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Background: Implant functionality has clearly increased over the past decades because of improvements in total shoulder arthroplasty systems. This means that prostheses are now being implanted in younger patients with high sports activity.

Hypothesis: The implantation of the total shoulder arthroplasty does not mainly influence the sports activity.

Study Design: Case series; Level of evidence, 4.

Methods: One hundred consecutive patients with unilateral total shoulder arthroplasty, followed for at least 1 year, were included in the study. Assessment preoperatively and 1 year and 2 years after operation included clinical examination and a validated questionnaire (Constant, Shoulder Pain and Disability Index [SPADI], and Disabilities of the Arm, Shoulder and Hand [DASH] scores, and the Short Form 36 [SF-36]). In addition, all patients received a sports questionnaire developed in house.

Results: Of the 55 patients who took part in sports before having shoulder disease, 49 (89%) were still able to participate after a mean follow-up of 2.8 years (range, 1.3-4.6 years). Seventeen patients had given up sports before total shoulder arthroplasty; 11 of them resumed activities after joint replacement but 6 did not start again. No patient had to stop sports because of the total shoulder arthroplasty. The sports most commonly mentioned were swimming (10 patients [20.4%]), golf (8 patients [16.3%]), cycling (8 patients [16.3%]), and fitness training (8 patients [16.3%]). Strength and range of motion, as well as the physical component summary (PCS) of the SF-36 and the Constant score (CS) after total shoulder arthroplasty, were significantly better in the sports group (49 of 100; PCS = 46, CS = 77) than in the nonsports group (45 of 100; PCS = 41,CS = 71). Eighteen patients (36.7%) stated that even after joint replacement, they still suffered restrictions on their sports activities because of shoulder problems. Whereas the overall mean age at follow-up was 68.9 years (range, 26-92 years), the mean age of patients participating in sports was significantly lower than in the nonsports group (63 vs 70 years; $P = .002$).

Conclusion: Total shoulder arthroplasty allows patients to participate in sports without significant restriction of their level of activity. The probability of being able to do sports postoperatively—if done preoperatively—is high. Long-term studies are needed to determine whether the greater loading on the joint will lead to more rapid wear and a higher rate of loosening with time.

Keywords: shoulder; arthroplasty; sports activity

The good results of shoulder arthroplasty reported in the literature, especially regarding function, inevitably give rise to greater expectations on the part of the patient. Time and again, in both the preoperative discussions and during follow-up visits, patients ask whether and to what extent they will be able to do sports after a shoulder replacement, whether particular types of sport are recommended or forbidden, and especially whether it will be physically possible and permitted to continue an existing sports activity after surgery.

In 2008, Healy et al[6] published a review of sports that were recommended or not advisable after total shoulder arthroplasty. Innumerable articles have described sporting abilities after hip, knee, and ankle joint replacements,[†] but we know of only 4 papers concerning shoulder arthroplasty.[8,9,13,20]

The aim of this study was to determine the sporting abilities of patients before they had shoulder disease, during this disease, and after shoulder joint replacement. In particular, we addressed the question of whether the implantation of an anatomical shoulder prosthesis had any effects on participation in different types of sport and on the intensity of performance.

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[†]References 1, 3-5, 7, 10-12, 14-17, 19, 21.

MATERIALS AND METHODS

Patients

Between June 2003 and September 2006, 155 Promos anatomical total shoulder prostheses (Plus Orthopedics, Smith & Nephew, Rotkreuz, Switzerland) were implanted in 139 patients who could be documented prospectively. Patients who had bilateral operations (n = 16, 32 prostheses), conversion to an inverse shoulder arthroplasty in the meantime (n = 3), replacement of the other shoulder joint after the start of the study (n = 6), or who were unable to complete the questionnaire because they did not speak the language sufficiently (n = 5) were excluded from the study. A total of 109 patients were included in the study but 6 of them (5.5%) moved to an unknown address and could no longer be contacted, and 3 patients (2.7%) did not return the questionnaire despite several requests. The patient population with complete data, therefore, consisted of 100 patients (91.7%).

Indication for anatomical total shoulder arthroplasty was an intact rotator cuff, which was verified by ultrasound in all patients preoperatively. In this study, there are only patients with a glenoid without bone loss (type A and B1) or a correctable bone loss without bone augmentation (type B2). There are no patients with a type C glenoid in this study. Therefore, all glenoid components could be implanted in an anatomical retroversion determined on a preoperative MRI.

All patients had clinical and radiological examinations preoperatively, and both 1 and 2 years after surgery as part of our departmental quality control. Results were documented using the Constant score, Shoulder Pain and Disability Index (SPADI), Disabilities of the Arm, Shoulder and Hand (DASH) score, and Short Form 36 (SF-36) questionnaire.

As a matter of course, we indicated the total shoulder arthroplasty only for patients who already underwent all possible nonoperative and minimally invasive procedures, such as oral analgesia, infiltrations, and physical therapy, and in some patients even an arthroscopic procedure without success. All patients who were treated by shoulder arthroplasty still suffered from advanced painful osteoarthritis despite conservative treatment attempts.

We prefer the total shoulder arthroplasty over humeral resurfacing and hemiarthroplasty because of the better long-term results already available.[2,18]

Surgical Technique

The patient is placed in a beach-chair position. A standardized deltopectoral approach is performed. The subscapularis tendon is transected 1 cm medial of the insertion on the lesser tuberosity together with the capsule. Then a circumferential mobilization of the subscapularis tendon is performed. The capsule is sharply released from the anterior glenoid and adhesions are resected. A continuation of the capsulotomy with release of the capsular contractures, especially inferiorly, facilitates the subsequently necessary dislocation of the humeral head. The humeral osteophytes are completely removed to expose the anatomical neck of the humerus. After humeral head resection, the arm is returned to the neutral position. To expose the glenoid, the humeral head is retracted posteroinferiorly. The capsulotomy is completed dorsally to get a circumferential arthrolysis with complete soft tissue release. Next, the glenoid is prepared for the pegged, cemented glenoid component. Only the glenoid pegs are cemented, not the entire posterior surface of the glenoid. Then the proximal humerus is exposed and the stem is broached step by step. The uncemented stem is impacted carefully until the implantation depth determined with the trial components is reached. After test reduction with the trial components, including the head, the definitive components are assembled in situ, respecting the anatomical landmarks (rotator cuff insertion superior, bare zone [between medial cartilage margin and insertion of the tendons] posterior, capsular insertion inferior and anterior). Three to 4 nonabsorbable No. 2 braided sutures are used for the transosseous reinsertion of the subscapularis tendon (ie, No. 2 FiberWire, Arthrex, Volketswil, Switzerland). Finally, the closure of the subcutis and skin is performed. The exact details of the surgical technique were published in 2009.[22]

Sports Questionnaire

We requested the patients to inform us about any possible existing restriction on their sporting ability and, in the case of such restriction, whether it was related directly to the shoulder or to a combination of shoulder problems and other reasons. In addition, we asked whether they had to give up or modify any particular sports activities because of the shoulder problem and, if so, which ones. The final item in the general part concerned the duration of shoulder disease before the prosthesis was implanted.

Part 2 of the sports questionnaire consisted of a list of common sports. Patients were asked to check the boxes of those in which they had participated before and during shoulder disease, and after surgery. There was, of course, space provided to add any other sports activity. The third part of the questionnaire distinguished between the main sport and activities of secondary importance.

Patients had first to name the most important sport in which they currently participated (main sport) and answer questions on the intensity, level, number of sessions per week, and duration of each session, as well as give a subjective assessment of shoulder strength and range of motion before and during the disease, and after surgery. Patients were also asked how soon after surgery they had resumed the particular sports activity, and at what stage they had achieved maximum performance. As the main sport was taken to be the one that patients currently considered most important (ie, after implantation of the prosthesis), it was possible that they had never previously participated in this activity. The same question structure was used for secondary sports.

The final part asked specifically about tennis and golf, as these 2 sports make great demands on the upper limbs, and we wanted to draw more precise conclusions about the ability to participate in them.

Functional Scores

Follow-up times varied somewhat, as the chronology of our quality control examinations (preoperative, 1 and 2 years postoperative) did not coincide exactly with the timing of the completed sports questionnaires. To obtain feedback with meaningful results, we selected the results of the general scores (SF-36, SPADI, DASH, Constant score) closest in time (ie, from the 1- or 2-year follow-up examination), as none of the patients had yet had their 5-year checkup. The questionnaires were evaluated on return. Patients were contacted again, by phone, and asked personally about any questions that remained open.

Statistical Analysis

Data were presented descriptively. Statistical analysis was carried out with the Wilcoxon W ranking test, using the SPSS 11.5 program (SPSS, Zurich, Switzerland).

RESULTS

Demographics

The 100 patients who could be included consisted of 39 men and 61 women. The mean age at the time of the study was 68.9 ± 10.8 years (range, 26.1-91.7 years); the mean age at operation was 66.2 ± 10.9 years (range, 22.6-87.4 years). On average, follow-up was 2.8 ± 1 years (range, 1.3-4.6 years).

The right shoulder was operated on in 61 patients and the left shoulder in 39. Ninety-three patients were right-handed, 4 patients were left-handed, and 3 were ambidextrous. Surgery was performed on the dominant side in 60 patients and the nondominant side in 40.

The principal diagnosis was primary osteoarthritis in 60 patients, secondary osteoarthritis—either posttraumatic or because of instability—in 34 patients, and rheumatoid arthritis in 6 cases (Table 1).

At the time of this investigation, no clinically relevant signs of radiographic loosening were observed.

TABLE 1
Patient Demographics

Number of patients	100
Male	39 (39%)
Female	61 (61%)
Follow-up, y	2.8 ± 1
Age at operation, y	66.2 ± 10.9
Age at time of study, y	68.9 ± 10.8
Operated side	
Right	61 (61%)
Left	39 (39%)
Right-handed	93 (93%)
Left-handed	4 (4%)
Ambidextrous	3 (3%)
Operation of dominant/nondominant shoulder	60 (60%)/40 (40%)
Main diagnosis	
Primary osteoarthritis	60 (60%)
Secondary osteoarthritis	34 (34%)
Rheumatoid arthritis	6 (6%)

Preoperative and Postoperative Sporting Activities

Fifty-five patients (55%) participated in sports before the shoulder disease, and 49 patients (49%) after shoulder joint replacement.

Figure 1 shows that 45 patients (45%) had no sports activities at any time before the shoulder problems or after joint replacement (group GI); 49 patients (49%) were involved with sports before shoulder disease and after surgery (group GII); and 6 patients (6%) did sports only before the joint disease (group GIII).

The mean age at the time of the study was 73 ± 9.3 years (range, 47.9-91.7 years) in group GI, 66.1 ± 11.2 years (range, 26.1-87.7 years) in GII, and 61.3 ± 7.8 years (49.9-71.6) in GIII. The patients in GI were therefore significantly older than those in group GII ($P = .001$).

In group GI, 29 patients (64.4%) had a diagnosis of primary osteoarthritis, 13 patients (28.9%) had secondary osteoarthritis, and 3 patients (6.7%) had rheumatoid arthritis as the main indication for shoulder joint replacement.

The distribution of diagnoses was similar in group GII: the main diagnosis was primary osteoarthritis in 29 patients (59.2%), secondary osteoarthritis in 18 patients (36.7%), and rheumatoid arthritis in 2 patients (4.1%).

Group GIII included 2 patients (33.3%) with primary osteoarthritis of the shoulder, 3 patients (50%) with secondary osteoarthritis, and 1 patient (16.7%) with rheumatoid arthritis (Figure 2).

The results for patients in group GI, who did no sports at all, were not further evaluated in the following sections.

Reasons for Postoperative Restrictions on Sports Activity

In group GII—patients who participated in sports both before shoulder disease and after surgery—18 patients (36.7%) stated that, even after joint replacement, they still suffered restrictions on their sports activities because of shoulder problems, irrespective of changing sport or giving up. After the operation, 9 patients (18.4%) suffered from restrictions not related to shoulder problems (back pain, rheumatoid arthritis, cardiovascular problems, etc) and 2 patients (4.1%) said that shoulder problems in combination with cardiovascular problems and pain in the rest of the musculoskeletal system were responsible for the restrictions. The remaining 20 patients (40.8%) reported no restriction at all on their sports activity (Figure 3).

Changing Sport/Giving Up

In group GII, 15 patients (30.6%) said that they had given up a particular sport because of shoulder problems.

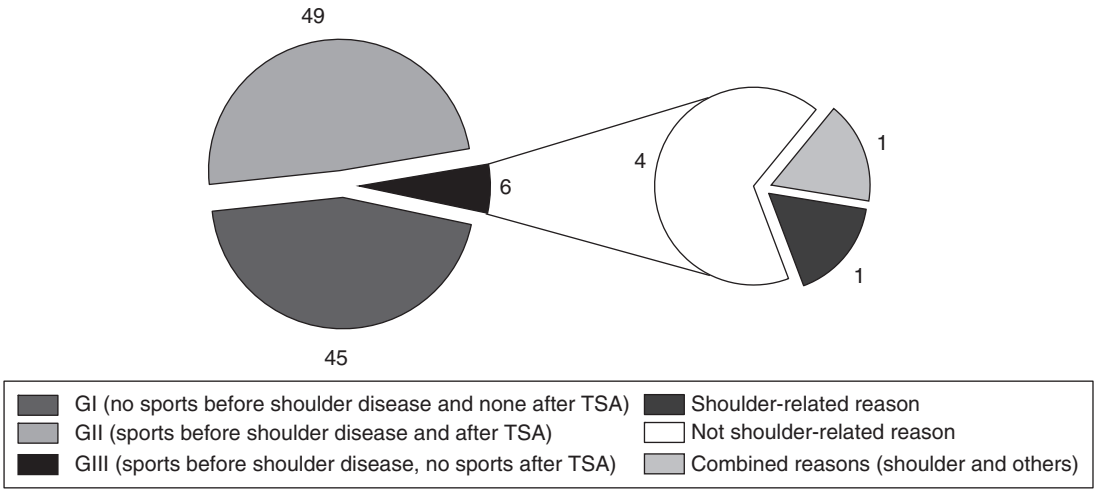

Figure 1. Arrangement in groups and reasons for giving up sports in group GIII.

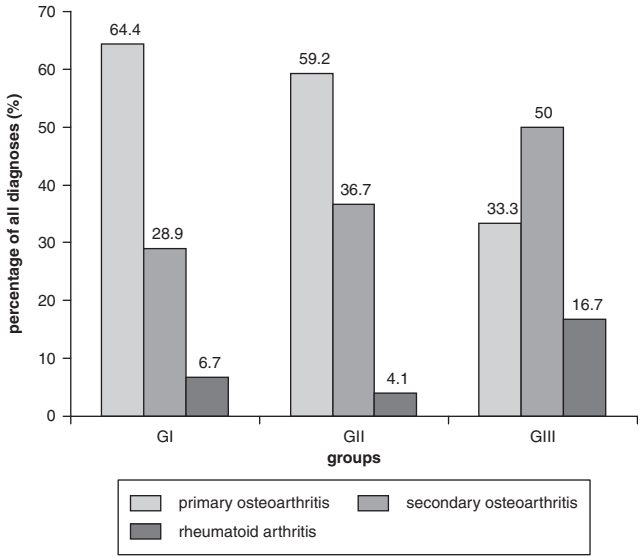

Figure 2. Percentage of all diagnoses.

Thirty-four patients (69.4%) did not have to either change or give up their chosen sport because of existing shoulder problems.

Of the 6 patients in group GIII, 1 (16.7%) said that the reason for giving up a particular sport was related to the shoulder, specifically to the strength of the affected shoulder both before and after surgery. The reasons were not shoulder related in 4 cases (66.7%): 1 patient had persistent pain after total knee joint replacement; 1 patient had chondrocalcinosis with symptoms in several large joints and kidney problems; 1 had rheumatoid arthritis also with multiple joints affected; and 1 had cardiological problems. In 1 case (16.7%), both the shoulder and age (65 years) were responsible for the patient having given up (Figure 1).

Duration of Shoulder Disease

In group GII, shoulder disease had been present for less than a year before shoulder arthroplasty in 3 cases (6.1%), for 1 to 2 years in 9 cases (18.4%), 2 to 3 years in 6 cases (12.2%), 3 to 5 years in 11 cases (22.4%), 5 to 10 years in 6 cases (12.2%), and more than 10 years in 14 cases (28.6%). From these figures, it can be seen that about half the patients in this group had suffered from shoulder disease for less than 5 years before surgery and half for more than 5 years.

In the GIII group, shoulder symptoms had been present for 2 to 3 years in 2 cases (33.3%), between 5 and 10 years in 1 patient (16.7%), and for more than 10 years in 2 patients (33.3%); 1 patient (16.7%) in GIII provided no information on this point.

Different Types of Sport

With respect to all sports, there was no significant difference in the type of sports participation before the shoulder disease and after shoulder arthroplasty (Figure 4).

Main Sport

The main sports most commonly mentioned in group GII were swimming (10 patients [20.4%]), golf (8 patients [16.3%]), cycling (8 patients [16.3%]), and fitness training (8 patients [16.3%]).

In group GIII, 2 patients gave cycling (33.4%) and in 1 patient (16.7%) each gave tennis, alpine skiing, and Nordic skiing as their main sport.

Level of Activity in the Main Sport. Two (4.1%) of the 49 patients in group GII said that they had never participated in their current main sport before the shoulder disease, 5 patients (10.2%) were previously competitive athletes, taking part in sport competitions, and 42 patients (85.7%) were recreational athletes.

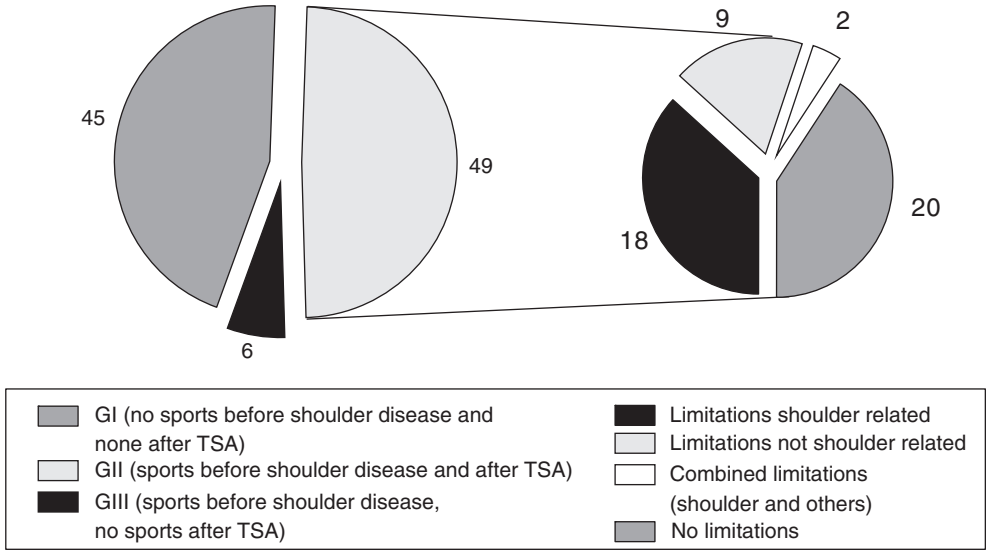

Figure 3. Limitations of sports after total shoulder arthroplasty in the ''sports group'' (GII).

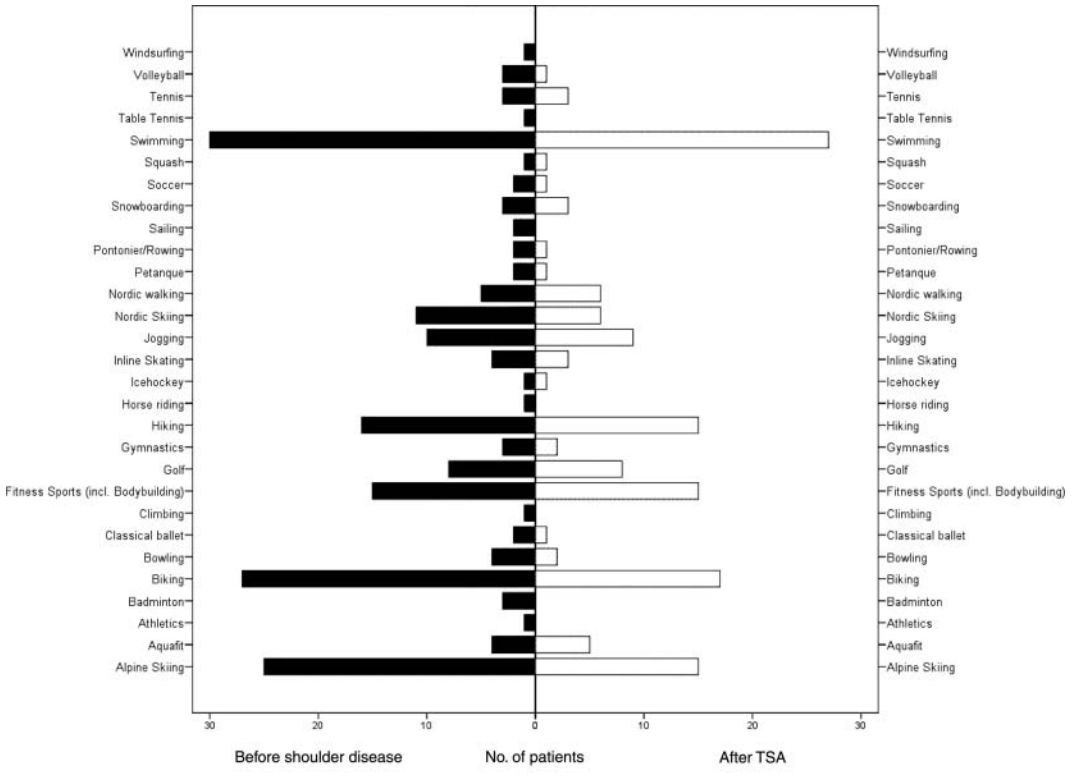

Figure 4. Organization of sports activities before shoulder disease and after total shoulder arthroplasty.

In the course of the shoulder disease (ie, before having the prosthesis implanted), 16 patients (32.7%) did not take part in their main sport, 2 (4.1%) continued to take part in competitive sports, and 31 patients (63.3%) continued recreational sports activities.

After the shoulder arthroplasty, 4 patients (8.2%) said they were competitive athletes; the remaining 45 patients (91.8%) were recreational athletes (Figure 5).

The main sports of the 4 competitive athletes who participated both before the shoulder disease and after shoulder arthroplasty were riding, jogging, cycling (mountain biking, to be precise), and pontoniering (a form of rowing). The patient who gave up being a competitive tennis player and switched to a recreational status said that the postoperative restrictions on his joint mobility and strength prevented him from continuing to play in tournaments.

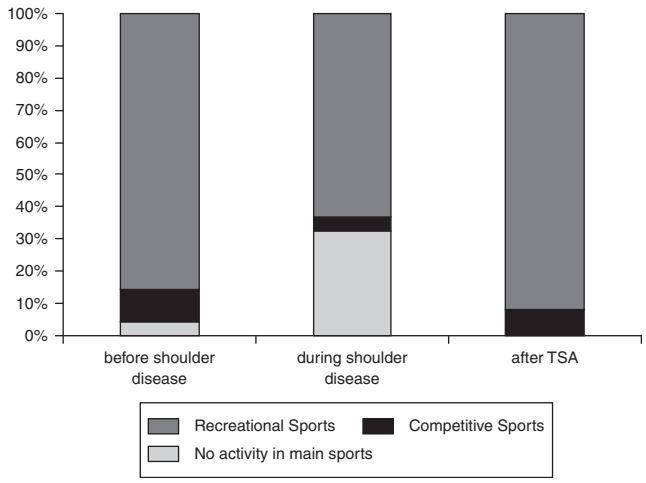

Figure 5. Level of sports activity in group GII.

TABLE 2
Sports Activity in GII[a]

Starting with sports activity postoperatively	
0-3 mo	12/49 (24.5%)
3-6 mo	21/49 (42.9%)
6-24 mo	15 (30.6%)
>24 mo	1 (2%)
Best postoperative level of sports activity, mo	11.2 ± 7
Frequency of training/wk	
Before SD	2.4 ± 1.6
During SD	1.2 ± 1.2
After TSA	2.3 ± 1.2
Duration/session, min	
Before SD	111 ± 81.3
During SD	75.5 ± 85.9
After TSA	116.3 ± 87.8

[a]SD, shoulder disease; TSA, total shoulder arthroplasty.

In total, 33 (67%) of the 49 patients were able to resume sports within 6 months: 12 of them within 3 months and a further 21 between 3 and 6 months after surgery. Apart from 1 patient (2%), all 49 patients were able to start sports again within 2 years of the operation. These 49 patients achieved their best postoperative level in their main sport at a mean of 11.2 ± 7 months (range, 2-36 months) after surgery.

Patients in group GII trained in their main sport on average 2.4 ± 1.6 times (range, 0-8) per week before the shoulder disease, 1.2 ± 1.2 times (range, 0-5) during the shoulder problems, and 2.3 ± 1.2 times (range, 1-6) postoperatively. On average, sports sessions lasted 111 ± 81.3 minutes (range, 0-290 minutes), 75.5 ± 85.9 minutes (range, 0-290 minutes), and 116.3 ± 87.8 minutes (range, 30-300 minutes), respectively (Table 2).

Subjective shoulder mobility was taken as 100% in the healthy state. With the shoulder disease, this mobility fell to a mean of 52.2% ± 13.6% (range, 30%-90%) and rose again after total shoulder arthroplasty to 88.11% ± 9.5% (range, 70%-100%).

Subjective strength in the healthy shoulder was also considered to be 100%. This fell to a mean of 49.4% ± 16% (range, 0%-90%) during the shoulder disease, and was 85% ± 12.2% (range, 40%-100%) postoperatively.

Irrespective of the nature of the main sport, it should be noted that 11 patients (22.4%) in group GII, who participated in sports before the shoulder disease, stopped their sports activity temporarily while the disease was causing problems, and resumed active sports after being given a shoulder prosthesis.

Tennis. Three patients (6.1%) in group GII played tennis both before and after the shoulder disease. One patient (2%), with the dominant shoulder involved, stopped playing tennis during the disease because of pain and restricted movement. Before the shoulder disease, all 3 patients (6.1%) could play all strokes (forehand, backhand, volley, and serve). Only 1 patient (2%) could play all strokes during the shoulder disease while 2 patients (4.1%) were clearly restricted with respect to possible shots and, as mentioned previously, 1 patient was forced to stop playing. This patient had the dominant shoulder involved and operated on, whereas the other 2 patients had the nondominant shoulder affected. The subjective range of motion was 100% before the shoulder disease, 57% (range, 50%-70%) on average during the disease, and 88% (range, 75%-100%) on average after total shoulder arthroplasty.

It must be noted that the patient who took 24 months to resume activity had not been playing tennis during the shoulder disease (3-5 years), and so needed longer after surgery to get back into the game (Table 3).

Golf. Eight patients (16.3%) played golf. Six patients (12.2%) played before and during the disease, as well as postoperatively. Two patients (4.1%) stopped playing during the disease but started again after surgery.

All 8 players (16.3%) said that their level of play was recreational. All 8 patients were right-dominant (100%). Four patients (50%) had the right dominant arm, their follow-through-arm, operated; 4 patients (50%) had the left arm, the leading arm, operated.

The average golf handicap at the time of the study was 23.1 ± 6.7 (range, 12.4-30.0). These patients played 2.6 ± 1.2 (range, 1-5) times/wk before the shoulder disease, 1.3 ± 1.3 (range, 0-3.5) times/wk during the disease, and 2.4 ± 0.8 (range, 1-3.5) times after the shoulder arthroplasty. Individual sessions lasted 243.8 ± 48.4 minutes (range, 150-290 minutes), 183.8 ± 126.4 minutes, (range, 0-290 minutes), and 247.5 ± 40.6 minutes (range, 180-290 minutes), respectively.

The mean maximum drive was 178.8 ± 48.2 m (range, 130-280 m) for healthy patients, 110 ± 91.5 m (range, 0-280 m) during the shoulder disease, and 173.1 ± 51.2 m (range, 120-280 m) postoperatively. The length of the postoperative drive was therefore nearly the same as in the healthy state.

The 8 patients began to play golf again postoperatively after a mean of 5.1 ± 2.4 months (range, 3-9 months), although it must be noted that half of them had already started after 3.5 months.

TABLE 3
Tennis and Golf Participation[a]

Number of patients playing tennis (GII)	3 (6.1%)
Frequency/wk	
Before SD	2 ± 1
During SD	0.3 ± 0.6
After TSA	2 ± 1
Duration/session, min	
Before SD	90 ± 52
During SD	20 ± 34.6
After TSA	80 ± 34.6
Starting with tennis postoperatively, mo	10.2 (n = 3)
Pain playing tennis	
Severe	0
Moderate	0
Mild	1 (33.3%)
None	2 (66.6%)
Number of patients playing golf (GII)	8 (16.3%)
Frequency/wk	
Before SD	2.6 ± 1.2
During SD	1.3 ± 1.3
After TSA	2.4 ± 0.8
Duration/session, min	
Before SD	243.8 ± 48.4
During SD	183.8 ± 126.4
After TSA	247.5 ± 40.6
Starting with golf postoperatively, mo	5.1 ± 2.4
Pain while playing golf	
Severe	0
Moderate	0
Mild	2 (25%)
None	6 (75%)
Pain after playing golf	
Severe	0
Moderate	0
Mild	4 (50%)
None	4 (50%)
Max driving length, m	
Before SD	178.8 ± 48.2
During SD	110 ± 91.5
After TSA	173.1 ± 51.2
Level playing golf: recreational	8 (100%)

[a]SD, shoulder disease; TSA, total shoulder arthroplasty.

Six of the 8 patients (75%) said they felt no pain at all in the operated shoulder when playing golf, while 2 patients (25%) said they had slight pain. After the game, 4 patients (50%) experienced no pain and 4 (50%) had slight pain (Table 3).

SPADI/Constant Score/DASH Score

The 1-year follow-up was used in 31 (33%) of the patients in groups GI and GII, while the 2-year follow-up scores were used for the other 63 (67%) patients in these groups (Table 4). Preoperative scores were not taken into account in this study.

The SF-36 physical component summary score shows that the patients in group GII were in significantly better physical condition than patients in group GI ($P = .02$). There was no significant difference between groups GI and GII in the mental component summary score ($P = .39$). No significant differences were found in either the DASH or DASH subcategories ($P > .05$). The overall SPADI and its subcategories showed no significant differences ($P > .05$).

The absolute Constant score was significantly better for group GII than group GI ($P = .007$); this applied equally to the categories of strength ($P = .009$) and range of motion ($P = .005$).

On the other hand, the differences with respect to pain and activity/activities of daily living were not significant ($P > .05$).

DISCUSSION

In today's society, people are increasingly participating in sports to a greater age. This is confirmed by the present study, which shows that despite an average age of 66 years at the time of operation, 49% of the patients were taking part in sporting activities.

Thanks to continuous improvement in the function of shoulder prostheses, patients more frequently ask about the possibilities of sports participation after a shoulder joint replacement. These questions arise both during preoperative discussions and at follow-up. The present study shows that the probability of being able to do sports postoperatively—if done preoperatively—is high.

Osteoarthritis of the shoulder joint resulted in only 1 patient (group GIII) in our study having to give up sporting activities completely; 37% of the patients had to accept restrictions on the intensity or frequency of their chosen sport after the shoulder replacement, and 30% of patients had to exchange their usual sports for others before operation. However, no patient had to stop all sports activities because of the shoulder prosthesis.

In comparison, the study by McCarty et al[13] showed that 19% of patients did not resume sports after surgery; about half of these patients had a medical condition affecting their ability to exercise as well as shoulder disease. It was not mentioned, however, to what extent the medical condition, shoulder problems, or both were responsible for giving up.

Schmidt-Wiethoff et al[20] also found 16% (ie, 12 of 74 patients) gave up sports entirely after a total shoulder arthroplasty, and 26% (19 of 74 patients) had clear limitations of their sporting ability. However, no precise details were given of these limitations or the reasons for them.

The sporting abilities of the patients in our study are high. More than two-thirds (69.4%) of the 49 patients were able to resume the same sports activity at the same level of intensity as before the shoulder disease.

Motivation and training are obviously also important. Even though 67% were able to start sports again within 6 months, the maximum performance was not achieved until 11 months after surgery. However, this shows that our follow-up period of 2.8 years on average, with

TABLE 4
Postoperative Scores[a]

Scores/Groups	GI (n = 45) Mean ± SD	GII (n = 49) Mean ± SD	*P* (GI/GII)	GIII (n = 6) Mean ± SD	*P* (GI, II/GIII)
SF-36 physical component summary	41.0 ± 11.2	46.2 ± 9.0	.02	42.2 ± 10.6	NT
SF-36 mental component summary	55.6 ± 9.3	55.7 ± 6.4	>.05	47.7 ± 12.9	NT
DASH[b]	76.6 ± 19.3	83.4 ± 12.7	>.05	69.6 ± 18.6	NT
SPADI[b]	78.6 ± 20.5	83.7 ± 16.5	>.05	68.7 ± 19.2	NT
Constant score: pain[c]	13.3 ± 3.2	13.9 ± 2.9	>.05	10.0 ± 5.4	NT
Constant score: activity[d]	18.6 ± 2.9	19.0 ± 2.3	>.05	17.0 ± 5.1	NT
Constant score: range of motion[e]	30.5 ± 6.0	33.6 ± 4.4	.005	30.0 ± 5.4	NT
Constant score: strength[f]	8.1 ± 5.5	10.8 ± 5.6	.009	12.3 ± 6.4	NT
Constant score: absolute[b]	70.8 ± 13.8	77.2 ± 10.6	.007	69.3 ± 9.7	NT

[a]SD, standard deviation; SF-36, Short Form 36; DASH, Disabilities of the Arm, Shoulder and Hand; SPADI, Shoulder Pain and Disability Index; NT, not tested (because of number of missing patients).
[b]0 = worst, 100 = best.
[c]0 = worst pain, 15 = no pain.
[d]0 = worst handicap, 20 = no handicap.
[e]0 = worst, 40 = free.
[f]0 = 0 kg, 25 = ≥12.5 kg.

a minimum of 1 year, should be long enough to allow meaningful conclusions with respect to sporting ability.

It also demonstrates that with respect to level, frequency, and duration of sessions, the sports activity that can be achieved after total shoulder arthroplasty is nearly the same as before the shoulder disease, which agrees with the findings of McCarty et al.[13] These authors found a very similar frequency of sports activity before and during shoulder disease, and after arthroplasty, although they did not give the duration of individual sports sessions.

Patients participated in a wide range of chosen sports. In particular, disciplines that place heavy demands on the shoulder, such as tennis and golf, were as well tolerated as other types of sport. No patient had to give up golf or tennis, and the same level of play was achieved postoperatively as preoperatively. However, validity here is reduced because of the small case numbers.

Our results on the frequency of playing golf, postoperative resumption of the game, and pain during and after playing, are comparable with those of the retrospective study by Jensen and Rockwood[8] published in 1998. They studied 24 patients who played golf before a unilateral or bilateral total shoulder arthroplasty or a hemiarthroplasty; 23 patients (96%) were still able to play or had started playing again by the mean follow-up of 53 months.

As our study shows, implantation of an anatomical shoulder endoprosthesis per se seems to have hardly any influence on sporting ability. Other factors, such as age and motivation, seem to have greater effects.

The patients in group GII (sports before and after joint replacement) showed a significantly better postoperative Constant score than those in GI (no sports either before shoulder disease or after prosthesis implanted). This could be taken to mean that a higher Constant score results in greater sporting ability. But looking at the differentiated scores, it can be seen that the better Constant score is attributable to higher values in the strength and function subscores, while pain levels and satisfaction are the same in the 2 groups. In addition, patients in group GII are significantly younger than those in GI. Against this background, we attribute the higher Constant score in group GII to the effect of training.

The Constant score was also determined by Schmidt-Wiethoff et al.[20] In comparison, the scores we obtained postoperatively were some 10 points higher in all 3 groups, even though on average the patients in our study were about 10 years older than those studied by Schmidt-Wiethoff et al, who included only patients below the age of 70 years.[20] Why this should be the case cannot be explained in the light of the present study. Patients in the study by McCarty et al[13] had an overall mean age at the time of follow-up similar to the patients in our study, but the authors did not determine the Constant score.

One weakness of this study is the relatively short follow-up. Even though in this study we show good functional results with total shoulder arthroplasty after 2.8 years, we do not know yet how the results with the newer generations of prostheses will be at long-term follow-up.

Sperling et al[23] pointed out that after a follow-up of 15 years, the results of total shoulder arthroplasty were unsatisfactory in 48% of shoulders treated by the Neer total shoulder arthroplasty, but they also found long-term pain relief and improvement in motion with shoulder arthroplasty. They indicated an estimated survival rate for total shoulder arthroplasty of 97% on average at 10 years, and 84% on average at 20 years. Furthermore, they stated that unsatisfactory result ratings were most commonly caused by motion restriction from soft tissue abnormalities. They recommended trying all possible alternative treatment methods before implanting a hemiarthroplasty or total shoulder arthroplasty, particularly in patients aged 50 years or younger.

Another weakness of this study is the absence of a detailed radiographic survey. We can only say that there

were no significant radiolucent lines paired with clinical symptoms that made a change of components necessary.

Long-term studies are needed to determine whether the greater loading on the joint will lead to more rapid wear and a higher rate of loosening with time. As this has not yet been elucidated, patients should be warned of the mechanical limits of the artificial joint as stipulated by the manufacturers—especially because, as we have shown here, the patients themselves experience hardly any restriction on their sports activity.

CONCLUSION

In case of painful osteoarthritis of the shoulder, we recommend trying nonoperative treatment methods first. If these therapies are not successful, we recommend a total anatomical shoulder arthroplasty.

Total shoulder arthroplasty allows patients to participate in sports without significant restriction on the level of activity. Other factors, such as age at implantation and motivation, seem to have greater influence on postoperative sports activities. Full information about the limits of a total shoulder arthroplasty must be given before the operation and during the rehabilitation process as these patients experience hardly any restriction on their sports activity.

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