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

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ABSTRACT – 2 groups of 50 patients each, matched for age, weight, height, gender and type of implant, were clinically and radiographically examined after THR. Group A regularly carried out alpine skiing and/or cross-country skiing, while group B did no winter sports. At 5 years, no signs of loosening were found in group A, whereas 5/60 implants in group B had signs of loosening, mostly of the femoral component ($p < 0.05$).

At 10 years, 30 patients remained in group A and 27 in group B. No new cases of loosening were found in group B, but 2/30 cases in group A. There was a higher ($p < 0.05$) average wear rate in group A (2.1 mm) than in group B (1.5 mm). The wear rate was particularly high (3–4 mm) in physically very active patients in group A with localized osteolysis at the interface.

It seems likely that in an even longer follow-up, the number of cases of aseptic loosening would be greater in group A than group B. Our findings, combined with the results of previously-published biomechanical studies, do not provide any evidence that controlled alpine and/or cross-country skiing has a negative effect on the acetabular or femoral component of hip replacements. The results of the biomechanical studies indicate, however, that it is advantageous to avoid short-radius turns on steep slopes or moguls.

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The number of elderly, physically active people is rising. In some countries, outdoor activities are, for a great part of the year, limited to winter sports. When asking whether skiing can be permitted after total hip arthroplasty, patients usually receive a variety of answers.

A critical analysis of the literature concerning the effects of physical activity on the outcome of total hip replacement reveals a number of methodological shortcomings, which preclude reliable recommendations. No previous study has dealt specifically with the effect of regular alpine or cross-country skiing on outcome following hip arthroplasty. Biomechanical studies have demonstrated that certain types of skiing manoeuvers (e.g., short-radius turns on a steep slope, or skiing on moguls), can create heavy joint contact forces, 1.5–5 times higher than those encountered during walking or running. Cross-country skiing and downhill skiing, with moderate-radius turns made on flat slopes create stresses which lie somewhere in-between (Van den Bogert et al. 1996, Nigg et al. 1997).

On the basis of these findings, one may speculate that controlled cross-country and alpine skiing activities should not have a negative effect on loosening of the prosthesis. We examined the effects of regular participation in winter sports on the outcome of hip arthroplasty, by means of a retrospective clinical study using two groups of 50 patients, matched for age, gender and body-size.

Table 1. Age, weight, height

	Group A	Group B
Mean age (range)	65 (47–84)	65 (42–79)
Mean weight (range), kg	77 (44–100)	78 (52–110)
Mean height (range), m	1.73 (148–193)	1.72 (150–189)
Sporting activity		
Alpine skiing	mostly more than 5 days	none
Cross-country	mostly classic (diagonal) and 10–15 km/day	none
Summer sport	none: 4/50	none: 25/50
Golf	+	–
Tennis	+	–
Trekking	+++	+
Biking	++	(+)
Swimming	++	+

– none, (+) rarely, + occasionally, ++ regularly, +++ frequently

Patients and methods

Patient groups (Table 1)

2 cohorts were matched for age, sex, height and weight. Each cohort consisted of 50 patients (42 men) who had had a hip replacement because of osteoarthrosis; 10 of the 50 patients in each group had undergone a 2-stage bilateral hip joint replacement. All patients in group A were active in sports, including alpine and cross-country skiing during the winter months, while patients in group B were minimally physically active and did not ski at all.

Patients who were active skiers (group A) were also more active in other sporting activities (Table 1). Only 4/50 patients in group A were not at all active in "non-winter sports' compared with 25/50 in group B. The 25 patients in group B who undertook other sporting activities were still less active compared to the patients in group A, and they preferred activities such as swimming or walking, whereas the patients in group A were particularly active in trekking (up to 6 hours in the mountains), in gymnastics and biking and also played tennis or golf. Most of the group A patients carried out cross-country skiing in the classic (parallel) style, covering a distance of 10–15 km daily. In group A, 19/50 patients did cross-country only, 12 of them for more than 5 days per season. 28/50 did alpine skiing for more than 5 days per season (up to 30 days) of whom 6 in addition did cross-country skiing for more than 5 days. They were all good-to-excellent skiers, falling only occasionally.

Table 2. Implants

	Group A	Group B
Cup		
Zweymüller threaded cup	59/60	59/60
Spotorno uncemented cup	1/60	1/60
Stem		
Weber-Stühmer cemented	42/60	41/60
Permalock (Ti) cemented	9/60	10/60
Spotorno CLS uncemented	9/60	9/60

Surgery

All operations were carried out by staff surgeons at the Schulthess Clinic, between 1986 and 1989. 3 types of implant were used, which were evenly distributed between the 2 groups (Table 2). The usual combination was a hybrid system of an uncemented acetabular device (Zweymüller threaded titanium cup (Sulzer Medica, Winterthur/ Switzerland)) and a cemented femoral prosthesis (Weber-Stühmer CrCoNi shaft (Sulzer Medica, Winterthur/Switzerland)) with a 28 mm ceramic head. In 9 cases in each group an uncemented stem (CLS shaft (Sulzer Medica, Winterthur/Switzerland)) was implanted. 8 patients in group A received a cemented Titanium (Permalock (Sulzer Medica, Winterthur/Switzerland)) femoral prosthesis, one patient bilaterally (= 9 Ti prostheses), compared to 8 patients in group B, 2 of them bilaterally (= 10 Ti prostheses).

Mid-term follow-up

The follow-up examination was carried out by 2 independent and experienced examiners who had not been involved in the surgery. The average follow-up for group A was 62 (60–63) months, and for group B, 60 (56–63) months. In addition to a physical examination, all patients were asked to complete a questionnaire. Pain was noted on a 0–10 visual analogue scale, and was assessed separately for the hip, back and knee. All patients were radiographed. The presence, location and extent of radiolucent lines were examined, as well as migration, tilting or subsidence. The rate of polyethylene wear was assessed, according to the method of Scheier et al. (1976).

Long-term follow-up

Soon after this "mid-term" follow-up study, it became evident that cemented Titanium femoral components (Permalock prostheses) had an extraordinarily high early loosening rate. Moreover, it was questioned by our statistician, whether the bilaterally-operated cases in which only one side worked loose should be included in the statistics, as other, largely unknown factors might be responsible for the loosening. In the long-term study, we therefore excluded all patients with cemented Titanium prostheses and all bilaterally operated cases. 3 patients in group A and 3 patients in group B had died before the long-term follow-up.

In 1998 and 1999, all the other patients were re-examined at our institution. The follow-up time was, on average, 10 (9–12) years in group A (30 patients) and 11 (9.5–13) years in group B (27 patients). The examination included a questionnaire, a clinical and a radiographic examination.

Statistics

The loosening rate data were analyzed, using Fisher's exact test with Stat View 4.0 Software for Apple Macintosh. Pre- to postoperative differences in range of motion and in wear rate were analyzed, using the paired t-test and Mann-Whitney U-test, respectively. The chi-square test was used to analyze group differences in the categorical data. Statistical significance was accepted at the 5% level.

Results

Mid-term follow-up

Pain. Group A had a mean pain rating of 0.6 (0–4) on a 0–10 VA scale and group B 0.8 (0–7) ($p = 0.9$).

Radiography

Acetabulum. In group A, 1 man had 2 mm cranial migration of the cup, but no tilting. The patient was painfree and active. Apart from skiing, he cycled 500 km each year and swam approximately 500 m every week.

In group B, 1 man had acetabular loosening of a threaded Zweymüller Titanium cup, and a pain rating of 5 on the visual analogue scale. The patient was totally inactive.

All other implants were radiographically unchanged and showed no radiolucencies.

Femur. In group A, a localized lucency in one of the zones 1–7 was seen in 6 cases. The radiolucency was not continuous and did not exceed 1 mm in width. All patients were painfree.

In group B, localized lucencies not exceeding 1 mm could be seen in one of zones 1–7 in 5 patients, 4 of whom were painfree, and the remaining patient complained of moderate to severe pain.

In 2 patients (1 man) from group B, a continuous zone of radiolucency was seen; he had moderate to severe pain on activity. In the male patient, both femoral components (Titanium Permalock cemented prosthesis) were loose. In 1 man with a bilateral hip replacement, subsidence was noted on one side, combined with moderate subjective pain. Each of the last 3 patients was considered to have stem-loosening (1 bilaterally).

In summary, we found no implant loosening in group A (60 implants in 50 patients), whereas in group B 5 of 60 implants in 50 patients were loose ($p = 0.029$).

Wear

To determine whether the wear rate of high density polyethylene (HDP) could affect the loosening rate, we compared the 6 most active patients in group A with the 6 least active ones in group B. After an average follow-up time of 6 years in group A and 7 years in group B, we found an average linear wear of 2.42 mm in group A and 1.16

mm in group B (p = 0.07).

Although the average difference of the wear rate in these small sub-groups failed to reach statistical significance, we believe that great physical activity may cause a higher wear rate.

Long-term follow-up

Pain. 24/30 patients in group A and 21/27 in group B had no pain at all, 3/30 in group A had only occasional slight pain (1 showing signs of spinal stenosis), compared with 6/27 in group B (some in relation to back pain or osteoarthrosis of the knee). 2/30 in group A had severe pain, 1 because of loosening of the femoral component and the other due to loosening of a Zweymüller cup. No patient in group B had severe pain. The difference in pain between the two groups was not significant (p = 0.5).

The mean flexion-extension range was 109° (85°–120°) in group A and 101° (40°–120°) in group B.

In group A, the walking ability (questionnaire analysis) was unlimited in 26/30 patients and limited in 4: 1 because of cup loosening, 1 because of femoral component loosening, 1 because of OA of the opposite hip and knee, and 1 because of spinal stenosis. In group B, 9/27 could walk for an unlimited time and 7/27 were able to walk for more than 1 hour. The remaining 11 patients had a more reduced walking ability: 1 because of the operated hip, 2 because of pain on the opposite side, 2 because of OA of the knee, 3 because of reduced general health and 3 for various other reasons (back, neurological problems and postfracture syndrome). The difference between the groups was highly significant (p = 0.0001).

Patients' assessment. In group A, 28/30 and in group B, 19/27 were satisfied or very satisfied.

2/30 in group A were not satisfied (the patients with implant loosening which afterwards had been successfully operated on). In group B, 1/27 was not satisfied because of residual femoral nerve paresis. The difference between the groups was not statistically significant (p = 0.2).

Implant loosening. Among the 30 patients in group A, we found 1 acetabular cup loosening (a threaded Zweymüller cup in a man). In another man, loosening was suspected (migration 5 mm); the patient had no pain, however, and was still very active in sports. Another patient showed a localized irregularity at the interface of the Zweymüller cup with no signs of progression or suspicion of loosening. 1 CrCoNi femoral component was definitely loose in a male patient.

In group B, there was no case of loosening in the 27 unilaterally operated patients with cemented CrCoNi femoral component and non-cemented Zweymüller threaded cup.

The loosening rate at the long-term follow-up was therefore 6.6% in group A and remained at the same level recorded at mid-term, namely 8.3% in group B. It should be noted that both patients in group A with component loosening were extremely physically active until shortly before reoperation.

Radiographic analysis. The average linear wear was 2.1 mm in group A (1–4 mm) and 1.5 mm in group B (0–3 mm) (p = 0.05).

The interface was considered to be normal on the acetabular side (with the non-cemented Zweymüller cup) in 27/30 patients in group A and in 26/27 in group B. In group A, there was 1 certain Zweymüller cup loosening and 1 suspected incipient Zweymüller cup loosening (see above). In group B, 1 case with localized osteolysis, but without signs of loosening (tilting or migration), was found.

On the femoral side, the interface was entirely normal showing no sign of radiolucency in 15/30 patients in group A and in 12/27 in group B. 8/30 osteolytic processes (strictly localized radiolucency with a diameter of more than 3 mm) similar to that shown in the Figure in zone 7 were found in group A. In 2 of these cases, there were 4 strictly localized osteolytic spots in 4 zones (Gruen zones 1, 3, 5, 7) and in another 2 cases, 2 spots in 2 zones (6 and 7). The remaining 2 cases had only a single osteolytic spot. Radiolucencies between 1–2 mm were found in 5 cases, 4 of them in zone 7 and 1 in zones 1 and 7. A radiolucency of less than 1 mm in zones 1 and 2 was found in 2 more cases.

7 of the 8 patients with osteolytic spots had a linear wear of 3–4 mm, which was clearly above the average value of 2.1 mm for group A. They were all extremely active in skiing and in the warmer seasons undertook mountain trekking for up to 6 hours. On the other hand, there were 6 very active patients in group A with only an average, or

Man, 75 years of age. Despite undertaking extreme sporting activities and receiving a cemented Titanium Permalock femur prosthesis, no clinical or radiographic signs of loosening were seen 8 years after surgery.

below average wear rate, and 2 more cases with notable wear (3–4 mm), but without osteolytic spots. The man with a loose cup (see above) showed only 1–2 mm wear.

In group B, only 3/27 cases with osteolytic spots were found, 2 of them showing wear of less than 1 mm. Radiolucencies (1–2 mm) were found in 9/27 cases, 6 of them were localized in zone 7, 2 in zone 1, and 1 in zone 5. In 3 more cases, a localized radiolucency of less than 1 mm was noted. The difference concerning the frequency of osteolytic spots in the 2 groups was not statistically significant ($p = 0.1$).

Discussion

The question regarding the influence of sporting activities on the longevity of total hip arthroplasty is controversial. Previous studies have failed to take into account potentially confounding factors such as age, sex, body weight and height, when attempting to identify the contribution of the sport itself.

Widhalm and Höfer (1990) addressed the question whether the risk for patients with artificial hip joints who participated in contact sports was greater than that associated with potential inactivity-induced osteoporosis following avoidance of sporting activities. They found a loosening rate of 18% in those who were active in sports, and of 57% in those who did not participate in sports. However. they did not study other sports activities, did not use homogeneous cohorts and did not control the effects of other factors relevant to the loosening problem.

Kilgus and Dorey (1991) compared the rate of loosening in patients with either a cemented resurfacing prosthesis (Nesse 1991) or a conventional cemented T28 stemmed prosthesis.

They classified the patients with each type of prosthesis as either active or inactive. There was a loosening rate of 43% in the active group compared with 25% in the inactive group. For those who had had conventional cemented stemmed prostheses, the respective figures were 28% and 6%. However, there was a discrepancy between the number of patients examined in each group and a poor match in relation to their average age, gender, body weight and height. Factors such as the implantation of unilateral or bilateral prostheses, and differences in the original indication for joint replacement (osteoarthrosis or otherwise) were not considered. The follow-up periods in the different groups also varied widely. Moreover, the poor outcome of resurfacing hip prostheses, in general, is well-known (Cotella et al. 1990, Nesse 1991).

Dubs et al. (1984) reported a reduced rate of loosening in total hip replacement surgery in those active in sports. However, the patient sample represented a very select group, and no statistical analyses were made, so that their conclusions led only to the descriptive observation that carefully executed sporting activities seemed not to be detrimental to the hip joint.

One of the factors which is assumed to influence the loosening of hip implants is the force acting on these implants. The forces exerted on the hip joint have been quantified for various sporting activities (Van den Bogert et al. 1996, Nigg et al. 1997). Controlled alpine skiing (long-radius turns on a flat slope) and cross-country skiing had the lowest loading of all skiing activities, lying in-between those associated with walking and running. Skiing on a flat slope with short-radius turns or on a steep slope with long-radius turns exerted slightly higher loading on the hip than running. Significantly higher loading was found for short-radius turns on a steep slope and for moguls.

It is of particular interest that the skiing activities analyzed showed higher medio-lateral and anterior-posterior forces as well as higher moments about the longitudinal (internal-external rotation) and transverse (flexion-extension) axes than those experienced during walking.

The purpose of our clinical study was to evaluate the outcome in patients with a particular interest in skiing. In the mid-range follow-up after 5 years, it could be seen that no loosening was present in the active group of 50 patients with 60 hip replacements, whereas in the inactive patients, 5 loose implants (1 acetabulum, 4 femoral shafts) were found in 4 patients. We therefore concluded that in the mid-term, even very active patients did not necessarily suffer any adverse effects from the pursuit of their activities. Measurement of the loss of polyethylene in the acetabulum in 6 extremely active patients, compared to 6 non-active patients, yielded values of 2.42 mm and 1.16 mm, respectively. Consequently, osteolytic processes due to the debris might jeopardize the success of the prosthesis to a higher degree in the active, compared to the inactive patient.

In the long-term follow-up, no further cases of loosening were found in group B, but 2 patients in group A developed aseptic component loosening. When analyzing linear radiolucencies (< 1mm or 1–2 mm), we found no difference between the 2 groups, whereas the more circumscribed osteolytic areas (> 3 mm) were definitely increased in group A. Here, 8 cases in group A versus 3 cases in group B were found.

It seems justified to speculate that these osteolytic areas could be due to the greater amount of polyethylene debris which was found to measure 3–4 mm in 7 of the 8 most active patients in group A. These patients not only went skiing, but were also very active in hour-long hiking in the mountains. The average loss of polyethylene in all patients in group A was 2.1 mm and therefore significantly increased ($p = 0.05$), compared to the value of 1.5 mm in group B.

The results suggest that there may be limits to the physical activity which patients with total hip replacement should undertake. However, despite the radiographically less favorable long-term result in group A, this was not reflected in the clinical findings (pain, activities of daily life). The subjective scores of patients in group A were definitely better than those in group B ($p = 0001$). One wonders whether patients who are inclined to be physically more active may also have a more positive outlook on life.

It seems likely that regular sporting activity will maintain better muscular balance and reduce the risk of osteopenia associated with ageing and disuse. However, there are limits which, if exceeded, may lead to more wear and osteolytic processes, as possible precursors of loosening. In analyzing the various physical activities regularly undertaken by patients in group A with loosening or a high wear rate and osteolytic changes at the interface, mountain trekking for several hours features most frequently. The physical challenge that this type of activity places on the knee and hip joints, particularly during descent, is well-known.

In conclusion, we found that in the 10-year perspective, the total number of problems following THR was lower in active than in inactive patients. There is still no evidence to explain why activity affords a protective effect, but it can be said that a careful execution of sporting activities—including alpine and cross-country skiing—is unlikely to damage the joint prematurely.

It is also obvious that the arthroplasty patient

should not necessarily decide at this time of his life to take up skiing, since the chance of injury through falls is increased. But there seems to be no reason to deny the experienced skier these activities which, apart from the psychological gains, will also have substantial benefits in terms of cardiovascular fitness. It is very likely, however, that negative long-term effects may be more frequent at least for extremely active people due to an increased wear rate of polyethylene; this aspect has to be studied further, especially with respect to comparison of the long-term results of metal to polyethylene, ceramic to polyethylene and the new metal to metal combination prostheses.

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