Enhanced recovery in total hip replacement
A CLINICAL REVIEW


From University College Hospital, London, United Kingdom

The outcome after total hip replacement has improved with the development of surgical techniques, better pain management and the introduction of enhanced recovery pathways. These pathways require a multidisciplinary team to manage pre-operative education, multimodal pain control and accelerated rehabilitation. The current economic climate and restricted budgets favour brief hospitalisation while minimising costs. This has put considerable pressure on hospitals to combine excellent results, early functional recovery and shorter admissions.

In this review we present an evidence-based summary of some common interventions and methods, including pre-operative patient education, pre-emptive analgesia, local infiltration analgesia, pre-operative nutrition, the use of pulsed electromagnetic fields, peri-operative rehabilitation, wound dressings, different surgical techniques, minimally invasive surgery and fast-track joint replacement units.

Cite this article: Bone Joint J 2013;95-B:1587–94.

Total hip replacement (THR) effectively improves quality of life in patients with osteoarthritis of the hip when non-operative treatment has failed. According to the 2012 Annual Report of the National Joint Registry (NJR) for England and Wales, 71 672 primary THRs were undertaken in 2011, an increase from just over 56 000 in 2005. Since the 1990s, various multimodal techniques to improve recovery and the outcome after surgery have been developed. Several terms have been coined for this, including ‘fast track’, ‘rapid recovery’ and ‘enhanced recovery programme’ (ERP).

In 1997 an approach to promote rehabilitation with an ERP was developed for colorectal surgery in Copenhagen, and it was subsequently adopted for orthopaedic patients. Significant reduction in patient morbidity and mortality and length of stay following THR can be achieved by using an ERP. Hospitals in the United Kingdom have also implemented fast-track protocols.

In this review we provide an evidence-based summary of measures and interventions that may help accelerate recovery and reduce length of stay in association with better functional outcomes following THR.

Materials and Methods
We conducted a search of electronic healthcare databases including MEDLINE, EMBASE, AMED and the Cochrane library to include studies published during the last ten years. Web of knowledge was also searched extensively. We used the following keywords: ‘enhanced recovery’, ‘accelerated recovery’, ‘fast track’, ‘rapid recovery’, ‘total hip replacement’ and ‘total hip arthroplasty’. All studies concerning ERPs and THR were included and papers not published in English were excluded.

Results
Various interventions can be employed and integrated into a clinical pathway.

Non-surgical interventions
Pre-operative patient education. This process claims to enhance early recovery and discharge from hospital by making patients active participants in their recovery and helping them to manage their expectations. This improves patient-reported outcome measures (PROMs), as unmet expectations result in dissatisfaction. A discrepancy between the expectations of the patient and surgeon was shown in a comparative study, which investigated the ability of patients to engage in athletics after THR – with higher expectations of activity reported by patients. Individual pre-operative teaching, either by telephone or in person, can reduce length of stay in patients undergoing THR by one day.

A randomised controlled trial (RCT) comparing pre-operative multidisciplinary standardised
information sessions with routine verbal information provided to patients in clinics found a pre-operative reduction in anxiety and pain in those receiving the briefing, but no statistical difference post-operatively (p = 0.18 and p = 0.07 for anxiety and pain, respectively) when compared with conventional protocols.13 Daltry et al14 showed that pre-operative educational preparation reduced length of stay and post-operative medication and anxiety. A further study investigated the value of pre- and post-operative education combined with home visits in comparison with a control group receiving ‘conventional’ rehabilitation.15 The study group had a significantly reduced length of stay by almost four days, and achieved better Oxford hip scores.16

Pre-operative education can be effective in reducing length of stay, but the costs of implementing a multidisciplinary pathway may initially increase. Estimates of hospital costs vary nationally and internationally, but reducing the length of stay by a day could save approximately £260 per surgery as part of their ERP, which reduced length of stay to a mean of 5.3 days compared with 8.3 days for the non-ERP patients. They adopted a policy of reduced fasting time to between two and three hours. If fasting for six hours was required, then they preloaded the patient with carbohydrate.

Pre-emptive analgesia. Pain and impairment of function are the main indications for THR.38 Understandably, post-operative pain reduces patient satisfaction,39,40 although this effect is greater in the long-term.41 Pain can also delay mobilisation and return of function.42,43 There are, however, mixed reports on the effect of pain and analgesia on length of stay. Although a significant reduction in length of stay has been reported following better pain management,44 this is not found universally.45

Understanding the physiology of pain is key to its successful management in this setting.46-48 The concept of administering analgesia before an injury as being more effective than the same analgesia given after injury has been termed ‘pre-emptive analgesia’.49 Unfortunately studies in this area are affected by many confounding factors.50

Intravenous opiates slow rehabilitation and reduce patient satisfaction.51 One strategy is to avoid the use of opioids altogether, using non-steroidal anti-inflammatory drugs (NSAIDs) as an alternative.52,53 NSAIDs, however, have drawbacks, including inhibition of bony anabolism, adverse effects on renal function, platelet dysfunction and gastric ulceration.52,54,55 These risks, and the risk of cardiac failure, especially in those with pre-existing cardiac pathology, must be carefully considered before treatment.56,57 The evidence for the use of NSAIDs in pre-emptive analgesia is now in doubt as a large body of research has been retracted.
by authors who had provided the initial evidence as to the efficacy of NSAIDs in this context.\textsuperscript{53,58} Lunn et al\textsuperscript{59} showed that a high pre-operative dose of methylprednisolone helped to reduce pain in the first 24 hours following surgery, but this had no bearing on rehabilitation or discharge.

**Local infiltration analgesia (LIA).** This form of treatment involves the intra-operative infiltration of drugs, which may be followed by boluses administered post-operatively using an intra-articular catheter.

Kerr and Kohan\textsuperscript{60} first developed LIA as part of a multimodal pain management and early mobilisation protocol after joint replacement. They reported good pain control and fewer narcotic side effects after THR, allowing mobilisation within four to six hours of surgery and discharge after an overnight stay. Kang et al\textsuperscript{58} randomly allocated patients undergoing total knee replacement for hip fracture into two groups, one receiving pre-emptive analgesia and LIA, and one without LIA. The patients in the former group had significantly less pain between days one and four, but no difference could be detected between the groups by day seven. The LIA group also had an overall reduction in opioid use and increased in satisfaction on discharge.\textsuperscript{58} Others have reproduced similar results,\textsuperscript{7} although some studies reported no convincing evidence to suggest that LIA reduces length of stay.\textsuperscript{61-63} This is further in contrast to a study by Andersen et al\textsuperscript{64} showing that it produced a significant reduction in length of stay.

In randomised studies, intra-operative LIA does seem to be effective for the first six to 12 hours in reducing pain and analgesic requirements.\textsuperscript{61-66} An RCT comparing LIA with placebo concluded that LIA provided no additional reduction in pain after THR when combined with a multimodal oral analgesic regimen of paracetamol, celecoxib and gabapentin.\textsuperscript{65} These results were also replicated in another RCT involving patients who underwent bilateral THR using an ERP.\textsuperscript{66} However, when LIA was used alone versus placebo in an RCT, it was found that pain scores were similar in both groups, but with less morphine consumption post-operatively in the LIA group.\textsuperscript{67} LIA versus epidural infusion produced similar pain relief, with a significant reduction in narcotic consumption in the former group (p = 0.004) and a reduction in mean length of stay by two days (p < 0.001).\textsuperscript{68} LIA had similar pain relief but less nausea and vomiting than intrathecal morphine.\textsuperscript{68} The use of a wound catheter to inject local anaesthetic boluses post-operatively shows promising results.\textsuperscript{64,68,69}

Different regimens for LIA are described in the literature, with different anaesthetic agents and doses being used (Table I).\textsuperscript{61-66}

**American Society of Anesthesiologists (ASA) grade.** A study comparing patients undergoing THR with an ERP to a group with conventional recovery showed that reduction in length of stay was greater in ASA grade 1\textsuperscript{70} patients, with the mean length of stay reduced from 5.0 days to 3.2 days (p < 0.001).\textsuperscript{71} Dwyer et al\textsuperscript{20} found similar benefits in the recovery for patients of ASA grades 1 and 2 compared with those of grade 3. Another study examining predictors of length of stay in a heterogeneous group of patients who underwent either total knee replacement (TKR) or THR involved in an ERP, reported that the probability of those of ASA grades of 1 and 2 staying fewer than three days in hospital was 60% and 20%, respectively, compared with ASA grade 3 patients.\textsuperscript{72}

**Pulsed electromagnetic fields (PEMF).** PEMF is a safe and non-invasive modality used to facilitate the repair and growth of bone and to reduce inflammation by acting as an adenosine agonist on the A2a receptors of inflammatory cells.\textsuperscript{73,74} This provides a strong anti-inflammatory effect and can reduce joint swelling, the need for NSAIDs to control pain, and the time to recovery. This approach to treatment is well accepted by patients.\textsuperscript{73,75}

There is a little evidence to demonstrate the effect of PEMF following TKR.\textsuperscript{75} An RCT on patients who had undergone revision THR showed that PEMF helped improve functional recovery and restore bone stock.\textsuperscript{74} In 1988 Heylings and McMllin\textsuperscript{76} reported the use of PEMF pre-operatively in improving pain and function in patients awaiting THR. They found that all patients who had three or more sessions of PEMF and an increased degree of mobility had better pain relief, used fewer analgesics and suffered less disturbed sleep. They advocated the use of this ‘non-invasive’ and ‘non-toxic’ form of treatment to increase movement and fitness prior to surgery, with the aim of accelerating recovery.

**Peri-operative rehabilitation programmes.** A multidisciplinary team approach including surgeons, anaesthetists, physiotherapists, occupational therapists and, most importantly, the patient, is essential.\textsuperscript{8} These practices have been developed since the 1990s,\textsuperscript{77} and in 2002 Kehlet and Wilmore\textsuperscript{78} described grouping together the various strategies to improve surgical outcome. Malviya et al expanded on this by introducing behavioural, pharmacological and procedural modifications to the original programme, with improved outcomes. The modifications include: detailed patient and staff education on the principle of “enhanced recovery”, the use of gabapentin and dexamethasone pre-operatively, same day mobilisation, low dose spinal anaesthesia and the use of tranexamic acid at induction. Peri-operative rehabilitation has been shown to reduce length of stay even in patients with ASA grade 3, a pre-operative Hb level of < 14 g/dl and a of BMI > 30 kg/m\textsuperscript{2}.\textsuperscript{20}

Highly organised and structured multidisciplinary teams will be more likely to see enhanced recovery and reduced length of stay following TKR and THR.\textsuperscript{79} Larsen, Hansen and Soballe\textsuperscript{80} supported these results specifically for THR with a mean reduction in length of stay of 3.1 days, and found significant improvement in health-related quality-of-life scores (p = 0.02).

There has been a call to change the focus to early and more intensive physiotherapy after THR,\textsuperscript{81} despite a systematic review in 2009 concluding that there was...
insufficient evidence to support this.82 Many studies have, however, shown that the length of stay can be reduced by the use of coordinated peri-operative rehabilitation programmes (Table II),7,9,20,79,83,84 although a review on the impact of pre-operative rehabilitation on the elderly found little information,85 leading to uncertainty whether physical function, quality of life and surgical outcomes are improved as a consequence.

### Post-operative hip precautionary measures

In a prospective RCT, unrestricted patients in an early rehabilitation group did not use a pillow between the legs while supine or sleeping on their side, were allowed to ride in a car, sit on a seat and lavatory of normal height and sleep in any position. These patients were compared with matched patients using standard rehabilitation with all precautions. There were no dislocations in either group, but the unrestricted patients recovered faster.86 Physical aids and precautions cost approximately $655 more per patient.87 Others have found it safe to omit the restrictions following the anterior and anterolateral approaches, and no increase in the incidence of early dislocation in 2612 hips was reported, with a 0.15% (four hips) rate of dislocation at a mean of five days (3 to 12) post-operatively.88 Mauerhan et al89 found a correlation between reduced length of stay and a higher rate of dislocation (r = 0.629; R^2 = 0.40; p = 0.13) after adopting pathways to reduce length of stay.

### Dressings

Dressings protect healing tissue, allow wound assessment, absorb exudates and ease pain.90 Concerns have been raised following the use of traditional adhesive dressings with regard to the short time required for them no longer to function properly, the high frequency of changes of dressing and blistering.91 The National Institute for Health and Clinical Excellence (NICE) guidelines report that no evidence has been found to support one dressing over another, but they recommend an island-interactive dressing.90 In a prospective audit of 100 patients comparing two types of dressing as part of an ERP in a district hospital, the use of conventional adhesive dressings resulted in significantly more dressing changes than the modern plastic film dressing with an inbuilt absorbent pad.91 The latter was also associated with significantly less blistering. In this matched group of patients there was

---

### Table I. Various local infiltration analgesia (LIA) regimes for total hip replacement (THR) in the literature (PCA, patient-controlled analgesia; LOS, length of stay)

<table>
<thead>
<tr>
<th>Authors</th>
<th>Design</th>
<th>Intervention</th>
<th>Control</th>
<th>Results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lunn et al61</td>
<td>n = 120. Placebo-controlled. Intra-operative LIA vs saline</td>
<td>150 ml ropivacaine 0.2% + adrenaline 1.5 mg + multimodal oral analgesic regimen</td>
<td>150 ml saline infiltration + multimodal oral analgesic regimen</td>
<td>No difference between groups in terms of pain scores during walking (p = 0.71) and opioid consumption (p = 0.45)</td>
<td>Double-blind, placebo-controlled study. Well-defined assessments. No comment on LOS between groups</td>
</tr>
<tr>
<td>Specht et al65</td>
<td>n = 60. Intra- and post-operative LIA infiltration vs intra-operative LIA alone</td>
<td>102 ml: 200 mg ropivacaine + 30 mg ketorolac + 1 mg adrenaline, ×2 further boluses after 10 and 22 hrs</td>
<td>102 ml: 200 mg ropivacaine + 30 mg ketorolac + 1 mg adrenaline, ×2 saline boluses after 10 and 22 hrs</td>
<td>No difference in pain scores between groups (p = 0.04) and opioid consumption (p = 0.5). Shorter LOS in the intervention group (p = 0.09).</td>
<td>Randomised, double-blind and placebo-controlled study</td>
</tr>
<tr>
<td>Andersen et al64</td>
<td>n = 12. Bilateral THR. Intra-operative LIA and post-operative infiltration vs no injection</td>
<td>170 ml total: 40 mg ropivacaine 170 ml saline to contralateral hip intra- and post-operatively at 8 and 24 hrs</td>
<td>Continuous epidural infusion</td>
<td>No clinically relevant analgesic effect of LIA. Pain scores were similar (p = 0.06) both at rest and on hip flexion. Median hospital stay was 4 days (2 to 7)</td>
<td>Randomised, double-blind, placebo-controlled trial in bilateral THR combined with multimodal analgesia</td>
</tr>
<tr>
<td>Busch et al62</td>
<td>n = 64. Intra-operative LIA with PCA vs PCA alone</td>
<td>40 ml: ropivacaine 400 mg + adrenaline 0.6 mg + ketoroloc 30 mg + morphine 5 mg</td>
<td>No LIA</td>
<td>Reduced post-operative patient-controlled analgesia requirements in the LIA group. Reduced pain on activity in patients</td>
<td>Control group did not receive ketorolac</td>
</tr>
<tr>
<td>Andersen et al64</td>
<td>n = 80. Intra-operative LIA and post-operative infiltration vs continuous epidural infusion</td>
<td>100 ml: ropivacaine 200 mg + adrenaline 0.5 mg + ketoroloc 30 mg, ×1 further bolus injection after 8 hrs</td>
<td>Continuous epidural infusion</td>
<td>Opioid consumption significantly reduced in the LIA group (p = 0.004). Pain levels at rest and during mobilisation were similar. LOS was reduced by 2 days (36%) in LIA group (p &lt; 0.001)</td>
<td>Unblinded</td>
</tr>
<tr>
<td>Parvataneni et al63</td>
<td>n = 71 (THR). Intra-operative LIA vs PCA</td>
<td>0.5% bupivacaine 200 to 400 mg + morphone 4 to 10 mg + 1/1000 adrenaline 300 μg + methylprednisolone 40 mg + cefuroxime 750 mg + 22 ml saline</td>
<td>PCA alone. No infiltration</td>
<td>Pain scores on day 1 were lower in the LIA group (p = 0.0067). Lower pain scores on days 2 and 3. Opioid consumption use was lower in the LIA group. LOS 3.2 days in the LIA group vs 4.2 in the control, not statistically significant</td>
<td>Prospective randomised study. Study included THR and knee replacement. Unblinded. Variable non-opioid regimen</td>
</tr>
</tbody>
</table>
no statistically significant difference in length of stay between the groups, but 75% of patients with the modern dressing were discharged by the fourth post-operative day, compared with the sixth day for the traditional group.91

**Surgical interventions**

**Conventional surgery and minimally invasive surgery (MIS).** MIS in THR has been defined as an incision of between 10 cm and 12 cm in length.92 This approach is reported to limit soft-tissue trauma, resulting in reduced post-operative pain, a smaller scar, better mobility, reduced length of stay and fewer blood transfusions.93 Some so-called MISs are performed through standard posterior approaches with smaller incisions,92,94,95 using special instruments, whereas others involve novel modified approaches.96-99 The mini-incision posterior approach is associated with a significant reduction in mean blood loss and shorter length of stay than the conventional posterior approach.100

There are two types of MIS for THR using either a single- or two-incision procedure.93,101 A comparison of these approaches shows significantly less time to walk, shorter length of stay, and increased operating time with the use of two incisions, but more complications were encountered in this group101 and it has fallen out of favour. Currently, interest is growing in the use of the direct anterior approach to the hip,102 where minimised soft-tissue trauma is thought to reduce rehabilitation time.103 However, complications may be encountered, including injury to the lateral femoral cutaneous nerve, dislocation and component malposition.102,103

A recent meta-analysis reported that MIS THR resulted in shorter length of stay (by one day), less pain at discharge (by almost 50%), less blood loss and better Harris hip scores (HHS)104 at three months (6-point difference) compared with conventional surgery. There was no difference in adverse outcomes between the two techniques.105 In a systematic review in 2009, Cheng et al106 found no difference in clinical or radiological outcomes between the two methods. Another systematic review of 28 RCTs and quasi-RCTs in 2011 showed that MIS THR resulted in a higher incidence of lateral femoral cutaneous nerve injury, but no clinical difference in blood loss or hip scores at final follow-up (six weeks to five years) and no difference in radiological outcomes compared with conventional approaches.107

**Fast-track joint replacement units.** These are designed to provide an ERP for patients undergoing THR, with facilities tailored to the goal of fast recovery.108 An excellent model was established in Denmark, which describes...
optimised logistics, has a care plan addressing fast track recovery, and pre-determined criteria for discharge and clear information on the length of stay.7 Tranexamic acid is administered 15 minutes prior to skin incision, in combination with both intra-operative LIA and a wound catheter 24 hours after surgery for boluses of LIA. Gabapentin and COX-2 inhibitors are administered on the day of surgery and subsequent seven days.7 Table II gives information on some units using ERP and their length of stay.

Discussion

The concept of ERP in THR has been widely implemented. The adoption of multimodal pathways and accelerated rehabilitation programmes discussed here appear to improve patient care and function while reducing length of stay. The concept of day-case THR for selected patients may be achievable, especially given that ERPs reduce the mortality rate significantly, even at two years.8

This review highlights the potential advantages of a robust pathway through which patients can learn about their procedure, organise their nutritional and physical status, learn what to expect from the surgery and peri-operative period, reduce the risks of surgery and speed up recovery and discharge.

Although a number of pathways have been described, there have been few multicentre randomised trials comparing outcomes from these dedicated centres to those of conventional services. The implementation of ERPs needs to be tailored to the services and expertise that are available.

The author or one or more of the authors have received or will receive benefits for personal or professional use from a commercial party related directly or indirectly to the subject of this article.

This article was primarily edited by G. Scott and first-proof edited by D. Rowley.

References


