Arch Orthop Trauma Surg (2009) 129:1585–1591
DOI 10.1007/s00402-009-0825-9

ORTHOPAEDIC SURGERY

Predictive factors influencing fast track rehabilitation following primary total hip and knee arthroplasty

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Received: 10 September 2008 / Published online: 7 February 2009

Abstract
Background Fast track rehabilitation after primary total hip (THR) and total knee replacement (TKR) is gaining popularity. We performed a prospective clinical trial to identify predictive factors for successful fast track rehabilitation.
Methods Between June 2005 and January 2006, 52 THR and 48 TKR were performed on consecutive patients off the local waiting list with no pre-selection or exclusion criteria. Patients underwent a fast track rehabilitation programme within a group-dynamic set-up aiming for discharge day 3 to 5 postoperatively. Demographic, clinical and social factors were analysed.
Results Eighty-four percent ($n = 44$) of THR patients and 73% ($n = 35$) following TKR achieved the target discharge. Average discharge after THR was 5.4 and 5.5 days after TKR. Delayed discharge was mostly related to medical, social and organisational reasons. Age, 3 m-get-up-and-go-test (3 m-TGUGT), home situation and preoperative walking distance were the main predictors for the early discharge after THR; age, diagnosis, ASA class and preoperative pain medication were influential for TKR. Perioperative complication rates were within or below the national average.
Conclusion Successful fast track rehabilitation is possible without pre-selection and does not seem to compromise clinical safety. However, a good social and physiotherapy community set-up should be available. The identified predictive factors could be helpful to identify candidates for fast track rehabilitation.

Keywords Total knee arthroplasty · Total hip arthroplasty · Rehabilitation · Fast track · Early discharge

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Introduction

Pressure on health economics, reduction in hospital beds and patient expectations have been an important motivators to try and reduce the length of stay after primary total hip (THR) and total knee replacement (TKR). The number of operations worldwide is increasing annually whilst the length of stay in the hospital is decreasing constantly. In 1974 Coventry reported protocols for managment of hip arthroplasties with discharge on day 21 for the Mayo Clinic [1]. In 1990 an average length of stay of 9–10 days was reported for the US [2]. In the UK, recent reports showed that the average length of stay following THR has further decreased from 11 days in 1999 to 8 days in 2002 [3]. Most recent data from the Scottish arthroplasty register showed an average stay of 8.0 days for THR and 7.6 days for TKR in 2007 with shorter length of stay in dense populations like Lothian [4].

With the introduction of "minimal-invasive" techniques shorter rehabilitation [5] and even the possibility of outpatient surgery[6, 7] have been advocated. For these programmes commonly younger and fitter patients are pre-selected, but limited data is available on the factors which actually make a patient eligible for such a treatment regime [8–10].

We have taken a different approach and performed a prospective clinical trial on all patients off the waiting list without exclusion criteria to identify positive or negative predictive factors for successful fast track rehabilitation.

Materials and methods

Between June 2005 and January 2006, 52 primary THR and 48 primary TKR were performed by the same surgical team (MS, IK, registrars and SJB). Patients were scheduled consecutively from our local waiting list and no pre-selection criteria were implemented. We used a slightly modified, but established fast track rehabilitation protocol that was implemented in 1997 and used in the Netherlands since (Joint care®; Biomet UK).

To allow for group treatment four patients of the same gender were seen around 1–2 weeks pre-operatively at the pre-admission outpatient clinic (PAC). A standardised educational programme was implemented by the first author, including visual (12-min VHS video, produced at NRI Edinburgh) and oral education (approximately 15 min) for the group. Patients were informed in detail about the post-operative treatment regime and the target discharge day 3 to 5. Discharge was allowed if our local discharge criteria (Table 1) were met.

Routine clinical and radiographic investigations were performed. Demographic data (Table 2), Harris-hip-score [11], Oxford-12 hip or knee questionnaires [12, 13] and American Knee Society Score (AKS) [14] were used regarding joint function whereas Short-Form-36 (SF-36) were estimated for social derived measurements. Patients were categorised into Charnley musculo-skeletal groups A–C prior THR and the comparable Insall-classification for TKR [14]. In group A walking distance is limited due to the operated joint, in group B due to bilateral joint involvement. Group C is classified, if walking distance is limited due to other medical or orthopaedic relevant comorbidities. To estimate gait capacity (IK) a standardised 3 m-get-up-and-go-test (3 m-TGUGT) was done [15]. From pilot-study data with 20 patients prior to the trial, two groups were determined (group 1: walking time <16 s, group 2: ≥16 s).

Table 1 Discharge criteria for THR and TKR

Independent with all transfers
Independent mobility with suitable walking aid
Functional ROM
Functional muscle power
Safe on stairs
Good understanding of home exercises
Good understanding of post-OP precautions

Patients were admitted in the afternoon before the operation in a four bedroom equipped with reclining chairs. A standardised anaesthetic and pain protocol was used (Table 3) and ASA-classification was recorded by the anaesthetic team.

All operations were performed by the senior author or his trainee under supervision using a modified limited incision lateral Hardinge approach in a lateral decubitus position under hypotensive spinal anaesthesia or if necessary with additional general anaesthesia. All implants were cemented with third generation technique (Refobacin Palacos-cement®, Biomet Merck; acetabulum: contemporary cup®, Stryker-Howmedica; femur: Olympia® stem, Biomet [16]). To allow for comparison one subfascial Redon-drain was used and removed on the first postoperative day. Intracapsular and periarticular soft tissue injections were performed at the end of the operation. TKR (Kinemax®, Stryker-Howmedica) was performed via a standard mediopatellar Payr-approach with applied tourniquet of 280–320 mm HG. Pre-operatively femoral and sciatic nerve blocks (with 0.375% bupivacaine) were given, thus not allowing for additional soft tissue injections. Meticulous intraoperative haemostasis was done and one intra-articular Redon-drain (knees) was removed on the first postoperative day.

Postoperatively, all patients received patient controlled analgesia (PCA) with 100 mg morphine and 100 mg cyclizine. Routine mobilisation with full-weight bearing (FWB) was started on day 1 by our physiotherapy team. Self-exercices were shown and trained once daily as routinely done in our hospital.

Comfortable reclining chairs were provided and patients were requested to sit in their chairs with normal clothes during daytime. All patients routinely attended a discharge class by our occupational therapists on day 3 postoperatively. Discharge between day 3 and 5 was recorded as acceptable. All patients discharged after day 5 were classed as failures and reasons for delay were documented.

Outpatient physiotherapy was requested if additional exercises were necessary or extension/flexion after TKR did not achieved 0°–0°–70°. Clinical follow-up was performed 6 weeks post-operatively by the first author. Range of motion (ROM), abductor strength following THR, use of walking aids, pain medication and degree of satisfaction were recorded.

Six months after discharge a questionnaire was sent out by a secretary not involved in the trial to record patient satisfaction regarding the operation and the fast track rehabilitation programme.

Statistical analysis

Statistical analysis was performed using SPSS version 12.0 software (SPSS, Chicago, IL). To examine differences between the two groups of interest χ^2 test or t test were

Table 2 Demographics, diagnoses, patient factors and scores

Patient factor	THR	TKR
Patients (*n*)	52	48
Age (years)	69.3 ± 9.4 (44–90)[a]	68.7 ± 11 (36–86)[a]
Gender		
Female (*n*)	34	30
Male (*n*)	18	18
BMI	27.7 (20–49)	31 (20–46)
Degenerative joint disease (*n*)	42	42 (5 valgus)
Rheumatoid arthritis (*n*)	6 (protrusio)	6 (4 valgus)
Posttraumatic osteoarthritis	2	0
DDH (roofgraft required)	1	DNA
AVN	1	0
Charnley or Insall Class A (*n*)	34	24
Charnley or Insall Class B (*n*)	4	14
Charnley or Insall Class C (*n*)	14	10
Social situation		
Lives with wife/husband	30	31
Lives with family	2	4
Lives alone	19	13
Lives in nursing home	1	0
SF-12		
PCS 12	50.6 ± 4 (42.6–61.8)	50.2 ± 6.8 (27–61.9)
MCS 12	53 ± 3.9 (41.4–58.2)	52.9 ± 4.8 (41.4–63.9)
SF36		
Physical function	24.9 ± 19.5 (0–80)	28.33 ± 21,9 (0–100)
Role physical	14.5 ± 28.6 (0–100)	19.44 ± 32.8 (0–100)
Bodily pain	26.7 ± 15.6 (0–78)	28.14 ± 18 (0–88.9)
General health	67.1 ± 18.5 (10–100)	62.22 ± 23.3 (5–100)
Vitality	44.7 ± 20.5 (0–85)	42 ± 22.4 (0–90)
Social function	43.5 ± 23.4 (0–89)	47.4 ± 25.8 (0–88.9)
Role emotional	45.3 ± 47.5 (0–100)	45.2 ± 46.1 (0–100)
Mental health	66.8 ± 21.4 (4–100	71.1 ± 19.3 (24–100)
Oxford-12 hip/knee	42 ± 7.3 (17–54)[a]	41 ± 8.9 (16–57)[a]
Harris-hip-score	40.6 ± 10 (20.8–65)[a]	DNA
American knee society		
Knee score	DNA	48 ± 14 (24–79)[a]
Function score	DNA	61 ± 19.7 (10–90)[a]
3 m-get-up-and-go-test (3 m-TGUGT)		
<16 s	25	27
>16 s	27	21
ASA		
1 (*n*)	2	1
2 (*n*)	40	23
3 (*n*)	10	24
Hb pre-OP (mg/l)	132 (88–158)	132 (87–153)
Hb post-OP day 2 (mg/l)	106 (83–133)	108 (77–131)
Blood transfusion rate (*n*)	5	6
Average operating time (min)	68 (49–93)	65 (42–110)
Average PCA dosage (mg)	19 (0–74)	32.5 (0–98)
DVT prophylaxis (n)		
Aspirin 100 mg; 12 weeks	46	31
Clexane 20/40 mg s.c.6 weeks	6	11
Warfarin	0	6

[a] Mean ± SD (range)

Table 3 Perioperative pain protocol

Drug/method	Amount	Time
Spinal anaesthesia if possible with intrathecal morphine	–	Pre-operatively
Soft tissue injection THR		
Levobupivacain 2.5 mg/ml	60 ml	Operatively
Ketorolac (Toradol®)	30 mg	
Adrenalin 1:1000	0.5 ml	
PCA pump		
Morphine	100 mg	Post-operatively
Cyclizine	100 mg	
Cyclizine®	50 mg	PRN
Ondansetron	4 mg	PRN
Paracetamol	1 g	qd
Oxycontin®	10 mg	bd (day 1–3 post-OP)
Oxynorm®	5 mg	4 hourly PRN
Dihydrocodeine	30 mg	4 hourly PRN
Lactulose	10–15 ml	bd
Senokot®	2 tabs	bd
NSAID if previously used		

PCA patient controlled analgesia, *PRN* as requested, *bd* twice per day, *qd* four times per day

used. The normal significance level for these tests was adjusted according to the method of Bonferroni–Holm using an α level of 0.05 as a global significant level.

Results

Complications (within 90 days after discharge)

Tables 4 and 7 show all perioperative complications and problems after THR and TKR. All post-operative transfusions (5 THR, 6 TKR) were required in patients with pre-operative anaemia (Hb <10 g/L, Table 2).

Re-admissions

Two patients after THR were readmitted to a hospital. One patient developed a superficial stitch abscess. One patient was readmitted with chest pain 5 days after discharge, but cardiovascular reasons could be excluded, discharged the same day.

Five patients after TKR required readmission: one subcuticular stitch abscess 14 days post TKR was treated successfully with excision. Two patients discharged with extension/flexion of 0°–0°–60° [MCL injury, received outpatient (OP) physiotherapy PT] and 0°–0°–75° (no OP PT) received closed manipulation under anaesthesia (MUA) 7 weeks after the operation. One patient requiring re-warfarinisation was readmitted with haemarthosis due to an INR of 4.1. This was managed conservatively and discharge was possible after 1 week. One patient with pre-existent Alzheimer's disease was readmitted to a local geriatric unit for confusion and social reasons; discharged home after 3 weeks.

Table 4 Perioperative complications within 90 days in comparison to NHS board complication rates

Complications	THR (*n*)	Rate	NHS board*	TKR (*n*)	Rate	NHS board[a]
DVT/PE	0	0.0	0.018	0	0.0	0.016
Deep infection	0	0.0	0.008	0	0.0	0.017
Hip dislocation	0	0.0	0.018	DNA	0.0	0.018

[a] NHS board data for complications within 90 days (between 1998 and 2003) = Scottish mean

Satisfaction and outcome (Tables 5, 6)

Table 5 shows the degree of satisfaction and clinical outcome after the operation and with the fast track rehabilitation programme. Six months post-surgery, patients after THR showed higher rates of satisfaction than after TKR (Table 6). However, both groups reported high acceptance and satisfaction with the fast track programme and the received peri-operative information. One of five after THR and 1/3 after TKR, who had previous TJR without fast track reported a preference of the "standard" rehabilitation programme with longer hospital stays. Twelve and 18% in both groups considered their hospital stay too short (Table 6).

Discharge after THR/TKR

The mean discharge following THR was 5.4 days (3–21) and 5.5 days (3–19) after TKR. Eighty-four percent after THR ($n = 42$) and 73% ($n = 35$) after TKR achieved the target discharge goal day 3 to 5. Reasons for delayed discharge (11% THR, 19% TKR) were mostly related to medical, social or organisational (Table 7).

The positive predictive factors for successful short track rehabilitatin after THR and TKR adjusted to day 3, 4 and 5 are summarised in Table 8.

In summary, the required walking time during the 3 m-get-up-and-go-test and the age of the patient were the main predictors for early discharge after THR. Home situation and walking distance prior to surgery were influencing the discharge after day 5 but not after day 3 or 4. In contrast, the 3 m-get-up-and-go-test did not influence discharge after TKR, but age and ASA class were influencial for early discharge on day 3. Diagnosis was important as patients with three compartmental involvement performed inferior to those with one or two compartmental involvement. As in

Table 5 Clinical data at 6-week follow-up

Patient factor	THR (*n*)	TKR (*n*)
Satisfaction		
Very satisfied	43	21
Satisfied	9	18
Unsatisfied	0	9
ROM (average degrees)		
Flexion	92 (80–100)	97 (30–130)
Extension	0	1.7 (0–25)
Pain medication		
None	18	8
Class 1	24	25
Class 2	10	13
Class 3	0	2
Walking aid		
None	6	13
One cane	28	26
One crutch	2	0
One canes	8	6
One crutches/zimmer frame	8	3
Trendelenburg limp after THR		
None	47	–
Mild	5	–
Moderate	0	–
Severe	0	–
Received outpatient physiotherapy after discharge		
Yes	6	24
No	45	24
Inpatient rehabilitation	1	0
Required additional physiotherapy		
Yes	0	3
No	52	45

Table 6 Patient questionnaire 6 months after discharge

Patient factor	THR (%)	TKR (%)
How would you rate your outcome of your THR/TKR?		
Excellent	57	37
Very good	34	27
Good	2	10
Fair	7	16
Poor	0	10
How would you rate the information you received pre-OP?		
Excellent	60	50
Very good	33	41
Good	7	6
Fair	0	3
Poor	0	0
Did you think being in a group with other patients undergoing the same operation was…		
Excellent	60	34
Very good	33	47
Good	7	19
Fair	0	0
Poor	0	0
How did you find the fast track rehabilitation programme compared to your experience the *l*ast time (previous OP)?		
Better	50	37
The same	33	27
Worse	17	36
Did you think your stay in the hospital was…		
Too long	0	0
Too short	18	12
Appropriate	82	88

THR preoperative walking distance was influencial for discharge on day 3 and type of preoperative pain medication influenced discharge on day 4 as patients using WHO class II and III medication performed inferior than patients using class I.

BMI, co-morbidities, gender, pre-OP pain levels, radiographic stage and function scores did not predict an early discharge.

Additional physiotherapy and occupational therapy/equipment

There was no increased necessity to organise home care in comparison to non-fast track patients (THR $n = 5$, TKR $n = 2$). The fast track groups had more post-discharge OT contacts (THR 5, TKR 2.4) in comparison to data from our

Table 7 Reasons for delayed discharge

Patient factor	THR (*n*)	TKR (*n*)
Physiotherapy	0	3
Social reasons	3	2
Medical reasons	0	5
Parkinson disease symptoms	0	1
Alzheimer disease	0	2
Chronic renal failure	0	1
COPD	0	1
Surgery related reasons	2	3
Cellulitis	2	0
MCL injury	0	1
Post-OP anaemia/transfusion	0	1
Swollen, painful joint	0	1
Transport problems	3	0
Total	8	13

Table 8 Predictive factors for early discharge

	Day 3	*p* value	Day 4	*p* value	Day 5	*p* value
THR	3 m-TGUGT	0.005**	3 m-TGUGT	0.001**	3 m-TGUGT	0.004**
	PCA (post-OP morphine use)	0.019*	Age < 75	0.037*	Age < 75	0.008**
			General health (SF–36)	0.005**	Home situation (lives alone)	0.014*
					Walking distance (>1mile)	0.021*
					Bodily pain (SF-36)	0.008**
					Mental health (SF 36)	0.048*
TKR	Age < 75	0.016*	Age < 75	0.002**	Age < 75	0.035*
	Diagnosis OA	0.04*	Diagnosis OA	0.042*		
	ASA <3	0.006**	Pain medication (none or WHO 1)	0.039*		
	Walking distance (>1 mile)	0.049*				

* $p < 0.05$

** $p < 0.01$

unit (THR 4.1, TKR 1.2). TKR patients required more equipment. Outpatient physiotherapy treatment was provided for 12% ($n = 6$) after THR and 50% ($n = 24$) after TKR, which was within our routine data in our unit.

Discussion

Fast tracking of arthroplasty patients seems attractive to patients, surgeons and health care providers. More effective use of existing NHS resources should be achievable thus decreasing waiting list time. Calculations of the Common House showed that by reducing the average inpatient stay by 2 days it would gain 510 more operations annually for a 60 bed unit [3].

Currently, there is only limited data available regarding predictive factors for successful fast track rehabilitation and reports about possible higher perioperative complication rates. Most protocols use pre-selection criteria which lack evidence based validation. A prospective study from Northern Ireland reported that 19% ($n = 82$) of their patients after THR could be discharged on day 2 post-operatively without compromising patient safety. These patients were typically thinner, younger, healthier and more likely to be male. The authors implemented fast track criteria pre-operatively and only chose patients with low anaesthetic risks (ASA 1 or 2) [10]. The same group reported that minimal-incision technique in THR showed no significant benefit in the early postoperative period [17] as was confirmed by others [18]. A retrospective report [9] showed that only age correlated with length of stay following primary THR and TKR. A prospective trial comparing patients requiring inpatient rehabilitation with discharges directly home reported that inpatient rehabilitation patients were older, had >2 comorbidities, lived alone and their post-operative pain level was higher [8].

The main limitation of our study is the relatively small sample size. Estimation upon the single significance of the investigated factors would require higher numbers of patients, thus statistical analysis is possible but within size limits. Our prospective trial showed that after THR and TKR different factors seem to influence fast track rehabilitation. Distinguishing between early discharge after 3 days or discharge after 4 or 5 days could identify different impact of observed factors.

In all the categories, age was an important influence as could be expected. For THR walking distance, home situation and the 3 m-get-up-and-go-test were relevant factors. Clinical scores as tested were only of minor importance. Some significant influence could be seen for general health and bodily pain as tested by the SF-36 questionnaire.

For TKR the 3 m-get-up-and-go-test showed no significant importance, whereas diagnosis, walking distance preoperatively, type of preoperative pain medication and ASA-classification were of significant importance. Clinical scores did not influence the time of rehabilitation at any stage.

Interestingly in both groups obesity, comorbidities, other joint pain or radiographic stage did not influence rehabilitation time. A recent study showed no influence of obesity in the midterm 5 years after TKR and no increase of complication rates [19]. In hip arthroplasty revision surgery patients with preoperative lower pain scores and fewer comorbidities had better functional outcomes after 2 years [20].

Our findings from 6 weeks after discharge showed good clinical results for the majority of our patients. Only 11% of THR and 50% of TKR patients received home physiotherapy after discharge. Debates about the need for outpatient physiotherapy treatment or hospital rehabilitation remain controversial, but cannot be fully discussed with our data as we did not test the effect of outpatient physiotherapy versus hospital rehabilitation.

Perioperative complication rates were within normal limits and even below the national average [4]. Age or comorbidities as negative factors regarding complication rates after primary TKR as found by others [21] did not affect our complication rates. However, the high re-admission rate after TKR is worrisome, but the sample size was too small to draw any firm conclusion.

A high degree of satisfaction was achieved with the applied fast track programme and most patients liked the idea of a group set-up and the increase of preoperative information. Although it seems justified to acknowledge local circumstances in the UK as cultural and local, patients seem to have different expectations and experiences following joint replacement [22]. Our hospital is a highly specialised centre with high-volume of joint replacements and our findings may not be similarly valid in lower volume units [21].

To our knowledge this is the first prospective trial without pre-selection criteria investigating influencing factors for fast track rehabilitation protocols. Our results showed that fast track rehabilitation with high levels of patient satisfaction is possible without compromising patient safety. Danish patients showed similar degrees of patient satisfaction after THR and TKR comparing accelerated hospital stays with conventional hospital stays [23]. However, more staff and a multidisciplinary effort are necessary for the intensified and condensed postoperative care pathway. Clinical pathways are used and established already in our department which have shown to play a decisive role in reducing the length of stay [24]. From our experience and the patients response it seems questionable as to whether inpatient stay could or should be further shortened. The identified factors for successful fast track rehabilitation can be used for further clinical trials to establish useful selection criterias which could be applied when placing a patient on the waiting list.

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