnaire: hiking, riding, dancing (including ballet-dance and jazz-dance), aerobics, swimming / aqua-jogging, soccer / handball / volleyball / basketball, down-hill skiing, cross-country skiing / jogging, fighting. In addition, patients could name other disciplines in a free text area of which the following frequently named disciplines were included in this analysis: golfing, bowling, tennis.

In the baseline-questionnaire we asked for sports disciplines performed during lifetime and those pursuit until total joint replacement. In the 5-year follow-up, the current level of sports activities was asked for. At both occasions it was ascertained whether patients engage in sports activities one or more hours per week.

The patients had the opportunity to give the following explanations for a reduction of sporting activities: pain in the replaced joint, pain in other regions, as a precaution, to go easy on the artificial joint, others (including free text like: due to age, impossibility to perform, heart failure, instability of the joint, vertebral pain).

The patients were also interviewed for comorbidity (e.g. diabetes, hypertension, cerebral infarction, fractures, myocardial infarction, cancer, thromboembolism, gastro-intestinal ulcers, or spinal disorders) and for surgical procedures in other major joints of the lower extremities. They also had the opportunity to mark painful joints on a scheme of the whole body.

In the baseline questionnaire, the distribution of radiographically determined osteoarthritis in hip, knee and finger / carpal joints (≥ grade 2 according to Kellgren and Lawrence [8]) was documented to classify mono- or bilateral and mono- and polyarticular distributions. The method for identification of polyarticular disease has been described earlier [6]. The definition of generalized OA (GOA) required the involvement of at least two distal or proximal interphalangeal joints and at least one carpometacarpal joint in addition to knee or hip osteoarthritis [6].
Data analysis

Engagement in sports activities at various points of time was primarily analysed by descriptive statistics. In addition, multiple logistic regression was carried out to assess determinants of engagement in sports activities for one or more hours per week five years after total knee or hip arthroplasty. The statistical analyses were performed using Statistical Analysis Systems (version 6.10), SAS Institute, Cary, North Carolina.
RESULTS
Overall, 809 patients receiving a total joint replacement of their knee or hip were recruited (Table 1).
Table 1
Characteristics of the study population at baseline among all patients and among patients with and without follow-up.

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>5-year follow-up</th>
<th>without follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hip</td>
<td>Knee</td>
<td>All patients [n (%)]</td>
</tr>
<tr>
<td><strong>Age at recruitment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 56 (%)</td>
<td>60.5 ± 9.7</td>
<td>66.3 ± 6.4</td>
<td>63.6 ± 8.8</td>
</tr>
<tr>
<td>56 – 60</td>
<td>74 (17.6)</td>
<td>40 (10.3)</td>
<td>114 (14.1)</td>
</tr>
<tr>
<td>61 – 65</td>
<td>82 (19.5)</td>
<td>92 (23.6)</td>
<td>174 (21.5)</td>
</tr>
<tr>
<td>66 – 70</td>
<td>75 (17.9)</td>
<td>124 (31.9)</td>
<td>199 (24.6)</td>
</tr>
<tr>
<td>&gt; 70</td>
<td>71 (16.9)</td>
<td>110 (28.3)</td>
<td>181 (22.4)</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>199 (47.4)</td>
<td>106 (27.3)</td>
<td>305 (37.7)</td>
</tr>
<tr>
<td>Female</td>
<td>221 (52.6)</td>
<td>283 (72.7)</td>
<td>504 (62.3)</td>
</tr>
<tr>
<td><strong>BMI</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 25</td>
<td>126 (30.0)</td>
<td>55 (14.1)</td>
<td>181 (22.4)</td>
</tr>
<tr>
<td>25 - &lt; 30</td>
<td>200 (47.6)</td>
<td>175 (45.0)</td>
<td>375 (46.4)</td>
</tr>
<tr>
<td>≥ 30</td>
<td>94 (22.4)</td>
<td>159 (40.9)</td>
<td>253 (31.3)</td>
</tr>
<tr>
<td><strong>Smoking</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-smoker</td>
<td>209 (49.8)</td>
<td>260 (66.8)</td>
<td>469 (58.0)</td>
</tr>
<tr>
<td>Ex-smoker</td>
<td>141 (33.5)</td>
<td>97 (25.0)</td>
<td>238 (29.4)</td>
</tr>
<tr>
<td>Smoker</td>
<td>70 (16.7)</td>
<td>32 (8.2)</td>
<td>102 (12.6)</td>
</tr>
<tr>
<td><strong>Comorbidity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>31 (7.4)</td>
<td>43 (11.1)</td>
<td>74 (9.2)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>190 (45.2)</td>
<td>225 (57.8)</td>
<td>415 (51.3)</td>
</tr>
<tr>
<td>Gout</td>
<td>44 (10.5)</td>
<td>63 (16.3)</td>
<td>107 (13.3)</td>
</tr>
<tr>
<td><strong>Osteoarthritis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unilateral</td>
<td>72 (17.9)</td>
<td>42 (12.6)</td>
<td>114 (15.5)</td>
</tr>
<tr>
<td>Bilateral</td>
<td>330 (82.1)</td>
<td>292 (78.4)</td>
<td>622 (84.5)</td>
</tr>
<tr>
<td>Mono-/biarticular</td>
<td>268 (80.7)</td>
<td>200 (65.2)</td>
<td>468 (73.2)</td>
</tr>
<tr>
<td>Polyarticular</td>
<td>64 (19.3)</td>
<td>107 (34.8)</td>
<td>171 (26.8)</td>
</tr>
<tr>
<td><strong>Total [n]</strong></td>
<td>420</td>
<td>389</td>
<td>809</td>
</tr>
</tbody>
</table>

(* Body Mass Index: normal < 25 kg/m², overweight 25 - < 30 kg/m², obese ≥ 30 kg/m²)
As table 1 shows, the distribution of major sociodemographic characteristics was very similar among all patients recruited and among those who participated in the 5-year follow-up. Mean age at baseline was about 63 years. The female to male ratio was about 2:1. More than 75% of the patients were either overweight or obese. About 40% had ever smoked, but only a minority of about 13% was still smoking at the time of recruitment. Over 50% of the patients were hypertensive. The great majority of participants (77% of the participants with knee OA and 80% of the participants with hip OA) could be followed 5 years later. As expected, the loss of patients for follow-up was age-dependent with 28.9% of those lost being over 70 years old at baseline compared with 22.4% in the whole cohort.

The distribution of unilateral and bilateral (around 84%) osteoarthritis as well as the distribution of mono- / biarticular and polyarticular (around 27%) osteoarthritis were similar at baseline and at the 5-year follow-up (Table 1).

5 years after total joint replacement an age-dependent decline in engagement in sports activities for one or more hours per week could be observed especially for knee patients (Figure 1).

Males were more active than females looking at life-time activities (79% versus 64% with one or more hours of sports activities per week) and at activities performed 5 years after total joint replacement (38% compared to 23%).

Although the majority of both hip patients (97%) and knee patients (94%) had performed sports activities during their life, only 36% (hip patients) and 42% (knee patients) had maintained sports activities at the time of surgery. (Figure 2). Five years postoperatively, the proportion of patients performing sports activities increased to 52% among hip patients, but further declined to 34% among knee patients. Accordingly, the proportion of hip patients performing sports activities for more than two hours per week increased from 8 to 14%, whereas this proportion further decreased from 12 to 5% among knee patients (Figure 2). Overall, more active patients revealing a higher intensity of their sports activities could be observed after hip than after knee replacement (Figure 2).

Figure 3) demonstrates that biking, hiking and swimming were the most important life-time sports activities among patients undergoing hip or knee replacement. However, preoperatively only a few patients (more in the knee than in the hip group) were still able to continue these activities, but most patients (more in the hip than in the knee group) could return to these activities after surgery and maintained their activity at the 5-year follow-up (Figure 3). Also looking at other sport activities like skiing, dancing and gymnastics hip patients demonstrated more profit after surgery compared to knee patients (Figure 3).

Pain in the replaced joint was referred to as a reason for the reduction of sports activities after total joint replacement about twice as often for the knee than for the hip joint, whereas precaution was more often mentioned for the hip than for the knee joint (Table 2).
Table 2
Main reasons for the reduction of sports activities 5 years after hip or knee replacement (in percent; 285 patients with hip and 312 patients with knee replacement):

<table>
<thead>
<tr>
<th>Reason</th>
<th>Hip</th>
<th>Knee</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain replaced joint</td>
<td>8.8</td>
<td>16.3</td>
<td>12.7</td>
</tr>
<tr>
<td>Pain elsewhere</td>
<td>25.6</td>
<td>29.2</td>
<td>27.5</td>
</tr>
<tr>
<td>Precaution</td>
<td>53</td>
<td>41.7</td>
<td>47.1</td>
</tr>
<tr>
<td>Others</td>
<td>11.9</td>
<td>10.6</td>
<td>11.2</td>
</tr>
<tr>
<td>No statement</td>
<td>0.7</td>
<td>2.2</td>
<td>1.5</td>
</tr>
</tbody>
</table>

In a multivariable analysis, the following factors at baseline were associated with engagement in sports activities for one or more hours per week five years after total knee or hip arthroplasty: Age (Odds Ratios, OR, 95% confidence intervals, 95% CI, for age groups 61-65, 66-70, and 71-75 compared to age group <=60: 0.65, 0.34-1.26; 0.67, 0.34-1.30; and 0.37, 0.17-0.77, respectively), sex (OR, 95% CI for men compared to women: 1.44, 0.86-2.41), replaced joint (OR, 95% CI for hip versus knee: 2.58, 1.49-4.47), heavy physical work (OR, 95% CI: 0.47, 0.26-0.83), smoking (OR, 95% CI: 0.31, 0.14-0.66), sports activities prior to replacement (OR, 95% CI: 2.80, 1.51-5.18, life time sports activities, OR: 2.54, 1.43-4.52).
DISCUSSION

To our knowledge this multicentre study performed in four institutions is the first large scale epidemiologic cohort study comparing engagement in sports activity performed during life-time, directly before and five years after surgery among patients undergoing primary total joint replacement for hip or knee OA.

At baseline, the two groups of hip / knee patients differed in the following parameters [6]: 47 / 27% males, 60.5 / 66.3 years old, 69.9 / 73.4 of pain on a visual analogue scale (ranging from 0 (no pain) to 100), 82.1 / 87.4% bilateral OA, 19.3 / 34.9% generalized OA. These differences might at least partly be responsible for differences in postoperative sports activities in both cohorts.

Five years after total joint replacement of the hip or knee joint, many of the patients had regained some of their life-time sports activities. This was especially true for biking, hiking and swimming. Patients with hip OA were particularly more active in biking, hiking, swimming, downhill skiing, gymnastics and cross country skiing / jogging when compared to knee patients at 5-year follow-up (Figure 3).

Brander et al. [9] did not compare differences in sports activities after total joint replacement in hip and knee joints, but they analyzed the functional outcome of 80 persons aged 80 and older (average 82.7 years for total knee and 82.6 for total hip arthroplasty), an age spectrum not included in our study. The mean of the Harris Hip Score improved from 60 to 88, whereas the mean of the Hospital for Special Surgery Score (knee) changed from 55 to 80.5. For the hip (knee) patients the preoperative pain was severe to moderate in 72% (93%) of the patients, the postoperative pain was mild to none in 100% (98%). More than 5-block ambulation of hip (knee) patients increased from 7% (2%) to 54% (50%). The study demonstrated not only the successful functional outcome of arthroplasty in the elderly, but also (slightly) better functional values for hip OA patients.

However, Weiss et al [10] demonstrated for patients with total knee replacement that kneeling and gardening were not only observed among the three most important activities mentioned by patients, but also among the three most difficult ones. This indicates that function might be limited after total joint replacement.

Especially in the lower extremity, the durability of total joint replacement seems to be dependent on mechanical forces. Kuster et al. [11,12] estimated the maximum tibiofemoral compressive force from kinematic and kinetic measures obtained during level (about 3.9 times body-weight during the early stance phase) and downhill walking (about 8 times). They also evaluated three different knee endoprosthesis designs for loads estimated for cycling, power walking, hiking and jogging and concluded that jogging or running should be discouraged after knee arthroplasty [12].

This might explain why surgeons might give different recommendations about activities after arthroplasty. Patients on the other side do not always consider the recommendations of their surgeons. Mont et al. [13] examined 50 male and 8 female tennis players (mean age 70 years) after total hip arthroplasty. Although only 14% of the patients’ surgeons approved this activity postoperatively, all patients played tennis three times a week on average one year after arthroplasty. Three patients (5%) required revision after a mean of 8 years.

Schmalzried et al. [14] analyzed the activity of 111 unrandomized patients with either knee or hip replacement using an electronic pedometer. The most active patient walked more than 3.5 times more than the average number of steps per day. Patients under 60 years of age walked 30% more than those above 60. Like in our study, men were more active then
women and walked 28% more. The authors postulate that these interindividual differences might influence the survival of knee or hip arthroplasties.

Gschwend et al. [15] examined differences in aseptic loosening between an active (alpine and cross-country skiing) (mean age 65 years, range 47-84) and an inactive (mean age 65 years, range 42-79) group of 50 patients each for total hip replacement and could not find a negative effect of skiing on the artificial components after 5-10 years of follow-up. After an average follow-up of 5.8 years Dubs et al. [16] observed a revision rate of 1.6% in the 61 sporty patients after total hip replacement, whereas the 49 patients without sports activities revealed a revision rate of 14.3%. Similar results were described for hip joints by von Strempel et al. [17] with a loosening rate of 5% in the sport group and 10% in the non-sport group, and by Widhalm et al. [18] with loosening in 18% versus 57%.

However, Kilgus et al. [19] found a 6% revision rate for less-active patients and a 28% revision rate for active patients with conventional cemented stemmed prothesis. They also described a higher revision rate for patients with non-osteoarthritis diseases than in patients with osteoarthritis as cause for total hip replacement (41 failures per 1000 person-years of follow-up versus 36 for the active and 16 versus 4 for the less active group) and discuss a reduced bone quality in the former group as a possible explanation for this observation.

Healy et al. [1] describe in their review that technical advances have reduced the loosening of implants in young active patients. For this group they recommend cementless acetabular implants in hip arthroplasty and cemented components in knee and shoulder replacement.

Among the patients included in this study, moderate activity was generally allowed, but we advised against high impact sports activities. Due to missing detailed recommendations about sports activities after total joint replacement in our study protocol and due to the 4-center design of our study slightly different suggestions are possible in different institutions.

Age above 75 years was an exclusion criterium in our study. Therefore, our results might not be representative for the elderly.

Since we did not include an age-matched control group without severe osteoarthritis of the hip or knee in our study, we cannot estimate the number of patients who have reduced the activities due to their increasing age rather than their arthroplasty. However, we did observe an age correlation of sports activities in our cohort.

Only 14% of our study population did not respond to our 5-year follow-up questionnaire or refused to participate. Reasons for rejection were the poor general health status or on purpose. Non-responders were older and likely to be less active than the responders, which may have led to a slight overestimation of the proportion of active patients at 5-year follow-up.

In general, total joint replacement allows a significant increase of sport activities at a five-year follow-up. In our study, hip patients revealed significantly better results than knee patients. One reason for this difference might be the fact that about 9% of the hip, but over 16% of the knee patients reported pain in their replaced joint. The hip group was also characterized by a higher proportion of males and younger patients (who are more likely to maintain sports activities according to our findings), a more localized pattern of OA distribution, and a lower pain score in the hip group compared to the knee OA patients. Nevertheless, a much higher engagement in sports activities was seen in hip patients even after control of potential confounders (including age) in multivariate analysis.
General reasons for a reduction of (special) sports activities after total joint replacement may be the increasing age of the patients, worries connected with an “artificial joint”, and the advice of the surgeon or physician to be cautious.

The possible influence of sport activities on the failure of total joint replacements has to be evaluated in a long-term follow-up of our patients.

At the moment we generally allow moderate activity, but we advise against high impact sports activities (with often uncontrolled and physically powerful joint movements; e.g. soccer, down hill skiing, tennis) after total joint replacement.

Acknowledgments:
The authors thank the Department of Trauma Surgery, University of Ulm (Chairman: Professor Dr. L. Kinzl), the Department of Orthopaedic Surgery, Klinik Dr. Baumann, Stuttgart (Professor Dr. C.T. Trepte) and the Department of Orthopaedic Surgery, Hessing-Klinik Augsburg (PD Dr. T. Naumann) for their collaboration in patient recruitment.
The authors also thank Dr. E. Raum for valuable contributions to data analysis.

The work was supported by the Federal Ministry of Research and Technology (BMFT, 01 EF 9406).

The Corresponding Author has the right to grant on behalf of all authors and does grant on behalf of all authors, an exclusive licence (or non exclusive for government employees) on a worldwide basis to the BMJ Publishing Group Ltd and its Licensees to permit this article (if accepted) to be published in ARD editions and any other BMJPGL products to exploit all subsidiary rights, as set out in our licence.
REFERENCES


15) Gschwend N, Frei T, Morscher E, Nigg B, Löhr J: Alpine and cross-country skiing after total hip replacement 2 cohorts of 50 patients each, one active, the other inactive in skiing, followed for 5-10 years. Acta Orthop Scand 2000; 71,3: 243-249


18) Widhalm R, Höfer G, Krugluger J, Bartalsky I: Ist die Gefahr der Sportverletzung oder die Gefahr der Inaktivitätsosteoporose beim Hüftendoprothesenträger größer ?
Folgerungen auf die Dauerhaftigkeit von Prothesenverankerungen. Z Orthop 1990; 128: 139-143

Legends:

Figure 1) Percentage of hip (a) and knee (b) patients performing sport for one or more hours per week according to age before and 5 years after total joint replacement.

Figure 2) Percentage of hip (a) and knee (b) patients performing sport during life-time, preoperatively and at 5-year follow-up at different intensities.

Figure 3) Comparison of specific sports activities at three different times (life-time, preoperatively and at 5-year follow-up) for hip (a) and knee (b) patients.
Patients with 1 or more hours of sport activities [% of all]

Age

< 56
56 - 60
61 - 65
66 - 70
> 70
TOTAL

Life-time
5-year follow-up