

Hip arthroplasty patients benefit from accelerated perioperative care and rehabilitation

A quasi-experimental study of 98 patients

Kristian Larsen¹, Torben Bæk Hansen¹, and Kjeld Søballe²

¹Orthopedic Research Unit, Holstebro Regional Hospital, Holstebro, ²Department of Orthopedics, University of Aarhus, Aarhus, Denmark
Correspondence KL: fekl2004@msn.com
Submitted 07-10-12. Accepted 08-04-02

Background and purpose More than 6,500 hip arthroplasties were performed in Denmark in 2005. Accelerated perioperative interventions are currently implemented, and the length of stay is thereby reduced. An increase in postoperative health-related quality-of-life (HRQOL) has been observed for hip patients after accelerated perioperative procedures compared to standard procedures. However, no studies have used HRQOL as a primary outcome. We therefore performed a before-after trial to investigate whether HRQOL would be improved postoperatively in hip arthroplasty patients undergoing accelerated perioperative care and rehabilitation intervention compared to those undergoing current intervention.

Patients and methods 98 elective primary hip arthroplasty patients underwent either a standard procedure or an accelerated perioperative procedure ($n = 48$ and $n = 50$, respectively). Primary outcome was difference in HRQOL measured with EQ-5D, which measures HRQOL in 5 dimensions (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) at the 3-month follow-up visit.

Results HRQOL was markedly improved in both groups. A significant difference in HRQOL at follow-up of 0.08 (95% CI: 0.01–0.15) in favor of the patients who received the accelerated intervention was observed ($p = 0.02$).

Interpretation Hip arthroplasty patients benefit postoperatively from accelerated perioperative care and rehabilitation procedures, with an HRQOL that is approximately 10% higher than that of patients receiving standard procedures.

In Denmark, the incidence of total hip arthroplasty (THA) is rising; it was 142 per 100,000 inhabitants in 2004, with more than 6,500 THAs performed in 2005 (Pedersen et al. 2005, Danish National Board of Health 2006, the StatBank Denmark 2006). Hip and knee arthroplasty are major surgical procedures that require interventions in order to minimize the postoperative stress response, characterized by endocrine-metabolic changes, inflammatory response, hyperthermia, and immunosuppression (Kehlet and Dahl 2003). New procedures to optimize the perioperative intervention—defined as the period from outpatient visit prior to hospitalization to discharge—are given several names, e.g.: multimodal intervention, joint care, accelerated intervention, and clinical pathway. An accelerated intervention is defined as a multimodal intervention taking place in a multidisciplinary organization in order to shorten time to convalescence (Wilmore and Kehlet 2001, Kehlet and Wilmore 2002, 2005). Until 2005, the outcome of accelerated perioperative care and rehabilitation interventions was conflicting (Dowsey et al. 1999, Kim et al. 2003, Reilly et al. 2005, Petersen et al. 2006). The main intention regarding results from accelerated procedures abroad and in Denmark has been to reduce the length of stay (LOS) and to minimize complications (Rasmussen et al. 2001, Husted et al. 2004, 2006). During an implementation process aimed at reducing LOS using accelerated perioperative care and rehabilitation interventions, we observed a possible benefit to health-related quality-of-life (HRQOL) in patients receiving total hip

arthroplasty (THA). To our knowledge, this has not been studied previously. We thus performed a study to investigate whether HRQOL was improved post-operatively in primary THA patients in patients who underwent accelerated perioperative care and rehabilitation intervention compared to those who underwent current intervention.

Patients and methods

The study was an effectiveness study using a before-after design, and took place in the Orthopedics Clinic of Holstebro Regional Hospital, Denmark, from June 2005 through March 2007. The procedures followed in the study were in accordance with the ethical standards of the local committee responsible for human experimentation and with the Helsinki Declaration of 1975, as revised in 2000. The study protocol was approved by the Medical Ethics Committee of Ringkjøbing and Southern Jutland Counties (ref.: 2627-04). The study was also registered with the Danish Data Protection Agency (J. no. 2004-41-4753).

Study subjects

All patients who were planned to undergo elective primary THA were invited to participate in the study. Patients in the current intervention group (in the “before” period) were included in the study if they were to undergo primary, elective THA, and if they were diagnosed after June 2005, operated, and treated following the prevailing (current) intervention between August 15, 2005 and February 15, 2006. Patients in the accelerated intervention group (in the “after” period) were included if they were to undergo primary, elective THA, and if they were operated and treated according to the accelerated intervention between August 15, 2006 and December 15, 2006. All patients except acute patients, revision patients, and patients who received more than 1 THA during the study period were included. Patients meeting the inclusion criteria were given written and oral information about the study at the initial visit, and patients who were interested gave their consent.

Sample size

The estimated sample size at follow-up was cal-

culated using actual data on HRQOL from a pilot study performed in May and June, 2005. The risk of performing a type 1 error was set at 5% using a two-sided analysis, and the power of detecting a true difference was set at 80%. HRQOL was observed to be 0.76 in the current intervention group at follow-up; least relevant difference was set at 0.1. Using a two-sample comparison of means with a standard deviation of 0.17, we needed at least 46 patients in each group at follow-up. To account for a possible loss of patients, at least 50 patients were included in each group.

Intervention

Intervention in both groups. Patients in both groups were subjected to identical operational procedures (posterior-lateral exposure of about 10 cm) and identical anesthetic procedures, which followed the Danish guidelines on uncemented implants for patients under the age of 65 (Danish Orthopaedic Society 2001, 2004). Medication for pain relief, nausea, and elimination were identical in both groups. Pain relief consisted of oxycodone hydrochloride and paracetamol; ondansetron was used for control of nausea, and for elimination we used magnesium. No changes in the above-mentioned procedures occurred during the study period. The areas to be investigated in our study were therefore the changes in the multidisciplinary organization, and the remaining elements in the multimodal intervention, which were: preoperative assessment and information, optimization of oral nutrition for increased protein and fluid consumption, early and intensive mobilization and exercise—hereafter defined as accelerated perioperative care and rehabilitation intervention (Table 1).

Current intervention in the “before” period. Nobody on the healthcare staff was aware of the ongoing study regarding the accelerated intervention. Patients were hospitalized on the day before surgery and placed in a general orthopedic ward. They were given hospital clothes to be worn during the whole stay, and were informed of the path and prepared for surgery. A nutrition screening was performed on the day of admission, and the patient ate according to the result. On the day before surgery, the patients were individually informed of the path by the surgeon, anesthetist, and nurse. Final blood tests, heart EKG, and radiographs were taken.

Table 1. Interventions in current and accelerated intervention groups for 98 patients who underwent total hip arthroplasty in Denmark, 2005–2006

	Current intervention group	Accelerated intervention group
<i>Multidisciplinary organization</i>		
1. Outpatient clinic	No information day.	Highly coordinated information day.
2. Ward	Hospitalization day before surgery. Different nurses in charge. Arthroplasty patients are spread over the ward.	Hospitalization on day of surgery. One nurse in charge of multidisciplinary team of nurses, occupational therapists, and physiotherapists. All arthroplasty patients are gathered in one separate part of the ward.
3. Operating theater	No difference.	
4. Rehabilitation center	Administered by physiotherapists for individual patients.	Integrated in ward as part of team mobilization.
5. Other departments	Less coordinated; in some cases in other departments' premises.	Highly coordinated.
<i>Multimodal intervention</i>		
1. Preoperative assessment and information	Individual information on the day of admission.	Information in teams at an outpatient clinic visit prior to hospitalization.
2. Attenuation of surgical stress response	No difference.	
3. Pain relief, nausea control, and elimination	No differences.	
4. Mobilization and exercise	Starting first day postoperatively; individual and gradual according to the patient's actual status. Four hours of mobilization daily.	Starting on day of surgery; early and intensive after preset goals; always in teams. Four hours of mobilization on first day postoperatively; else eight hours of mobilization daily.
5. Oral nutrition	Nutrition screening and common focus.	Nutrition screening and special focus on consumption of 1.5 L of fluid daily, including 2 protein beverages.

Patients were mobilized out of bed and started training the first day postoperatively. During the days that followed, mobilization was increased in order to reach the discharge criteria (see below). During the stay, care was given in response to the patient's actual needs, and rehabilitation was adjusted according to the patient's immediate state (Table 1).

Accelerated intervention in the "after" period. Likewise, nobody from the healthcare staff was aware of the ongoing study. All patients, with 1 relative each, were invited to an information day on the Friday before their week of surgery. The purpose of the information day was both to inform the patients in groups of the accelerated path, but also to prepare the patients for surgery during individual consultations with the surgeon, anesthetist, and nurse. Final blood tests, heart EKG, and radiographs were taken. All patients were hospitalized in the new "accelerated" unit (a separate part of the same ward) on the day of surgery. The

patients used their own clothes during the whole stay in order to avoid adopting a sick role. Healthcare staff worked to achieve written preset daily goals regarding: (1) information, (2) pain relief, (3) nausea control, (4) nutrition, (5) mobilization, and (6) elimination. Information on the information day concentrated on goals during the hospital stay, a planned discharge on the fourth postoperative day on completion of discharge criteria, how to relieve pain, mobilization strategies, and provision with walking aid and other remedies. As a supplement to the nutrition screening the patient had a daily intake of two protein beverages, with a total fluid consumption of at least 1.5 L (Milne et al. 2005). Mobilization started on the day of surgery. On first postoperative day, the goal was 4 h out of bed including training with a physiotherapist and an occupational therapist. We aimed at more than 8 h of mobilization per day for the rest of the hospital stay. Patients followed a diary with the above-mentioned preset goals for nutri-

tion, fluid consumption, and mobilization (Table 1). For further detailed information regarding the accelerated intervention, see The Unit of Perioperative Nursing Care.

Discharge criteria

Fulfillment of the discharge criteria was decided on by surgeons who were unaware of the ongoing study. Equal discharge criteria in both groups were: (1) acceptance of discharge, (2) sufficient pain control, (3) awareness of procedures for ending medication, (4) knowing the restrictions, (5) being able to walk safely with or without walking aids, (6) being able to walk on stairs, (7) being able to perform home exercises, (8) knowing how to increase home exercises, (9) being able to cater for one's own personal needs, (10) that helping aids had been delivered and installed, and (11) that the wound showed no signs of infection.

Baseline

All patients who were included filled in a preoperative questionnaire at the diagnostic inpatient visit in relation to the standard hospital quality improvement procedures. The questionnaire included EQ-5D (Szende and Williams 2004) together with other questions and questionnaires. EQ-5D measures HRQOL in 5 dimensions (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression) and has been shown to be valid and reliable (Fransen and Edmonds 1999, Szende and Williams 2004). EQ-5D is also the instrument preferred to measure outcome at the patient level by the Swedish National Hip Arthroplasty Register (<http://www.jru.orthop.gu.se>). HRQOL scores were calculated using the "official Danish time trade-off scores" (Pedersen et al. 2003). Valuation of the 245 health states, including death and unconsciousness, ranges from worst state of health (–0.550) to best state of health (1.0). Data on patient characteristics were obtained from the hospital register.

Follow-up

At the 3-month control visit, all patients again filled in a postoperative follow-up questionnaire in relation to the quality improvement procedures of the hospital. The follow-up questionnaire included EQ-5D.

Outcome measures and statistics

The primary outcome measure was HRQOL at the 3-month follow-up visit, measured with EQ-5D. Data were entered twice using EpiData 3.1 (Lauritsen and Bruus 2003-2005). We estimated the adjusted HRQOL at the 3-month follow-up visit using a multivariate linear regression analysis. Due to expectation of non-normal data and a potential correlation between HRQOL at baseline and HRQOL at follow-up, we estimated non-parametric confidence intervals based on 2,000 bias-corrected and accelerated bootstrap replicates, according to Manca et al. (2005). The analysis included the variables: group (current or accelerated), HRQOL at baseline as a continuous variable, gender (male or female), age as a continuous variable, diagnosis (arthrosis or other), and implant type (uncemented or cemented). All analyses were performed using STATA 9.1 (StataCorp, College Station, TX). The significance level was set at $p < 0.05$.

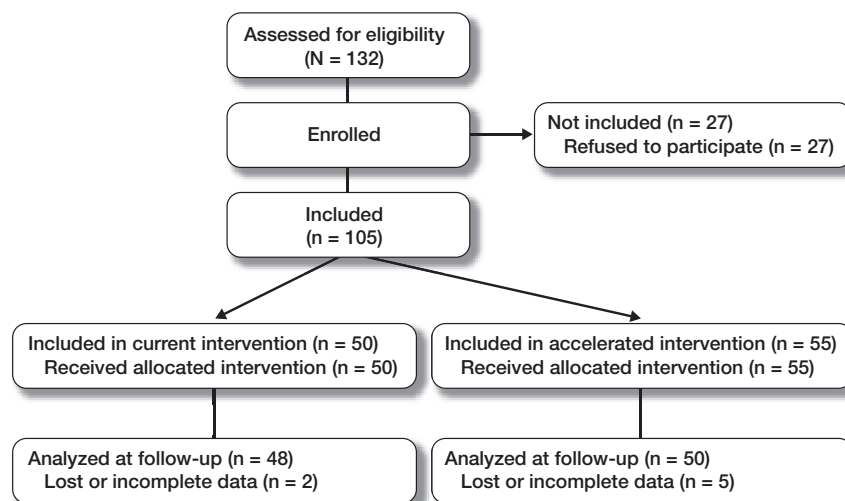
Results

Patient characteristics

Altogether, 132 patients were eligible for the study. Of these, 27 patients (20%) refused to participate, thus leaving 105 patients at baseline to be included in the two intervention periods. We planned for 50 patients to receive the current intervention in the preimplementation ("before") period and 55 to receive the accelerated intervention in the postimplementation ("after") period. Two patients who received the current intervention and 5 who received the accelerated intervention had incomplete or missing data at follow-up and were excluded from analysis (Figure). No statistically significant differences between the patients who were included and excluded were found regarding: sex, age, diagnosis, procedure, or HRQOL at baseline. Patient characteristics for the patients who were included are given in Table 2.

Quality of life

At the 3-month follow-up visit, both groups reported a markedly increased HRQOL. The 48 patients who received the current intervention had an average HRQOL of 0.77 (SD 0.18) and an average gain in HRQOL from diagnosis to the



Flow chart of patients.

Table 2. Baseline and perioperative data for 50 hip patients who received the current perioperative care and rehabilitation intervention and 55 patients who received a new accelerated intervention, 2005–2006

Group	Current intervention (n = 50)	Accelerated intervention (n = 55)
Female/male ratio	23 / 27	27 / 28
Age, mean (SD)	67 (9.8)	65 (9.6)
Arthrosis coxae/other	50 / 0	53 / 2
Ratio of cemented / uncemented implants	23 / 27	15 / 40
HRQOL ^a at baseline, mean (SD)	0.54 (0.24)	0.55 (0.22)
Length of stay, mean (SD)	7.3 (1.8)	4.2 (1.8)

^a Health-related quality-of-life from EQ-5D, a questionnaire measuring 5 aspects of health-related quality of life.

follow-up visit of 0.24 (SD 0.32). The 50 patients who received the accelerated intervention had an average HRQOL of 0.85 (SD 0.15) and an average gain in HRQOL from diagnosis to the follow-up visit of 0.29 (SD 0.22). Multivariate analysis of the 98 patients revealed a clinically relevant difference in HRQOL—in favor of the accelerated intervention—of 0.08 (95% CI: 0.01–0.15) ($p = 0.02$). Except for the primary group intervention variable, none of the other covariates included could significantly predict HRQOL at follow-up in the multivariate analysis (Table 3).

Discussion

To our knowledge, this is the first study using HRQOL as a primary outcome measure to demonstrate that patients receiving THA actually do increase their HRQOL postoperatively when following an accelerated perioperative care and rehabilitation intervention, as compared to the current intervention used in our hospital. One explanation may be that the patients are not in a sick role; they are taught to follow and achieve preset goals. This means that the patients concentrate more on what they can do and less on what they cannot do. The shorter hospital stay and earlier mobilization must also lead to a reduced deterioration of physical performance, and therefore also a quicker regain of it.

The positive result obtained for HRQOL in this effectiveness study is in line with the results of a randomized clinical trial (RCT) (Larsen et al. 2008). In the present study, at the 3-month follow-up visit we found a significant and clinically relevant difference in HRQOL of 0.08 for THA in favor of the accelerated intervention. Our result is also in line with the Dutch study by Brunenberg et al. (2005) who demonstrated a clinically relevant effect in quality-adjusted life-year (QALY) of 0.05 favoring the hip patients. At 3-month follow-up, they reported a difference in HRQOL of 0.09 in favor of the accelerated intervention. Thus, there seems to be good evidence for a gain in HRQOL

Table 3. Adjusted mean difference of quality of life at the 3-month follow-up visit between the current and the accelerated perioperative care and rehabilitation intervention, for 98 hip patients

Variable	Coefficient	95% CI	P-value
Accelerated vs. current intervention	0.08	(0.01–0.15)	0.02
HRQOL at baseline, continuous	0.05	(-0.09–0.22)	0.5
Gender, male vs. female	-0.01	(-0.08–0.08)	0.9
Age, continuous	-0.001	(-0.01–0.002)	0.5
Diagnosis, arthrosis vs. other	-0.01	(-0.13–0.05)	0.7
Implant type, uncemented vs. cemented	0.03	(-0.08–0.11)	0.6
Multivariate linear regression including group, HRQOL at baseline, sex, age, diagnosis, and type of implant.			

for THA patients receiving accelerated perioperative intervention—of approximately 10% at the 3-month follow-up visit compared to the current intervention. In both the study by Brunenberg et al. (2005) and the study by Larsen et al. (2008), HRQOL reached the highest level and the greatest difference between interventions around the 3-month visit. When estimating QALY, the overall difference between the interventions will therefore be less because of a 9-month contribution, with minor differences between the groups.

We believe that our 2 groups were similar at baseline, as all patients were included consecutively, and the proportion of patients who were unwilling to participate was of the same order as seen in our previous study (Larsen et al. 2008). We believe that we were successful in blinding the healthcare staff regarding HRQOL as an outcome, as they were unaware of the ongoing study. Likewise, the patients were not specifically aware of HRQOL as an outcome measure because it was part of a questionnaire used in monitoring the general effect of treatment. We also believe that the discharge procedures were identical in both groups, as they were administered by surgeons who were not aware of the ongoing study, and because discharge was only executed upon completion of all discharge criteria. The information about a planned day for discharge was presented in order to give patients an opportunity to plan their return home, and they did not concentrate on a set day for discharge but rather on the achievement of discharge criteria. We believe that we successfully minimized any potential observer bias, using questionnaires. We do not believe that the fact that this was not a RCT invalidates this

study, because the results we obtained in our RCT have been confirmed, and we are actually more interested in investigating what results are under usual circumstances of healthcare practice. Our analysis of HRQOL also included adjustment of the result for the most common confounders in order to get the most precise estimate of the effect of an accelerated intervention.

We believe that results the same as those we have achieved in this study can be obtained in all other orthopedic wards when implementing an accelerated perioperative care and rehabilitation intervention. Although the results have been demonstrated in 3 studies in 2 countries, it is still a great challenge to master a new multidisciplinary organization and a new multimodal intervention.

Contributions by authors

All authors have contributed to the planning, interpretation and revision of the manuscript. KL collected and analyzed the data.

No competing interests declared.

Brunenberg D E, van Steyn M J, Sluimer J C, Bekebrede L L, Bulstra S K, Joore M A. Joint recovery programme versus usual care: an economic evaluation of a clinical pathway for joint replacement surgery. *Med Care* 2005; 43: 1018-26.

Danish National Board of Health, Center for Evaluation and Health Technology Assessment. Evaluation of patient path for patients undergoing primary total hip or knee arthroplasty. Danish National Board of Health, Danish Centre for Evaluation and Health Technology Assessment, Copenhagen 2006.

Danish Orthopaedic Society: Guideline for primary hip arthroplasty. Hellerup, Denmark 2001.

Danish Orthopaedic Society: Guideline for knee arthroplasty. Preliminary report 2004.

Dowsey M M, Kilgour M L, Santamaria N M, Choong P F. Clinical pathways in hip and knee arthroplasty: a prospective randomised controlled study. *Med J Aust* 1999; 170: 59-62.

- Fransen M, Edmonds J. Reliability and validity of the Euro-Qol in patients with osteoarthritis of the knee. *Rheumatology* 1999; 38: 807-13.
- Husted H, Holm G, Sonne-Holm S. Reduced length of hospital stay after total hip and knee arthroplasty without increased utilization of other resources. *Ugeskr Laeger* 2004; 166: 3194-7.
- Husted H, Holm G, Rud K, Bach-Dal C, Hansen H C, Andersen K L, Kehlet H. Length of stay after primary total hip and knee arthroplasty in Denmark, 2001-2003. *Ugeskr Laeger* 2006; 168: 276-9.
- Kehlet H, Dahl J B. Anaesthesia, surgery, and challenges in postoperative recovery. *Lancet* 2003; 362: 1921-8.
- Kehlet H, Wilmore D W. Multimodal strategies to improve surgical outcome. *Am J Surg* 2002; 183: 630-41.
- Kehlet H, Wilmore D W. Fast-track surgery. *Br J Surg* 2005; 92: 3-4.
- Kim S, Losina E, Solomon D H, Wright J, Katz J N. Effectiveness of clinical pathways for total knee and total hip arthroplasty: literature review. *J Arthroplasty* 2003; 18: 69-74.
- Larsen K, Sørensen O G, Hansen T B, Thomsen P B, Søballe K. Accelerated perioperative care and rehabilitation intervention for hip and knee replacement is effective! *Acta Orthop* 2008; 79: 149-59.
- Lauritsen J M, Bruus M. EpiData 3.1. A comprehensive tool for validated entry and documentation of data. The Epi-Data Association, Odense, Denmark, 2003-2005.
- Manca A, Hawkins N, Sculpher M J. Estimating mean QALYs in trial-based cost-effectiveness analysis: the importance of controlling for baseline utility. *Health Econ* 2005; 14: 487-96.
- Milne A C, Potter J, Avenell A. Protein and energy supplementation in elderly people at risk from malnutrition. *Cochrane Database of Systematic Reviews* 2005, Issue 1. Art. No.: CD003288. DOI: 10.1002/14651858.CD003288.pub2.
- Pedersen K M, Wittrup-Jensen K, Brooks R, Gudex C. *Værdisætning af sundhed*. Syddansk Universitetsforlag, Odense 2003.
- Pedersen A B, Johnsen S P, Overgaard S, Soballe K, Sørensen H T, Lucht U. Total hip arthroplasty in Denmark: incidence of primary operations and revisions during 1996-2002 and estimated future demands. *Acta Orthop* 2005; 76: 182-9.
- Petersen M K, Madsen C, Andersen N T, Soballe K. Efficacy of multimodal optimization of mobilization and nutrition in patients undergoing hip replacement: a randomized clinical trial. *Acta Anaesthesiol Scand* 2006; 50: 712-7.
- Rasmussen S, Kramhoft M U, Sperling K P, Pedersen J H, Falck I B, Pedersen E M, Kehlet H. Accelerated course in hip arthroplasty. *Ugeskr Laeger* 2001; 163: 6912-6.
- Reilly K A, Beard D J, Barker K L, Dodd C A, Price A J, Murray D W. Efficacy of an accelerated recovery protocol for Oxford unicompartmental knee arthroplasty. A randomised controlled trial. *Knee* 2005; 12: 351-7.
- Szende A, Williams A. Measuring Self-Reported population Health: An International Perspective based on EQ-5D. EuroQOL Group, 2004.
- The StatBank Denmark (open database on the Internet). Statistics Denmark. 2006. (Cited 2006 June 27). Available from: <http://www.statistikbanken.dk/statbank5a/default.asp?w=1280>
- Unit of Perioperative Nursing Care (homepage on the Internet). Copenhagen: 2006. (updated 2006 May 24; cited 2006 July 3). <http://rh.dk/rh.nsf/Content/enhedforperiopeativsygepleje~ortopdkirurgi0~knoghoftealloplastik>
- Wilmore D W, Kehlet H. Management of patients in fast track surgery. *BMJ* 2001; 322: 473-6.