High prevalence of hip arthrosis in former elite javelin throwers and high jumpers

41 athletes examined more than 10 years after retirement from competitive sports

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ABSTRACT We studied the occurrence of hip arthrosis in 19 former elite javelin throwers and 22 former elite high jumpers 10 years or more after their retirement from competitive sports. Any restriction in the activities of daily living was assessed with an ADL-questionnaire. We compared the radiographic findings with male, age- and body mass index-matched controls (non-athletes). 22 of 38 hips in the javelin throwers (7 of 38 hips in the controls) and 15 of 44 hips in the high jumpers (6 of 44 hips in the controls) were classified as stage II or worse (Kellgren); hip arthrosis was commoner in both groups than in the controls. Despite considerable radiographic degenerative changes, the reduction of function in activities of daily living (FFbH score 96% in javelin throwers and 99% in high jumpers) was slight, as compared to a corresponding normal population.

Javelin throwing and high jumping as competitive sports entail a high risk of subsequent hip arthrosis.

There is some controversy regarding the commoner occurrence of hip arthrosis in high-performance competing athletes. Some data suggest that in boxers, weightlifters, wrestlers in athletics, soccer and ice hockey the frequency of hip arthrosis is increased (Kujala et al. 1994), but in long distance runners, the findings are contradictory. Retrospective studies by Konradsen et al. (1990), Puranen et al. (1975), and Sohn and Micheli (1985) and prospective ones by Panush et al. (1986) showed no increase in the risk of hip arthrosis in distance runners, while retrospective studies by Marti et al. (1989) and Spector et al. (1996) showed a higher risk of hip arthrosis.

Javelin throwers are particularly prone to changes in the lumbar spine—e.g., spondylolysis and spondylolisthesis (Neusel et al. 1987, Steinbrück et al. 1980, Schmitt et al. 2001), which can become symptomatic with advancing age. In high jumpers, most problems occur in the knee and ankle joints, especially in the takeoff leg.

The aim of our study was to determine which changes occur in the hip joints of elite javelin throwers and high jumpers at least 10 years after their retirement from active competitive sports, as compared with age- and BMI-matched controls and whether such changes cause symptoms.

Subjects

We examined 19 male javelin throwers and 22 male high jumpers after they retired from high-performance competitive sports. The inclusion criteria were: (1) retirement from competitive sports at least 10 years before; (2) personal best of at least 70 meters for javelin throwers who were competing in the 1970s or 80 meters for javelin throwers who were competing in the 1980s; personal best of at least 2.18 meters for high jumpers; (3) activity as specialist javelin throwers or high jumpers and not as multi-event athletes; (4) age of 40 years or more.

After examining the lists of top performers (German Athletic Association 1972–1986), we

found 23 javelin throwers who fulfilled our inclusion criteria. 4 of these have died since compilation of the lists. The remaining 19 javelin throwers agreed to participate. 26 high jumpers fulfilled the inclusion criteria, 4 were unwilling to take part in the study. The total study group was made up of former Olympic and world champions, world record holders and national top athletes. The follow-up examination was done 19 (10–28) years after retirement from competitive sports.

We used a questionnaire for the competition and training history and to elicit subjective complaints involving the musculoskeletal system during and since their involvement in high-level competitive sports. After evaluation of the questionnaires, we selected points of emphasis for the clinical examination and for diagnostic imaging techniques that could yield more information, and factors that might be implicated in the development of secondary hip arthrosis (metabolic, inflammatory or anatomical changes, lesions and operations). We also recorded the amount of involvement in sports since retirement from elite competition and the exposure to occupational stress. We used the hip version of the Hanover Functional Ability Questionnaire (FFbH) to assess how much the subjects were restricted in their activities of daily living (ADL). This short self-administered questionnaire (18 items) assesses the functional limitations of patients with musculoskeletal disorders. They can answer questions, such as "can you walk upstairs from one floor to the other?" by writing 1) yes, 2) yes, but with trouble, 3) no or with the help of another person. Data from various studies indicate that the FFbH meets the relevant psychometric criteria of acceptability, reliability, validity, and sensitivity to change (Kohlmann and Raspe 1996).

After evaluating the anthropometric data (body mass index (BMI)), we did a clinical examination of the mobility of each hip joint. Radiographs were taken and evaluated with Kellgren and Lawrence's method (Lawrence 1977). We determined the presence of joint space narrowing, osteophytes at the acetabulum and femur, subchondral sclerosis and cysts. As in most epidemiological studies, we used the criterion for definitive hip arthrosis—i.e., arthrosis grade 2 or worse (Felson 1988)—and determined the degree of deformation of the hip joint by calculating the center edge (CE) angle with Wiberg's method (dysplasia < 23 degrees) and the indicator of femoral head coverage ACM angle with Idelberger and Frank's method (dysplasia < 39 degrees, protrusion > 51 degrees) (Brückl 1992).

All radiographic findings were compared with radiographs of male, age (± 5 years)- and BMI (± 2)-matched controls (sports activity no more than twice a week, no participation in competitions). The matched controls were recruited prospectively as consecutive hospital-based controls. Over a 2-year period, we registered all patients with hip or pelvic injuries radiographed in our clinic and used a questionnaire and an interview to obtain information about sports activity, previous injuries, diseases, medication, occupation and health. Patients having chronic diseases and/or heavy work were excluded.

Statistics

The inter- and intra-rater reliability of the Lawrence Score had been determined in an unpublished study and measured by Kappa (κ) and the intra-class coefficient (ICC). 129 radiographs of hips were assessed twice by one rater (A) and once by another (B). Lawrence scores were determined on each side (left and right hips) and agreement was calculated rater A for each side, and between rater A and rater B. The intra-rater reliability ranged from $\kappa = 0.62$ to $\kappa = 0.63$ and the inter-rater reliability from $\kappa = 0.59$ to $\kappa = 0.70$. The intra- and inter-rater reliability, based on the ICC, ranged from 0.82 to 0.85 and from 0.76 to 0.86, respectively.

In the present study, all 41 radiographs were independently assessed three times. In the other statistical analyses, we used the mode (most frequent value) of the three ratings.

Mean and range or standard deviation of each continuous variable were determined. The relation between the severity of radiographic arthrosis and the other variables was calculated with Pearson's or Spearman's (r_s) correlation coefficient as appropriate. If the severity differed in any athlete in the two hips, the more severe grade was used for analysis.

Pairwise comparison of the prevalence of hip arthrosis was done using odds ratios (OR) with 95% confidence intervals (CI).

Table 1. Anthropometric data and sport-discipline-specific characteristics of 19 former elite javelin throwers and 22 high jumpers (CSC: competitive sport career). Values are mean (range)

	Javelin	High jump
Age	52 (40–59)	47 (42–57)
Age, controls	51 (40–58)	48 (40–58)
BMI	28 (24–32)	23 (21–28)
BMI, controls	28 (24–32)	24 (21–28)
Personal record	81.6 (71.0–96.7)	2.24 (2.18–2.36)
CSC in years [a]	13 (4–23)	11 (5–17)
Years after CSC [a]	20 (11–25)	19 (10–28)
Training while CSC [a,b]	14 (5–25)	17 (8–28)
Strengthening training while CSC [a,b]	5 (1–12)	5 (2–10)
Sports activity after CSC [a,b]	5 (2–12)	5 (1–15)

[a] 3 javelin throwers and 5 high jumpers were not active after CSC and they were not included in the calculation of the means
[b] hours/week

Results

None of the athletes or controls had taken up a physically-demanding profession after retiring from competitive sports, and none had a history of accidents or metabolic diseases. 3 throwers and 5 jumpers have participated in no sports after giving us their competitive career; the others spend between 1 and 15 hours weekly at some leisure sport (tennis, golf, weightlifting).

The anthropometric data and sport-specific parameters are shown in Table 1. None of the athletes and non-athletes had chronic diseases, regular medication, heavy labor in their profession, were regular smokers or alcoholics.

During their active competitive sport phase, 3 javelin throwers had complained of hip pain, 2 on the side of the drive leg, and 1 on the side of the plant leg. 4 throwers had had injuries of the adductor muscles of the drive leg, which in 1 case had required surgery for a complete rupture, while 3 athletes had had similar injuries in the plant leg.

At the follow-up examination, 6 athletes complained of pain in the hip, the hip on the drive leg side being affected in 4 cases and the hip on the plant leg side in 5. In addition, 2 athletes needed total hip replacements on the drive leg side.

Flexion of the hips was limited to less than 110 degrees on the drive leg side in 4 of the throwers and on the plant leg side in 3, and internal rotation with the hip joint flexed at 90 degrees was limited to less than 15 degrees in 8 throwers, both on the plant leg and on the drive leg sides. No high jumpers had limitation of motion in both hip joints.

Radiographic evaluation to detect the occurrence of hip arthrosis showed no significant difference between the two hips. Hip dysplasia was not found in any of the hips (Table 2); 2 athletes had moderate protrusion bilaterally. Joint space narrowing and osteophytes at the femur were found more often in athletes than in controls (Table 3). Arthrosis stage 2 or worse was found in 22 of 38 hips (11 drive leg/11 plant leg side) in javelin throwers, and in 6 of these hips (2 drive/4 plant leg side) in 5 of the athletes, arthrosis stage 3 or worse was found. Of these, 2 javelin throwers required an endoprosthesis. 7 of 38 hips in the control group were classified as stage 2 or worse.

In high jumpers, 15 of 44 hips (8 takeoff leg/7 swinging leg side) were classified as stage 2 or worse and 6 hips of controls (Table 4). No significant differences between the plant and drive legs in javelin throwers and swinging and takeoff leg in the high jumpers were found.

Table 2. CE and ACM angles of javelin throwers, high jumpers and controls

	Javelin throwers (n = 19) Mean (SD)	Controls (n = 19) Mean (SD)	Paired differences Mean (SD)	P-value	High jumpers (n = 22) Mean (SD)	Controls (n = 22) Mean (SD)	Paired differences Mean (SD)	P-value
CE right	34 (7)	39 (4)	–5 (9)	0.03	35 (4)	38 (5)	–3 (6)	0.02
CE left	34 (7)	38 (4)	–4 (9)	0.06	36 (5)	39 (5)	–3 (7)	0.1
ACM right	44 (4)	45 (3)	–1 (5)	0.4	45 (3)	46 (3)	–1 (5)	0.4
ACM left	45 (3)	45 (3)	0 (4)	0.8	46 (2)	46 (3)	0 (4)	0.8

Table 3. Degenerative changes on radiographs of the hips in highly-competitive athletes and controls

	Javelin throwers (n = 19)		Controls (n = 19)		High jumpers (n = 22)		Controls (n = 22)	
	Plant leg	Drive leg	Right	Left	Takeoff leg	Swinging leg	Right	Left
Joint space narrowing	11	11	3	4	8	7	2	3
Osteophytes								
acetabulum	18	18	19	19	22	22	20	22
femur	8	9	5	4	4	5	3	4
Sclerosis	11	11	2	3	8	7	2	3
Cysts	3	3	2	1	2	2	1	2

Table 4. Degenerative changes on radiographs of the hips in highly-competitive athletes and controls, using the classification of Kellgren and Lawrence

	Javelin throwers (n = 19)		Controls (n = 19)		High jumpers (n = 22)		Controls (n = 22)	
	Plant leg	Drive leg	Right	Left	Takeoff leg	Swinging leg	Right	Left
Grade 0								
Grade 1	8	8	16	15	14	15	19	19
Grade 2	9	7	3	1	6	5	3	3
Grade 3		4	0	3	2	2		
Grade 4								
THR	2							

THR – Total hip replacement

The prevalence of hip arthrosis among elite high competitive javelin throwers was 3 times higher than in age and BMI matched controls (OR = 6.1; 95%CI: 2.1–17). The prevalence of hip arthrosis among former elite high jumpers was 2.5 times higher than in age- and BMI-matched controls (OR = 3.3; 95%CI: 1.1–9.5). The OR (95%CI) of the pooled sample was 4.4 (2.1–9.1).

The mean functional capacity (FFbH) was 96% (67–100) in javelin throwers and 99% (94–100) in high jumpers.

We found a positive correlation between the severity of the arthrosis and the end of the high-level competition phase (r_s = 0.33; p = 0.04); but after adjustment for age, the correlation coefficient fell to r = 0.11 (n.s.). No correlation was found with the duration of the high-performance phase, the hours per week spent in training, the percentage of time spent in power training, the amount of time spent on sports after a competitive career and the BMI.

A correlation was detected between the severity of arthrosis and more marked restriction of activities of daily living, as assessed with the Hanover Function Questionnaire (FFbH (r_s = 0.31; p = 0.05)). The above correlations refer to the pooled sample of athletes (n = 41), but we also found a correlation between ADL and arthrosis in the javelin throwers (r_s = 0.65; p = 0.003).

Discussion

The hip joints of javelin throwers are particularly subject to stress. To adopt an optimal release position, which involves aligning the shoulder, javelin and hip, the javelin must be withdrawn during the last 5 transition steps, and the last step taken before the release phase is an impulse step—i.e., a long, jump-like, low drive-off from the drive leg with no loss of speed, one of the essential preconditions for top performances. In the step onto the plant leg immediately after the impulse step, the speed of the hips is blocked, the moment of greatest arc tension is reached, the upper body is turned around the lateral axis of the hip joint and the speed is transferred to the airfoil by bringing the throwing arm forward. In the final (block) phase, marked flexing of the plant leg with a jump around copes with the body weight that has resulted from the abrupt block (Joch 1997). In elite javelin throwers, more than 70% of the speed of the throw is developed in the last 0.1 s (Morriss and Bartlett 1996).

With up to 50,000 javelin throws or throws of other missiles, such as balls or shots per year, the hip joints are subjected to massive stress. In addition, intensive training exercises entailing stress on the hips (e.g., deep knee-bends) are done. In the evaluation of radiographic changes, we found no difference between the two hips, therefore it is not only the plant phase that stresses the hip.

In the late 1960s, international high jumpers began to use the flop technique instead of the straddle technique. The curved path before takeoff involves rotational forces on the ankle, knee and hip joints. We found that these loads and thousands of jumps in training and competition can cause degenerative changes in the hip joint.

Long-term stresses may lead to microtraumata and degeneration of the joint cartilage (Buckwalter and Lane 1997). Vingard et al. (1993) have shown that sports involving high acceleration or braking forces are particularly likely to cause such changes. The extreme stresses that a javelin thrower is exposed to from the approach phase to the blocking phase favor the development of microtraumata and ultimately of arthrosis in the area of the hip joint.

We compared our data to the occurrence of hip arthrosis in a general population (Lawrence 1977, van Saase et al. 1989, Sun et al. 1997) and found that the frequency of arthrosis in our athletes was definitely higher. In our study group the prevalence of hip arthrosis in javelin throwers is 3.1 times, and in high jumpers 2.5 times that in the age- and BMI-matched controls (nonathletes). BMI should be considered as a preselection factor for choosing throwing or jumping disciplines in childhood. As we showed in the ankle joints of high jumpers, excessive exercise in athletes can cause the formation of osteophytes, which have no relation to arthrosis (Schmitt et al. 2003). Radiographs of the hip joints show that athletes have a higher incidence of femoral osteophytes and narrowing of the joint space than controls, a sign of excessive exercise.

We found a significant correlation between reduced function in activities of daily living on the Hanover Function Questionnaire in our study population and the stage of arthrosis, but the reduction was classified as slight, as compared with that seen in the normal population (men aged 40–59 years, n = 666, FFbH = 86%) (Kohlmann et al. 1999), which shows that radiographically-advanced hip arthrosis may be present even without a reduction in function in the activities of daily living.

Although no significant correlations with the extent of the arthrosis were detected in the evaluation of a subject's training data, hip arthrosis was commoner in elite class javelin throwers and high jumpers than in age- and BMI-matched nonathletes.

No competing interests declared.

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