Accelerated rehabilitation after total knee replacement

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Received 31 August 2004; accepted 20 November 2004

Abstract

This study records the length of hospital stay of 50 total knee arthroplasty patients involved in an accelerated postoperative rehabilitation protocol, and a control group of patients undergoing routine rehabilitation. This protocol involved modifications to normal knee replacement procedure, including infiltration of bupivacaine and adrenaline to the divided tissue layers at the time of surgery, spinal anaesthesia, and mobilisation on the day of surgery. These modifications were combined with an organised multidisciplinary approach anticipating issues that may delay discharge. In addition, patients and hospital staff were encouraged to expect an earlier discharge from the hospital. The mean length of hospital stay after surgery was reduced to 3.6 (S.D. 1.0) days, from a previous departmental average of 10.5 days. The control group inpatient stay was 6.6 (S.D. 2.6) days. Plasma bupivacaine levels were found to be well within safe levels, and pain records indicated that the protocol did not cause increased levels of discomfort. American Knee Society and Oxford knee scores demonstrated good levels of knee function at 6 weeks post surgery. In addition, it was noted that no postoperative blood transfusions were required. This is regarded as a significant further benefit.

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Keywords: Total knee replacement; Rehabilitation

1. Introduction

Functional recovery and speed of return to independent living after total knee replacement may be improved by an earlier discharge from the hospital [1,2]. There may also be a reduced incidence of thromboembolic complications [3] and hospital acquired infection, and the financial burden to the hospital is lessened because hospital beds are required for shorter periods [2].

An audit of inpatient stays after 91 total knee replacements in our department revealed that patients were being discharged after a mean hospital stay of 10.5 days, which is comparable with published data on lengths of hospital stay after knee replacement surgery [4,5].

It was observed that a patient’s discharge from the hospital might be delayed for several reasons, including the expectation of the patients, surgeons, physiotherapists, occupational therapists, and nurses that a normal discharge time was approximately 7–10 days post operation. Discharge was also frequently delayed by hospital transport, delays in supplying aids to the patient’s homes, and the prescription of discharge medication not being completed in good time. In addition, it was observed that the normal practice of delaying patient mobilisation until the day after surgery may slow the rehabilitation and the recovery of independent mobility. It was thought that enabling earlier mobilisation may more rapidly restore a patient’s confidence in their ability to perform normal activities without assistance.

This study tested the hypothesis that significant reductions in the length of hospital stay could be achieved if each stage of a patient’s treatment with total knee replacement could be optimised to hasten discharge. A multidisciplinary approach including all staff involved with the care of patients undergoing knee replacement surgery was undertaken to address these issues.
2. Methods

2.1. Subjects

Every patient admitted for routine primary total knee replacement under the care of the senior author (P.G.) over an 11-month period was included in this study. No other selection or exclusion criteria were employed. A total of 50 patients (30 female) underwent 51 total knee replacements (one patient underwent a staged bilateral procedure) using the accelerated rehabilitation protocol. The mean patient age was 72.3 (S.D. 9.9) years (range 50–88 years).

2.2. Control subjects

The lengths of inpatient stay of a control group of 80 patients undergoing routine total knee replacement during the same period as the study group, but without undergoing the accelerated rehabilitation protocol, were recorded. The control patients were under the care of four other consultant orthopaedic surgeons, and were treated at the same hospital as the patients undergoing accelerated rehabilitation. The control group mean patient age was 71.3 (S.D. 8.1) years (range 42–84 years).

2.3. Outcome assessment

American Knee Society scores [6] and Oxford functional rating scores [7] were recorded preoperatively, and then at 6 weeks post surgery, for a subgroup of 23 randomly selected subjects undergoing the accelerated rehabilitation protocol. Range of motion of the knee was also recorded at 6 weeks post surgery.

2.4. Postoperative pain assessment

Eight patients undergoing the rapid rehabilitation protocol and eight control patients undergoing standard rehabilitation were randomly selected to undergo pain assessment using a visual analogue scale, graded 0–10 (10=most pain). These subjects were asked to record their pain levels prior to surgery, each day for 1 week post surgery, and once at 2 weeks post surgery.

2.5. Accelerated rehabilitation protocol

2.5.1. Preoperative considerations

The patients were reviewed in a combined preassessment clinic with members of the surgical team, physiotherapists, occupational therapists, and nursing staff. Patient education regarding a more rapid rehabilitation and return home was instituted, and patients were encouraged to arrange their own transport home with family or friends in good time. Home circumstances, mobility requirements, and social issues that may delay discharge from hospital were noted, and measures were taken to address these prior to arrival in hospital. It was intended that all patients should be discharged to their own home and without the requirement for a home carer, rather than an intermediate care facility.

Routine preoperative laboratory investigations (including full blood count) were arranged, and appropriate microbiology swabs and samples were sent for analysis.

The patients were admitted the evening prior to surgery, and daily low molecular weight subcutaneous heparin (enoxaparin sodium, 40 mg) was commenced. Anti-embolic compression stockings were prescribed.

A postoperative analgesic regimen was prescribed preoperatively in readiness for the patients’ requirements. This regimen was tramadol hydrochloride, 50 mg tds, pm; diclofenac sodium, 75 mg, bd; and paracetamol, 1 g, qds. Aspirin, 75 mg, od, was prescribed for 6 weeks postoperatively as anti-embolic prophylaxis. A regular anti-emetic (prochlorperazine or cyclizine) and lansoprazole were also prescribed.

2.5.2. Anaesthetic technique

All subjects received a spinal anaesthetic of bupivacaine and diamorphine, and were conscious throughout the procedure. Intravenous ketorolac and an antiemetic were administered. Light sedation was occasionally used.

2.5.3. Operative technique

All total knee replacements were carried out by, or under the direct supervision of, one consultant orthopaedic surgeon (P.G.). The prosthesis used was either the Scorpio single axis total knee system (Stryker Corporation, Kalamazoo, Michigan, USA) in six patients, or the AGC knee (Biomet, Warsaw, Indiana, USA) in the remaining patients. All implants were cemented.

Knee replacement was performed in a standard manner, with an intramedullary guide rod used for femoral component alignment, and an extramedullary guide used for the tibial component. The procedure was performed under tourniquet control, until a point just prior to insertion of the cement. At this stage, the divided layers of the wound were infiltrated with 80 ml of bupivacaine 0.25% with 1:200,000 adrenaline. This was administered to reduce postoperative pain and bleeding.

The cement and prostheses were then inserted, and the tourniquet released prior to closure. No drains were used. Wound closure was achieved with absorbable “vicryl” sutures and skin closure with a continuous subcuticular suture. A light gauze, cotton wool, and crepe dressing was applied.

2.5.4. Postoperative considerations

2.5.4.1. Day of operation. No epidurals were used. The patients were mobilised using a walker frame at approximately 4 h post-op, under physiotherapist supervision. Straight leg raising exercises were encouraged, and a pillow was placed under the heel of the operated leg to allow the
knee to rest in a fully extended position. Intravenous patient-controlled analgesia (PCA) systems were commenced for overnight analgesia.

2.5.4.2. First postoperative day. The postoperative haemoglobin level was measured. The dressing was reduced to a light non-adherent dressing. The PCA was discontinued, but only after commencement of the pre-prescribed analgesic regimen, to ensure that pain levels were well controlled throughout the recovery period. Regular anti-emetics were continued, and the patients underwent further range of motion, quadriceps, and hamstrings exercises. Walking with a frame was continued.

At this point, discharge medication was prescribed to ensure that the patient was not delayed because of waiting for the pharmacy to dispense their medication.

2.5.4.3. Second postoperative day. The patients continued to walk with the assistance of a frame or walking sticks.

2.5.4.4. Third and subsequent postoperative days. The patients were encouraged to climb steps and, in keeping with departmental policy after routine total knee replacement, were only discharged home when able to walk safely with two sticks and climb stairs independently. No patients were discharged until the physiotherapists and occupational therapists were confident that the patient would be safe in their home without the need for home assistance or carers. The day of discharge was recorded.

2.5.4.5. Post discharge management. A home visit from the district nurse was arranged on the first day after discharge to ensure that the patient had not encountered any difficulties. Physiotherapists visited on the second and seventh post discharge day. The patients were reviewed in the outpatient clinic at 2 and 6 weeks.

2.6. Control (standard rehabilitation) protocol

The control group attended preassessment clinics managed by the same non-surgical staff as those involved in the accelerated rehabilitation programme. The control patients were therefore exposed to a similar highly organised approach to arranging occupational therapy and social support requirements. The remaining aspects of the control group inpatient stay were not influenced by the accelerated rehabilitation protocol. Knee replacement surgery was performed without the infiltration of local anaesthetic and adrenaline, patients were not mobilised on the day of operation, and physiotherapists did not make home visits following discharge.

2.7. Plasma bupivacaine levels

The Medical Toxicology Unit in London has advised that adverse effects of bupivacaine have been observed in patients with a plasma bupivacaine concentration of 4 mg/l and above. To ensure that the infiltration of the wound with 80 ml of 0.25% bupivacaine (200 mg) did not result in plasma levels exceeding 4 mg/l, the plasma bupivacaine levels of five randomly selected subjects undergoing the rapid rehabilitation protocol were assessed immediately after tourniquet deflation, and at 2, 4, 12, 24, and 48 h postoperatively. Two subjects did not undergo plasma level assessment at 48 h.

3. Results

All results refer to those recorded from the group of patients undergoing accelerated rehabilitation, unless otherwise indicated.

3.1. Duration of hospital stay

The control group of patients were discharged at a mean of 6.6 (S.D. 2.6) days after surgery, and patients undergoing accelerated rehabilitation were discharged at a mean of 3.6 (S.D. 1.0) days after surgery. This represents a reduction in the length of hospital stay in both groups of patients, but more so in the accelerated group (unpaired t-test accelerated versus control groups, \( P < 0.001 \)).

3.2. Discharge delays and complications

All patients were discharged to their own homes. No patients required home carers. One patient had one’s stay extended for 1 day due to a delay in equipping the home with appropriate mobility aids. Another patient’s stay was extended to 7 days due to a delayed recovery in renal function. Three patients had their stay extended due to the planned discharge date falling on a bank holiday, resulting in the reduced availability of physiotherapy. Two patients were readmitted to hospital with suspected deep vein thrombosis (DVT). Subsequent duplex ultrasound scanning demonstrated no DVT. One further patient was readmitted with failure to cope at home, and with associated leg and ankle pain. Investigations did not identify a specific cause for this.

3.3. Blood loss

The mean preoperative haemoglobin level was 13.7 (S.D. 1.6) g/dl. The mean post operative haemoglobin level was 10.7 (S.D. 1.3) g/dl. No patients required blood transfusion.

3.4. Functional outcome assessment

Preoperatively, the mean American Knee Society score was 94 (S.D. 23), and the mean Oxford functional rating score was 40 (S.D. 7.3). At 6 weeks post surgery, the American Knee Society score had increased to 128 (S.D. 348 D. Isaac et al. / The Knee 12 (2005) 346–350
26.3), and the Oxford score had fallen to 28 (S.D. 7.6), both indicating a significant improvement in function (paired \( t \)-test, \( P<0.001 \)). Mean active range of knee motion at 6 weeks post surgery was recorded as 2\(^\circ\) (S.D. 6.8\(^\circ\)) to 106\(^\circ\) (S.D. 10.1\(^\circ\)).

3.5. Pain levels

All eight accelerated rehabilitation patients who were asked to provide visual analogue scores of their post-operative pain levels returned completed pain records. Completed pain scores were obtained from five of the eight patients in the control group who were asked to record pain scores. The remaining three records were not obtained due to difficulties in following up the control group after discharge from hospital.

The numbers of patients submitting records of pain levels were insufficient to allow statistical comparison of the pain levels between the accelerated rehabilitation and control groups. It was observed, however, that pain levels in the accelerated rehabilitation group were lower than those in the control group (Fig. 1). These data indicate that accelerated rehabilitation does not produce excessive pain.

3.6. Plasma bupivacaine levels

The plasma concentration of bupivacaine in the five subjects tested reached a maximum level of 1.02 mg/l (Fig. 2), recorded in one subject. This indicates that the infiltration of 200 mg of bupivacaine with adrenaline was safe, resulting in plasma levels well below the range associated with toxic effects.

4. Discussion

This study has demonstrated that careful attention to several aspects of inpatient care can reduce the length of stay following total knee replacement. While several studies have demonstrated that modifications to care pathways can significantly reduce inpatient stay after total knee replacement [1,2,4,8], none has demonstrated mean stays as low as the 3.6 days reported here.

In keeping with previously published data [1,8,9], we observed no evidence of an increased complication rate. The readmission rate of 5.9% compares favourably with other published readmission rates which can reach 18% over a 12-month period for all knee replacement-related morbidity [10]. Two of the three readmissions were arranged soon after discharge by the visiting district nurse to allow rapid investigation of suspected deep vein thromboses. No thromboses were detected. It is likely that the attending district nurse was unfamiliar with the relatively swollen appearance of legs at an early stage after total knee replacement, which may resemble the signs of a deep vein thrombosis. The accelerated rehabilitation protocol has been continued at this hospital after the period detailed in this study, and during the last 12 months there have been no further readmissions. This may demonstrate that community staff are now becoming familiar with the typical presentation of limbs following total knee replacement.

Although each factor incorporated in the rapid rehabilitation protocol was not studied independently, it is the opinion of the authors that changing the expectations of patients and hospital staff plays a significant role in reducing the length of hospital stay. It is noteworthy that both the...
accelerated rehabilitation group and the control group achieved a reduction in the length of stay compared to patients prior to the commencement of this study. Both groups of patients were being rehabilitated by staff members who were learning that patients could be safely discharged at an earlier date than previously expected.

It is also thought that the administration of local anaesthetic and adrenaline to the surgical wound prior to cementation of the prosthesis contributes to the rapid rehabilitation observed here. Local anaesthetic infiltration and the subsequent early mobilisation are the features of the inpatient treatment of the accelerated rehabilitation group that differs most notably from the control group. The protocol negates the requirement for postoperative epidural anaesthesia, and hence allows the patient to mobilise without pain on the day of the operation. This increases the patient’s confidence in their ability to mobilise and, we believe, hastens their rehabilitation. Mobilisation on the day of surgery has previously been reported after unicompound knee replacement, and was believed to contribute to a short hospital stay [11].

The reduction in postoperative bleeding due to the infiltration of adrenaline has avoided the requirement for blood transfusion in every case. This is of great significance when compared with reported blood transfusion rates after unilateral knee arthroplasty of approximately 8–11% [12,13]. Indeed, a review of the literature reveals no other studies demonstrating a blood transfusion rate of zero following total knee replacement, even after the introduction of strategies to reduce transfusion requirements. Such a finding has significant cost and health implications.

Upon review in the outpatient clinic, enquiries confirmed that the patients were happy with the early discharge home and level of support they received. Significant improvements in the American Knee Society and Oxford knee scores were demonstrated, and knee motion at 6 weeks post surgery compares favourably with results published elsewhere [14].

One potential advantage of early discharge from hospital is a reduction in the overall cost of treatment. It must be noted that the accelerated rehabilitation protocol employed here involves two home visits from the physiotherapists. The control group did not receive home physiotherapy. At the present time, the contribution of such a practice to a successful outcome following early discharge is unclear. The potential financial savings due to early discharge may be reduced by the cost of providing more intensive community treatment. It should be noted that the physiotherapists involved in the rehabilitation of the accelerated patients have observed that this group did not require a greater duration of physiotherapy to achieve satisfactory range of motion than the control group, although specific data were not recorded.

In conclusion, this study has demonstrated that an organised multidisciplinary approach combined with relatively minor modifications to surgical and anaesthetic technique can successfully and safely reduce the length of inpatient stay after total knee replacement.

References