The benefit of modified rehabilitation and minimally invasive techniques in total hip replacement

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ABSTRACT

INTRODUCTION We wished to assess if an intensive rehabilitation regimen alone, or one combined with modified anaesthetic and surgical techniques, can change the speed of rehabilitation or the length of hospital stay after total hip replacement.

PATIENTS AND METHODS We compared 44 patients who had followed a traditional care pathway, with 38 patients who had rehabilitated under a new rehabilitation protocol, with 40 patients who had also received modified, minimally invasive techniques. The speed of rehabilitation was measured in terms of three specific milestones accomplished on the day after surgery.

RESULTS We found a statistically significant improvement in the day after surgery each activity was possible. The length of hospital stay was reduced from 6.5 days to 5.4 days to 4.1 days, a difference which was also statistically significant.

CONCLUSIONS The data support the view that a new rehabilitation protocol alone can reduce the length of hospital stay and hasten rehabilitation. The combination of modified anaesthetic and minimally invasive surgical techniques with the new rehabilitation regimen can further improve short-term outcome after total hip replacement.

KEYWORDS

Total hip replacement – Minimally invasive surgical procedures – Rehabilitation

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Total hip replacement (THR) is one of the most rewarding of surgical interventions. As a cost-effective procedure,¹ it improves the quality of life of many thousands of patients each year. Because of the large number of procedures performed, health managers have long tried to confine its costs, mainly by targeting implant selection and length of hospital stay,² without necessarily affecting the quality of the care provided.⁵

Surgical and anaesthetic techniques, in combination with postoperative care, have evolved greatly over the past 40 years and have significantly reduced the length of time patients spend in hospital, both before and after THR. Thirty years ago, a length of stay of 21 days was indicated for a primary procedure,⁴ a number that had gradually fallen to 10–12 days by the early 1990s.⁵ The advent of care pathways has further reduced this figure^{6,7} and a length of hospital stay of 5 days for an uncomplicated THR is currently considered as standard in many institutions.⁸

The introduction of minimally invasive hip surgery has once again targeted the length of stay, promising stays of as short as 24 h.⁹ It has been introduced in combination with new anaesthetic techniques and rehabilitation protocols,

which render it difficult to establish which part of the overall protocol is actually responsible for this reduction in length of stay. The purpose of this study was, therefore, to establish whether physiotherapy alone, or a combination of rehabilitation and clinical techniques, can improve rehabilitation after total hip replacement and/or reduce the length of stay.

Patients and Methods

Data were gathered on three groups of patients. The first group (A) comprised 44 patients who had undergone 49 THRs between October 2002 and May 2003. Pre-operative diagnosis was osteoarthritis for all patients. Data for this group were collected retrospectively through their medical files. Group A had rehabilitated following the care pathway, which was in use at our institution at that time. A care pathway follows a patient in the peri-operative period and dictates the exact actions for each day in every aspect of the nursing care. Our pathway (Table 1) adopted a 7-day length of stay.¹⁰

The second group (B) comprised 38 consecutive patients who underwent 40 THRs between July and December 2003.

Table 1 An example of a completed care pathway chart, which applied to the patients of group A: only that part dedicated to physiotherapy is shown**Postoperative day 1**

- ✓ Chest clear
- ✓ Circulatory exercises achieved
- ✓ Static quadriceps contraction achieved
- ✓ Static gluteal contraction achieved
- ✓ Inner range quads performed
- ✓ Active assisted hip–knee flexion 30° minimum
- ✓ Stand with frame
 - Sat out in chair
- ✓ Mobilised by physiotherapist

Postoperative day 2

- ✓ Circulatory exercises achieved
- ✓ Static quadriceps contraction achieved
- ✓ Static gluteal contraction achieved
- ✓ Inner range quads performed
- ✓ Active assisted hip–knee flexion 40° minimum
- ✓ Active hip–knee flexion 30° minimum
- ✓ Active assisted abduction 20° minimum
- ✓ Mobilised with frame in room with assistance
- ✓ Sitting to standing achieved with assistance
- ✓ Sat out in chair

Postoperative day 3

- ✓ Circulatory exercises achieved
- ✓ Static quadriceps contraction achieved
- ✓ Static gluteal contraction achieved
- ✓ Inner range quads performed
- ✓ Active assisted hip–knee flexion 40° minimum
- ✓ Active hip–knee flexion 30° minimum
- ✓ Active assisted abduction 20° minimum
- ✓ Mobilised with frame in room with assistance
- ✓ Sitting to standing achieved with assistance
 - Mobilised with elbow crutches and assistance

Postoperative day 4

- Isometric extension achieved
- ✓ Active assisted hip–knee flexion 60° minimum
- ✓ Active hip–knee flexion 50° minimum
- ✓ Active abduction with sliding board to 40°
- ✓ Mobilised with crutches ± assistance

Postoperative day 5

- ✓ Isometric extension achieved
- ✓ Active assisted hip–knee flexion 70°
- ✓ Active hip–knee flexion 60°
- ✓ Active abduction with sliding board to 40°
- Active exercises in standing taught
- ✓ Mobilise with crutches independently
 - Stairs achieved

Postoperative day 6

- ✓ Active assisted hip–knee flexion 70°
- ✓ Active hip–knee flexion 60°
- ✓ Active abduction with sliding board to 40°
- ✓ Active exercises in standing taught
- ✓ Mobilise with crutches independently
- ✓ Stairs achieved

Postoperative day 7

- ✓ Active hip–knee flexion 70°
- ✓ Active abduction with sliding board to 40°
- ✓ Active exercises in standing taught
- ✓ Stairs achieved independently
- ✓ Patient knows how to get in and out of car
- ✓ Performing exercises independently
- ✓ Home exercises performed and discussed

The diagnoses were osteoarthritis (37 patients; 39 THRs), and avascular necrosis (1 patient). Data for group B were collected prospectively. Patients in this group were mobilised postoperatively following a protocol of 20 exercises (Table 2), under physiotherapy supervision and starting on the first postoperative day. Each day, patients were encouraged to practise as many of these exercises as felt comfortable without strict guidelines. They were discharged home when they could undertake at least 85% of the protocol (17 out of the 20 activities) unless their medical condition dictated otherwise. Anaesthetic techniques and postoperative analgesia were the same for groups A and B

and included general, non-hypotensive anaesthesia, a patient-activated morphine pump for the first 24 h and oral medication thereafter, according to subjective pain.

The third group (C) comprised 40 consecutive patients who underwent 41 THRs between January and July 2004. Their diagnoses were osteoarthritis (39 patients; 40 THRs) and avascular necrosis (1 patient). Data were again collected prospectively. The anaesthetic technique, in addition to general, non-hypotensive anaesthesia, included a lumbar plexus block with 20–30 ml of ropivacaine or bupivacaine with epinephrine, delivered through a single injection. The duration of the block was 3–4 h and no morphine pump was

Table 2 An example of a chart completed by the physiotherapists according to the protocol, which was followed by the patients of groups B and C

	Day 1	Day 2	Day 3, etc.
Circulatory exercises	✓	✓	✓
Breathing exercises	✓	✓	✓
Bed mobility taught	✓	✓	✓
Gluteal and quadriceps exercises	✓	✓	✓
Assisted hip/knee flexion to 90°	✓	✓	✓
Stand with frame with assistance	✓	✓	✓
Sit out in chair	✓	✓	✓
Assisted bed exercises	✓	✓	✓
Walk with frame with assistance		✓	✓
Walk with crutches with assistance			✓
Independent with frame		✓	✓
Independent with crutches			
Walk into corridor		✓	✓
Standing exercise at wall bar		✓	✓
Practice step			✓
Practice stair			✓
Independent with bed exercises		✓	✓
Walking outdoors/uneven ground			
Walk circuit of ward			✓
In/out of bed independently			✓

used postoperatively. Oral analgesics were used after that period according to subjective pain, as for groups A and B. Specialised instrumentation for minimally invasive surgery was used and care was taken that the length of the incision did not exceed 10 cm whenever possible. Otherwise, there was no difference in the surgical technique used, in terms of muscle or bone handling. Patients in group C followed the same protocol postoperatively as those in group B but started their mobilisation the day of surgery.

All patients underwent surgery by the senior surgeon (RNV) through a posterolateral approach and received an uncemented socket (Duraloc [DePuy, Warsaw, Poland] in 24 THRs in group A; Trident [Stryker-Howmedica-Osteonics, Allendale, NJ, USA] in all remaining cases) and an uncemented, hydroxyapatite-coated stem (Accolade TMZF; Stryker-Howmedica-Osteonics). Postoperative routine antithrombotic prophylaxis was 75 mg of aspirin daily for 30 days. The medical condition of nine patients in group A and six in group B dictated enoxaparin as their antithrombotic agent.

Patients who were discharged to rehabilitation establishments were excluded from the study. This was the situation for one patient in each of the three groups, the reason being the lack of assistance at home. One patient in group B and

one in group C were originally scheduled for a resurfacing arthroplasty but had to be converted intra-operatively to a THR. These patients were also excluded. In two patients of group C, a local anaesthetic block was not feasible and they were also excluded from the series.

Body mass index (BMI) was used for the assessment of obesity. We recorded the duration of surgery, skin-to-skin, in minutes. For groups B and C, the length of incision in centimetres was recorded at the end of the procedure in the lateral decubitus position. Postoperative pain was subjectively assessed by patients in groups B and C every day using a visual analogue scale from 0–5 (0 indicating no pain and 5 unbearable pain) and the mean value during their in-hospital stay was recorded. In order to compare the three groups in terms of speed of rehabilitation, three functional milestones were chosen which were common to both protocols and which were considered essential for postoperative mobility after THR.^{8,11,12} These were walking with a frame with assistance (task 1), walking with crutches independently (task 2) and practising stairs (task 3). The three groups were thus compared in terms of the day after surgery on which each of these activities was possible. The lengths of stay in hospital were also recorded and compared.

Statistical analysis

Statistical analysis was performed with SPSS v11.5 for Windows statistical software (SPSS Inc., Chicago, IL, USA). Analysis of variance was used to compare mean values between the groups with a confidence interval of 95%, and the level of significance was set at $P = 0.05$. *Post-hoc* analysis with the Bonferroni test was used to identify the differences between the three groups. An independent-samples, two-tailed, *t*-test was used to compare the mean values of pain and incision size between groups B and C. The chi-squared test was used to find differences in the proportions of men and women between the groups.

Results

Group A contained 20 men and 24 women with a mean age of 68.7 years (95% CI, 65.9–71.5). Their mean BMI was 27.5 kg/m² (95% CI, 26.3–28.7) and the mean operating time 36.4 min (95% CI, 33.8–39.1). Group B contained 13 men and 25 women, with a mean age of 65 years (95% CI, 61.68.4). Their mean BMI was 26.9 kg/m² (95% CI, 25.6–28.1) and the mean operating time was 36.1 min (95% CI, 34.1–38.1). Group C contained 13 men and 28 women with a mean age of 67.8 years (95% CI, 64.5–71). Their mean BMI was 27.6 kg/m² (95% CI, 26–29.1) and the mean operating time was 41.7 min (95% CI, 38.8–44.5). There was no statistical difference found in the male:female ratio ($\chi^2 = 1.28$; $P = 0.52$), age ($F = 1.5$; $P = 0.22$), or BMI ($F = 0.33$; $P = 0.72$) between the groups rendering these three groups comparable. There was a significant difference in operating time ($F = 5.63$; $P = 0.005$) which, as shown with *post-hoc* analysis, was only detectable between group C and the other two groups, suggesting that minimally invasive techniques needed more time.

The mean length of incision was 13.9 cm for group B (95% CI, 12.9–14.9) and the median was 13.5 cm. In group C, the mean length of incision was 10.90 cm (95% CI, 9.9–11.96) and the median 10 cm. The pain scores were 2.2 (95% CI, 2–2.4) and 1.9 (95% CI, 1.6–2.1), respectively. Both differences were statistically significant ($t = 4.36$, $P < 0.0001$ for mean incision length; $t = 2.1$, $P = 0.039$ for the pain score).

Patients in group A managed task 1 at a mean of 2.1 days (95% CI, 2–2.2) after surgery, task 2 at 4.6 days (95% CI, 4.3–4.9) and task 3 at a mean of 4.9 days (95% CI, 4.5–5.2). Patients in group B managed task 1 at 1.4 days (95% CI, 1.3–1.6) after surgery, task 2 at 2.7 days (95% CI, 2.4–3) and task 3 at 3.9 days (95% CI, 3.6–4.3). Patients in group C managed task 1 at 0.6 days (95% CI, 0.56–0.8), task 2 at 2.2 days (95% CI, 1.8–2.7) and task 3 at 2.8 days (95% CI, 2.4–3.3). These differences were statistically significant ($F = 117.7$, $P < 0.0001$ for task 1; $F = 56.35$, $P < 0.0001$ for task 2; $F = 27.98$, $P < 0.0001$ for task 3).

Post-hoc analysis showed that, for task 1, significant differences existed both between groups A and B ($P < 0.0001$) and groups B and C ($P < 0.0001$). This suggested that the benefit of earlier mobilisation attained by the new rehabilitation regimen was further enhanced by the use of a reduced incision and a modified anaesthetic protocol. For task 2, however, a significant difference existed only between groups A and B ($P < 0.0001$) and not between groups B and C ($P = 0.16$). This suggested that our minimally invasive protocol had only a small influence on the ability of patients to mobilise after THR. Finally, for task 3 the difference was greater between groups B and C ($P < 0.0001$) than between groups A and B ($P = 0.002$) showing that the ability to climb stairs was improved by our new regimen, and even more so by the minimally invasive protocol.

Group A had a mean hospital stay of 6.5 days (95% CI, 6–6.9), group B a mean stay of 5.4 days (95% CI, 5.1–5.8) and group C 4.1 days (95% CI, 3.5–4.6). These differences were significant ($F = 30.35$, $P < 0.001$) with a greater degree of significance between groups B and C ($P < 0.0001$) than between groups A and B ($P = 0.003$).

There were no intra-operative or in-hospital complications in either group. In group A there was one dislocation, which was reduced closed. In group B there were two dislocations reduced closed, one superficial infection which was treated in another institution with surgical debridement and antibiotics and one deep-vein thrombosis. In group C there were two dislocations, one of which had to be revised because of subsidence of the femoral component.

Discussion

The concept of minimally invasive hip replacement is a recent arrival in orthopaedics. It aims to reduce surgical trauma, facilitate patients' recuperation, reduce length of hospital stay and improve patient satisfaction and the procedure's cost-effectiveness. However, it has been practised in combination with modified anaesthetic and analgesic techniques and new rehabilitation protocols. It is, therefore, difficult to distinguish which of the new techniques, if not all, is of benefit to the patient. This problem has already been highlighted by Lieberman¹³ and Callaghan.¹⁴

Postoperative rehabilitation after THR has traditionally followed strict guidelines, which dictated the accomplishment of specific milestones each day after surgery.^{15,16} However, patients often surprise their surgeons by a faster-than-expected mobilisation. Moreover, the importance of an intensive rehabilitation regimen for better, early, functional outcomes after hip surgery has already been shown.^{17,18} We wished to establish if a new rehabilitation programme, alone or in combination with a new minimally invasive protocol, would hasten rehabilitation and/or reduce length of stay. We found that such a protocol did improve our patients' rehabilitation, and

reduce their length of hospital stay. These parameters were further improved with the introduction of minimally invasive techniques. However, we believe that a small incision alone is not capable of affecting short-term outcomes after THR; anaesthetic techniques and pain management are also critical and may be more important than incision size.

Munin *et al.*,¹⁹ in a randomised controlled trial, also concluded that patients who underwent a total hip or knee replacement were able to tolerate an early intensive rehabilitation programme safely. This yielded a faster achievement of short-term functional milestones. Dorr²⁰ has also recently reported his experience with a mini posterior technique. He concluded: 'the most important factors allowing early discharge include patient selection, patient motivation, anaesthesia and pain management techniques and the postoperative protocol'.

Evidence thus now exists that the size of incision alone does not influence the rehabilitation or discharge time of patients who have undergone a total hip replacement. Asayama *et al.*²¹ found no difference in hospitalisation time or speed of rehabilitation between patients operated through a mini-anterior or a conventional anterior approach. Similarly, Woolson *et al.*²² have recently reported that there was no difference in the length of hospital stay or a patient's condition after discharge between those who received a mini posterior or a standard posterior incision at THR.

Those authors who have reported a decreased hospitalisation time and/or an accelerated rehabilitation with the use of minimally invasive hip surgery have all used a modified peri-operative protocol.^{9,23,24} Those who did not change their regimens failed to report a difference.²⁵⁻²⁸ For example, Duwelius *et al.*⁹ reported their experience in four different institutions with a two-incision, minimally invasive technique. They used modified peri-operative protocols and reported a reduced length of stay but their series was a selected fraction of their standard practice, comprising younger, slimmer and highly motivated individuals. Goldstein *et al.*,²⁶ who did not change their peri-operative regimen, found no difference in speed of rehabilitation or length of stay between a mini- and a conventional incision, although the patients in their mini-incision group had a lower BMI than those who received a conventional incision. Pavone *et al.*,²⁷ in a prospective study of two groups of patients with a mini-posterior and a conventional incision found the same when both groups followed an identical peri-operative protocol.

Conclusions

The data support the view that an intensified rehabilitation and modified operative regimen can reduce length of stay and hasten the achievement of short-term functional milestones after total hip replacement. We believe that the use of similar protocols is responsible for the results

reported for mini-incision techniques, rather than the surgical techniques themselves.

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