FUNCTIONAL OUTCOME AFTER CEMENTLESS, CUSTOM-MADE TOTAL HIP REPLACEMENT IN PATIENTS YOUNGER THAN 60: A 5-YEAR FOLLOW-UP

ALTMIŞ YAŞINDAN GENÇ HASTALARDA ÇİMENTOSUZ ISMARLAMA TOTAL KALÇA PROTEZLERINDEN SONRA FONKSİYONEL SONDURUM

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ABSTRACT

Aim: In this study, we documented changes in gross motor function (GMF) using the Harris Hip Score (HHS), and studied the interdependence of pain, GMF and range of motion (ROM) in young patients treated with cementless custom-made total hip replacement (THR).
Methods: 79 patients (<60, mean age 46.2 years) were studied for 5 years. Total HHS and sub scores (pain, GMF, ROM, deformity) were analysed preoperatively and at four times postoperatively. We analysed interdependence among scores, body mass index (BMI), age and primary diagnosis.
Results: We found positive outcome after THR, with improvements in pain, GMF and ROM. Pain relief was reported for the first two months, after which improvement in GMF was evident and coincided with further improvement in scores for pain and ROM. Patients with congenital hip dysplasia had lower HHS and a minor increase over time.
Conclusion: After an initial improvement in pain, there was a significant improvement in GMF from two months to 5 years postoperatively. Patients' primary diagnosis significantly influenced the scores between 1 and 5 years postoperatively.
Key Words: Functional outcome, total hip replacement, young patients, Harris Hip Score, rehabilitation.

ÖZET

Amaç: Bu çalışmada çimentosuz ısmarlama total kalça protezi (TKP) ile tedavi edilen genç hastalarda Harris Kalça Skorunu (HKS) kullanarak kaba motor fonksiyonlarda (KMF) değişimi araştırdık ve KMF, hareket genişliği (HG) ve ağrı arası bağıntıyı araştırdık.
Metod: Beş yıl boyunca 79 hasta (<60, ortalama yaş 46.2 yıl) değerlendirildi. Toplam HKS ve alt skorları (ağrı, KMF, HG, deformite) ameliyet öncesi ve ameliyattan sonra dört kez değerlendirildi. Skorlar ile vücut kitle indeksi (VKİ) yaş ve primer tanı arası bağıntıyı inceledik.
Bulgular: TKP sonrasında ağrı, KMF ve HG de düzelme ile karakterize olumlu bir son durum saptadık. Ağrıda düzelme KMFda düzelmenin hemen arkasından HGde düzelme ile eş zamanlı olarak ilk iki ay içinde gözlendi. Konjenital kalça displazisi olanlarda HKS daha düşüktü ve zaman içinde hafif bir artış gösterdi.
Sonuç: İlk olarak ağrıda gözlenen bir düzelmeden sonar ameliyattan sonar iki aydan 5 yıla kadar KMFda belirgin bir düzelme vardı. Hastaların primer tanısı ameliyat sonrası 1 ve 5 yıl sonrasında skorları anlamlı düzeyde etkiledi.
Anahtar kelimeler: Fonksiyonel son durum, total kalça replasmanı, genç hastalar, Harris Kalça Skoru, rehabilitasyon.

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INTRODUCTION

Over the last decades, surgical procedures for total hip joint replacement have changed dramatically (1). Surgery outcome has been reported in terms of pain relief, implant stability and improvement in motor function (2-4).

For cemented prostheses, excellent early and intermediate results have been reported. However, late complications, such as loosening of the prosthesis and destruction of bone tissue by cement particles have been reported (5,6), for which reason new surgical techniques have been developed, which focus on cementless implants with porous coatings (7-13). Cementless implants are typically used in younger patients with good bone quality, so that bone ingrowth required for the initial fixation of the implant can be expected (10-14). Previous studies have reported good mid- to long- term clinical and radiological results for cementless prostheses in young populations (10,14-17). Results from the Norwegian THR register (18) and the Swedish National THR register (3) however, have reported higher rates of implant failure in younger patients with cementless THR. The observed discrepancy between reported results stresses the need for further follow-up studies on functional improvements in this patient group. Young and active patients in particular aim to recover to, and maintain a maximal level of functionality after THR. Long-term follow-up of the functional outcome in this population is therefore needed to optimize the rehabilitation process.

The Harris Hip Score (19) is a commonly used scoring system to assess the functional outcome following THR and has been validated as a reliable and sensitive method (20-22). The score has a maximum of 100 points, including four sub scores: pain (max 44 points), gross motor function (max 47 points), range of motion (max 4 points) and absence of deformity (max 4 points). Increased total HHS scores and the scores of the different sub items reflects improvement in clinical outcome, gross motor function and pain reduction.

Previous studies have reported improved clinical outcome in young patients after cementless THR by comparing preoperative clinical scores and the scores at the final follow-up with intervals ranging from two to fifteen years postoperatively (10,23-27). Following the time course of functional improvement following THR, however, is essential to monitor and consequently optimize the rehabilitation process for individual patients to achieve the maximal level of motor function in the long term. Only a few studies have reported these changes in clinical scores more than once during the postoperative period. Kim et al. (14) reported changes in clinical outcome over 9.8 years using HHS. Significant pain reduction was reported for a young population during the first six weeks after surgery; thereafter only a significant increase in GMF was reported. Highest HHS and sub scores were found three years after surgery. Ström et al.(17) reported a significant improvement for pain, walking ability and range of motion three months after surgery in young patients (mean age 54 yrs at time of surgery) which persisted after 12 and 24 months.

We studied changes in functional outcome using HHS in a young population of 79 patients up to 5 years after THR with cementless implants (28). To gain insight into the rehabilitation process and functional recuperation following THR, we analyzed the timing of changes in sub scores of the HHS (GMF, pain, ROM and deformity) in detail. We additionally analysed the influence of Body Mass Index (BMI), age and primary diagnosis on the evolution of the functional outcome scores and different sub scores.

METHODS

This retrospective study was based on 79 patients, who had undergone THR at the Orthopaedic Department of the University Hospital of KULeuven, Belgium. Patients were followed up from September 1998 until December 2005. Inclusion criteria were patients younger than 60 years, who received a unilateral, primary, custom-made prosthesis with hydroxyapatite coating (28).

All patients received a standard physiotherapy protocol from the first day after surgery. This protocol comprised a daily session (30 min) focussing on isometric contraction of the M. gluteï and M. quadriceps (hold for 6 sec, 10 times), mobility exercises in stand (hip flexion with flexed knee, hip flexion with straight leg, hip extension and abduction) and gait rehabilitation. On the second postoperative day, gait rehabilitation was started using a walking frame, which was replaced with crutches on day four. This protocol was continued during the hospitalisation period (7 to 10 days). No further physical therapy was provided after discharge from hospital. All patients were advised to use crutches to partially bear their weight for up to 6 weeks following surgery.

Patient HHS scores were recorded for all patients at five times: one day prior to surgery (T1), 6-8 weeks (T2), 12-16 weeks (T3), one year (T4) and 5 years after surgery (T5). For T1, the HHS was calculated from the patient's records, based on the patient's comments on intensity and frequency of pain, use of external support and walking distance noted in the anamnesis. For T2, T3, T4 and T5, pain and GMF scores were calculated from a self-reported questionnaire (Appendix). A validated Dutch translation of the original HHS was used. The ROM (ab/adduction, flexion/extension and internal/external rotation of the hip joint) and deformity score (including contractures and limb length discrepancy) were tested by the consulting physician. BMI was calculated based on patients' weights and lengths, as documented in the preoperative anamnesis.

We used SAS statistical procedure Proc Mixed (SAS 8.02), with unstructured covariance to quantify the changes in total HHS and the sub scores. The Proc Mixed procedure offers repeated measures analyses for longitudinal data that account for within-subject co-variability, and corrects for missing data (29,30). Covariances with BMI, age and primary diagnosis as fixed effects were tested in the Proc Mixed procedure. The total sample was therefore divided into four (equal size) BMI- and age groups, and four primary diagnosis groups (Table 1). Significance level was set to p≤0.001.

RESULTS

The sample comprised 51 men and 28 women with a mean age of 46.2 years. Mean Body Mass Index (BMI) was 26.6±4. Forty-four (56%) patients had a left THR and 35 (44%) a right THR. The most frequent primary diagnosis was osteoarthritis (52%), followed by avascular necrosis (22%) and congenital hip dysplasia (14%, Table 1). 12% of the diagnoses, e.g. patients with posttraumatic dysplasia and epiphysiolysis, were classified as "other".

Tables 2 and 3 summarize the changes in total HHS and in the GMF, pain and ROM HHS sub scores. HHS increased significantly up to 1 year postoperatively, after which there was an insignificant decline. Mean pain scores increased significantly in the first 6-8 weeks after surgery, indicating pain relief. Scores then remained constant for one year postoperatively, after which scores declined slightly, although insignificantly. GMF only improved from 6-8 weeks after surgery. Overall, GMF increased after THR up to 1 year after surgery, and then remained constant.

Further analysis of the pain scores showed time related changes in pain levels. Preoperatively, all patients reported pain and 73 (92%) of these reported moderate, marked or severe pain. Five years postoperatively, 41 patients reported no pain, none reported severe pain, although 12 reported moderate or marked pain. Preoperatively, 51 patients had a moderate or severe limp and only three had no limp. At T4 postoperatively, limping decreased markedly, when the largest number of patients presented without limping (27) and only two patients reported a severe limp. At T5, 24 patients had no limp and only 14 had a moderate or severe limp.

Table-I
Cohort Demographics (n = 79)

	Mean ± SD
Age (year)	46.2 ± 9.8
Age group 1 (57 - 60 year)	59.2 ± 1.1
Age group 2 (50 – 56 year)	52.1 ± 1.8
Age group 3 (40 -49 year)	45.4 ± 3.2
Age group 4 (21 – 39 year)	33.8 ± 5.5
BMI	26.6 ± 4.2
BMI group 1 (29.4 – 39.9 kg/m^2)	31.4 ± 2.7
BMI group 2 (26.9 – 29.1 kg/m^2)	27.8 ± 0.8
BMI group 3 (24.4 – 26.7 kg/m^2)	25.6 ± 0.7
BMI group 4 (16.7 – 24.0 kg/m^2)	20.8 ± 2.2
	Number
Gender	
Men	51 (64 %)
Women	28 (35%)
Side	
Left	44 (56%)
Right	35 (44%)
Primary diagnosis (no. patients)	
1. Osteoarthritis	41 (52%)
2. Avascular necrosis	17 (22%)
3. Congenital hip dysplasia	11 (14%)
4. Other	10 (12%)

BMI = Body Mass index, SD = Standard Deviation

Table-II
Means and standard deviations (SD) for the Harris Hip Score and sub scores at 5 time points.

	T1 preoperative		T2 6-8 weeks		T3 12-16 weeks		T4 1 year		T5 5 years	
	mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
HHS	47.3	15.4	70.4	14.9	80.0	16.3	87.3	15.0	83.7	20.5
Pain	14.6	7.2	35.3	10.3	36.6	9.1	39.5	7.4	36.6	10.9
GMF	26.5	8.8	26.3	7.8	34.8	9.4	39.1	8.7	38.5	10.7
ROM	4.6	0.5	4.7	0.1	4.8	0.1	4.7	0.2	4.7	0.4
Deform	3.7	0.5	4	0	4	0	4	0	4	0

HHS = total Harris Hip Score, GMF = Gross Motor Function, ROM = Range of Motion, Deform = absence of anatomical deformities.

Table-III

Results of the repeated measures analysis: p and t values for the comparison of HHS and sub scores at different times

		HHS	Pain	GMF	ROM
Preoperative (T1) – 6 to 8 weeks (T2)	t value	5.10	8.56	-0.83	1.04
	p value	< 0.001	< 0.001	0.4088	0.2999
6 to 8 weeks (T2) – 12 to 16 weeks (T3)	t value	2.61	0.68	3.98	0.22
	p value	0.0101	0.4979	< 0.001	0.8292
6 to 8 weeks (T2) – 1 year (T4)	t value	5.75	2.82	7.08	-0.09
	p value	< 0.001	0.0054	< 0.001	0.9296
6 to 8 weeks (T2) – 5 years (T5)	t value	4.69	1.53	6.68	0.09
	p value	< 0.001	0.1288	< 0.001	0.9256
12 to 16 weeks (T3) - 1 year (T4)	t value	2.32	1.85	2.00	-0.32
	p value	0.0217	0.0657	0.0470	0.7480
1 year (T4) - 5 years (T5)	t value	-0.9	-1.33	-0.07	0.20
	p value	0.3701	0.1856	0.9432	0.8381

HHS = total Harris Hip Score, GMF = Gross Motor Function, ROM = Range of Motion.

Preoperatively, 44 patients were able to walk without aid, 21 used one or two canes, or crutches. Increased use of crutches is reported at T2 due to the partial weight bearing recommended to all patients during the first six weeks after surgery. Thereafter, the use of walking aids decreased up to five years postoperatively, at which point 50 patients could walk without an aid and only eight patients were dependent on a cane or crutches for walking. The increased walking distance confirms an improvement in walking ability after THR. Preoperatively, only one patient could walk with no limitation. This number increased progressively until T4 (36) and remained nearly unchanged until T5. Over time, the number of patients who could only walk indoors decreased, with a clear increase, however, at T2 (19) coinciding with the period of recommended partial weight bearing and use of crutches. Similar to the increase in walking distance, the ability to climb stairs increased over time. The largest number of patients who could climb stairs without a banister was reported at T4 (37), after which there was a slight reduction in the ability to climb stairs. Ability to perform specific ADL (putting on socks and shoes, sitting in a normal chair and using public transport) improved after THR. No significant changes were found for the mean ROM-score. The deformity score remained constant over time and was not included in further analyses.

Patients' primary diagnosis significantly influenced the total HHS (p≤0.001). Patients with congenital hip dysplasia (CHD) had a lower HHS at each time point and showed only a relatively minor increase in HHS over time, compared to patients with avascular necrosis and osteoarthritis (Figure 1). Lower HHS in patients with CHD resulted from lower GMF and pain scores (indicating more pain). Between one and five years after surgery, patients with CHD showed a clear decrease in pain score (i.e. increase in pain), GMF and total HHS, while patients with avascular necrosis showed an increase in these scores (Figure 1). Age and BMI had no significant

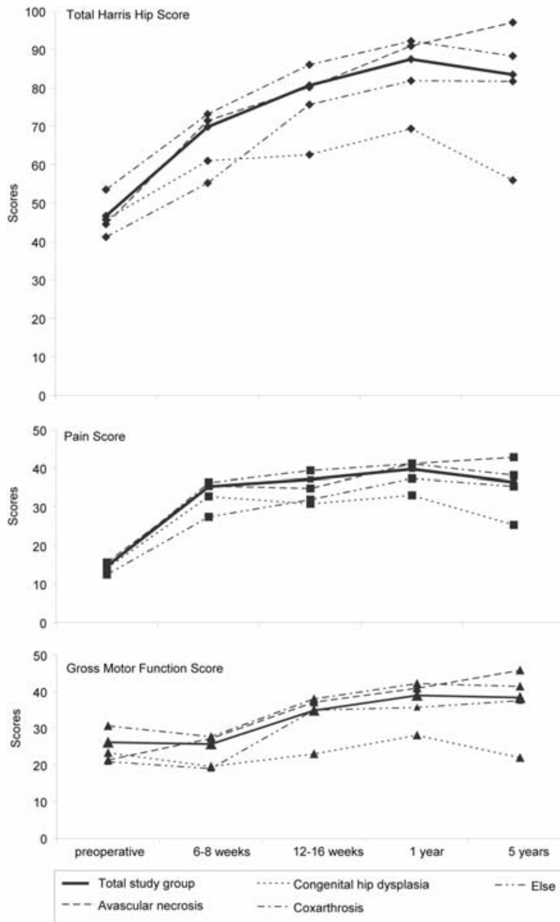

Figure 1. Evolution in total Harris Hip Score (HHS, max 100) Pain Score (max 44) and Gross Motor Function Score (GMF, max 47) at five time poin for the primary diagnosis groups.

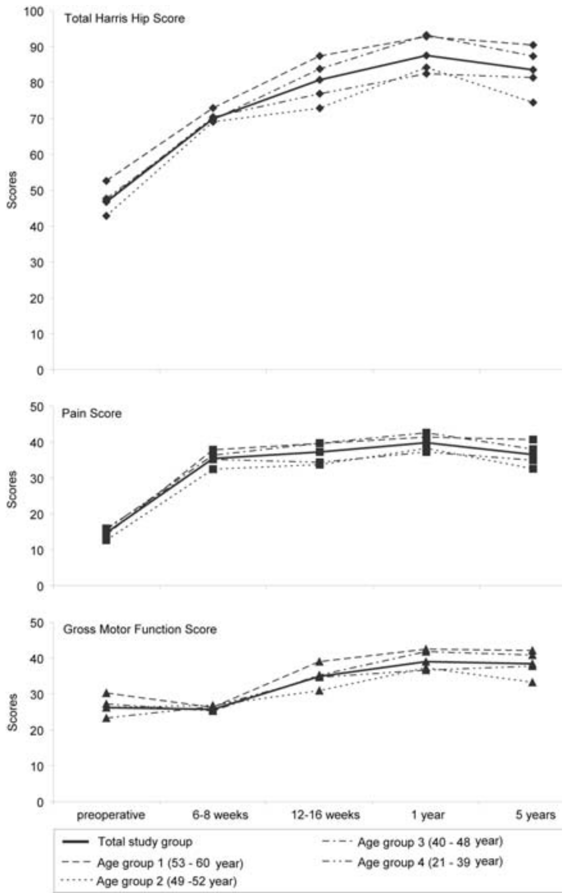

Figure 2. Evolution in total Harris Hip Score (HHS, max 100), Pain Score (max 44) and Gross Motor Function Score (GMF, max 47) at 5 times for 4 age groups.

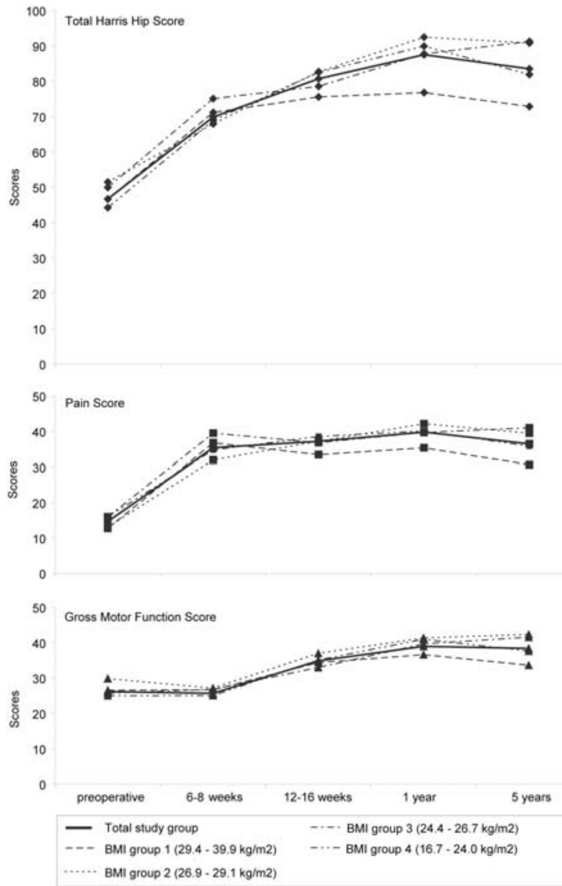

Figure 3. Evolution in total Harris Hip Score (HHS, max 100), Pain Score (max 44) and Gross Motor Function Score (GMF, max 47) at 5 times in 4 BMI-groups.

effect (Figure 2 and 3). A significant covariance between primary diagnosis and GMF score was found ($p \leq 0.001$). Patients with congenital hip dysplasia had a lower GMF score and showed relatively minor improvement in GMF compared to patients with avascular necrosis and osteoarthritis. For the pain score, there was no covariance with BMI, age or primary diagnosis.

DISCUSSION

Total HHS is widely used as an outcome measure in clinical follow-up studies after THR. The interdependency of the different sub scores over time, however, has only seldom been reported in previous studies (14,17,31). Analysis of the individual sub scores of the HHS (GMF, pain, ROM and deformity) provides more detailed information on patients' clinical outcomes after THR, which could be used to evaluate and optimize patient-specific physical therapy programs following THR. Defining optimal rehabilitation programs is particularly essential for young and active patients, who expect to return to, and maintain a normal level of functionality following surgery.

Our follow-up study of 79 patients (average age 46.2 yrs) showed improvement in clinical outcome, reflected by increased HHS after THR with cementless, custom made, hydroxy-apatite coated total hip prostheses. These improvements in clinical outcome are similar to the results of McLaughlin et al. (10), Duffy et al. (23), Kim et al. (14), Singh et al. (24) and Robertson et al. (26), who reported clinical follow-up for five to ten years using HHS of young patients with cementless THR .

Detailed analysis of the temporal changes of the HHS sub scores revealed a pronounced discrepancy in the timing of reported improvement of pain score and improvements in GMF on the longer and shorter term.

The pain score improved significantly in the first 6 to 8 weeks after surgery with an increase in the number of patients reporting no pain. However, GMF only improved significantly from 12-16 weeks after surgery, from which time the number of patients without a limp increased, walking distance increased and use of walking aids decreased. The remarkable increase in crutch use and decrease in walking distance, 6-8 weeks after surgery, occurred during a period when all patients were recommended to practice partial weight bearing after surgery. Overall, our results indicate an improvement in walking ability during the first year after THR, shown by reduced limping, increased walking distance, a reduction in use of walking aids and an increased ability to climb stairs.

Our results are similar to the HHS and sub scores of Kim et al.(14), who reported an increase in pain score (18 to 40) in the first six weeks after operation, followed by an increase in GMF scores. After one year, Kim et al. (14) reported higher HHS scores (91) and sub scores for pain (42) and GMF (40) than in our own study.

At 5 years follow-up in our study, there was an increase in the number of patients with marked pain (8.5 %), although the total GMF score continued to increase. From one to five years after surgery, there was only a minor decline in the parameters describing gait performance. At T5, there was an increased number of patients with a severe limp, using crutches, or unable to walk, and a decrease in the ability to climb stairs. On the other hand, the sub scores for activities of daily living (putting on socks and shoes, sitting and using public transport), increased further from one to five years after surgery resulting in a further increase in the total GMF score.

Kim et al. (14) reported maximal HHS and sub scores at three years follow up, followed by a minor decline up to five years after surgery. Thereafter HHS and sub scores remained constant until final follow up (at a mean time of 9.8 years after surgery). Similar trends were reported by Xenos et al. (31) in an older patient group (mean age=58 yrs; range = 22 to 81 yrs). Their study showed an increase in the number of patients with a severe limp and increase in use of crutches between five and ten years after surgery. The earlier decline in our study can be related to a progressive decline in the health status of patients with osteoarthritis, accounting for 46% of the studied population.

The observed changes in pain score in our study corroborate results reported by Xenos et al. (31) for the two year follow-up, but do not support the further pain reduction up to 10 years after surgery reported by Xenos et al., (90% of the patients were pain free 10 years post surgery) or by McLaughlin et al. (10) (67% were pain free at the final follow-up at 10.2 years, in a young population). In the studies of Xenos et al., and McLaughlin et al., HHS was recorded by the researcher, and the pain score was assessed specifically for hip pain. In our study, the scores were collected from a self-reported questionnaire. The known difference in outcome after THR between patients' self reported (as in our study), and physicians' evaluation (20,32) may therefore account for the lower pain scores in our study compared to the results of McLaughlin et al. (10) and Xenos et al. (31). Furthermore, since 46% of the patients in our study suffered from osteoarthritis, it is likely that the pain score for the hip includes the patients' subjective perception of painful joints other than the operated hip.

Whereas the initial improvement in HHS was mainly due to pain relief, there was only an improvement in GMF after two months. These findings suggest that timing is crucial for monitoring changes in GMF after THR, and that evaluations to record changes in GMF are of limited use when applied during the first 6 to 8 weeks after surgery. The selection of the time points for data collection in this retrospective study therefore influenced the change in the scores. For instance, the imposed partial weight bearing during the first two months after surgery influenced the GMF score. However, differences in functional abilities of individual patients are still reflected at T2 in the alternative use of walking aids or the use of crutches out-of-doors.

Primary diagnosis impacts long-term outcome after THR. Patients with CHD showed a pronounced decrease in GMF and pain score (i.e. increasing pain) between one and five years after surgery, which lowered the mean outcome of the total study population at five years follow up. The CHD diagnostic group had lower outcome scores and made fewer improvements compared with the other diagnostic groups. Furnes et al. (18) also reported a significantly poorer outcome for patients with CHD, compared with other diagnostic groups. These findings show that a patient's primary diagnosis is an important factor in the evolution of functional outcome following THR. BMI (33-35) and age, however, did not significantly influence patients' functional recovery following THR. Thus, for the age group we studied, clinical outcome following THR depended largely on the primary diagnosis leading to surgery and was not influenced by age or BMI.

CONCLUSION

In conclusion, positive outcomes were reported up to five years after THR in young patients. Although continuous improvements in activities related to daily living were documented up to five years after surgery, there was a minor decline in pain score (i.e. increase in pain) and decrease in walking ability at the final evaluation. The changing interdependency of the sub scores with time has not been reported previously. Although pain reduction was the immediate result of the surgery, improvement in GMF only occurred from two months after surgery. These results emphasize the importance of time in the monitoring of changes in GMF after THR. In our patient sample, the primary diagnosis significantly influenced the evolution of functional recovery after THR.

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Appendix. Self-Report Harris Hip Score Questionnaire

Topic	Max.Score
1. Pain	
A. None or ignores it	44
B. Slight, occasional no compromise in activities	40
C. Mild pain, no effect on average activities, rarely moderate, pain with unusual activities, may take aspirin	30
D. Moderate pain, tolerable but makes concessions to pain. Some limitations of ordinary activity or work. May require occasional pain medicine stronger than aspirin.	20
E. Marked pain, serious limitation of activities	10
F. Totally disabled, crippled pain, pain in bed, bedridden	0
2. Function	
A. Gait	
1. Limp	
a. none	11
b. slight	8
c. moderate	5
d. severe	0
2. Support	
a. none	11
b. cane for long walks	7
c. cane most of the time	5
d. one crutch	3
e. two canes	2
f. two crutches	0
g. not able to walk	0
B. Activities	
1. Distance walked	
a. unlimited	11
b. 1 km	8
c. 0.5 km	5
d. indoors only	2
e. zero	0
2. Stairs	
a. normally without using a railing	4
b. normally using a railing	2
c. in any manner	1
d. unable to do stairs	0
3. Shoes and Socks	
a. with ease	4
b. with difficulty	2
c. unable	0
4. Sitting	
a. comfortably on ordinary chair one hour	5
b. on a high chair for one-half hour	3
c. unable to sit comfortably in any chair	0
5. Enter public transport	
a. yes	1
b. no	0