

## Pros and Cons of Fast-track Total Knee Arthroplasty

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Received: January 10, 2014

Revised: February 9, 2015

Accepted: February 12, 2015

Published online: June 23, 2015

### ABSTRACT

Background: Existing literature emphasizes the benefits of fast-track total knee arthroplasty (TKA), mainly because this diminishes the length of stay (LOS) in hospital. Fast-track is defined as a hospitalization which provides the best possible evidence-based treatment and a hospital stay of maximum 3 days. However, many authors still don't use fast-track TKA due to its potential risks, mainly in elderly patients with comorbidities and some special circumstances (bilateral TKA in one stage, revision TKA). Questions: (1) Should fast-track TKA be the default, used unless contra-indicated; (2) Is it justifiable in all kind of patients and circumstances? Methods: A Cochrane Library, PubMed (MEDLINE) and Google Scholar search related to the results of fast-track TKA and the justification of fast-track TKA in all kind of patients was systematically analyzed. The keywords used were: TKA and fast-track, and TKR and fast-track. The main criteria for selection were that the articles were focused in the aforementioned questions. Results: 919 articles were found, with 27 meeting the selection criteria. Of them, only four have been included in the Cochrane Library because of their high grade of evidence. Many authors agree on that fast-track TKA yields similar or better results than the classical standard-track. The four articles included in the Cochrane Library have shown that patients undergoing fast-track TKA recover better after general anesthesia than after spinal anesthesia, that

fibrin sealant (fibrin blue) is not beneficial in diminishing drain output or in improving functional recovery, and that fast-track rehabilitation reduces the consumption of analgesic drugs and LOS. Conclusion: Fast-track TKA should be used in all kind of patients, although the procedures for patients having different age/gender/preconditions would be different. In fact, preoperative anemia in fast-track TKA is associated with an increased risk of receiving transfusion during admission, increased risk of readmission within 90 days from the procedure, and increased risk of LOS of more than 5 days.

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**Key words:** Total knee arthroplasty; Fast-track; Pros; Cons; Economical impact; Health system

Rodriguez-Merchan EC. Pros and Cons of Fast-track Total Knee Arthroplasty. *International Journal of Orthopaedics* 2015; 2(3): 270-279 Available from: URL: <http://www.ghrnet.org/index.php/ijo/article/view/1255>

### INTRODUCTION

Total knee arthroplasties (TKAs) have been used for at least thirty years, but surgeons are of course always trying to improve their results and decrease length of stay (LOS)<sup>[1]</sup>.

Fast-track defined as a hospitalization which provides the best possible evidence-based treatment and a hospital stay of maximum 3 days, uses fewer clinical resources with the aim of decrease perioperative morbidity and LOS<sup>[2]</sup>. The treatment concept called "fast-track" is based on information, motivation and logistics and the use of available evidence-based interventions within all aspects of treatment, care, rehabilitation, anesthesia, pain management, etc. The ultimate goal is to reduce the need for hospitalization to a maximum of 3 days without additional resources - while maintaining a very high patient satisfaction and very few complications.

The purpose of this review is to analyze whether fast-track TKA should be the default mode of care and to clarify whether it is justifiable in all kind of patients.

## METHODS

A review was performed on the role of fast-track TKA. The search engines were MEDLINE (PubMed), Google Scholar and the Cochrane Library, and the final date was 22 August 2014. The keywords used were: TKA and fast-track, and TKR and fast-track. 919 articles were found. Of these, twenty-seven were selected and reviewed because they were deeply focused on the aforementioned questions<sup>[1-27]</sup>. Of them, only four have been included in the Cochrane Library because of their high grade of evidence<sup>[3-6]</sup>.

## RESULTS

The types of studies reported have a low level of evidence (levels III and IV). Most of them are prospective case series (level IV).

A number of topics have been analyzed in the literature of fast-track TKA: preoperative anemia<sup>[7]</sup>, intraoperative fibrin sealant<sup>[6]</sup>, type of anesthesia<sup>[4,8]</sup>, pain<sup>[9-11]</sup>, postoperative rehabilitation<sup>[3,5,12,13]</sup>, risk of postoperative deep vein thrombosis (DVT)<sup>[14,15]</sup>, postoperative delirium<sup>[16,17]</sup>, outcome<sup>[1,18]</sup>, length of stay (LOS) in hospital<sup>[2,19-21]</sup>, fast-track in special situations (elderly patients with comorbidities<sup>[16]</sup>, bilateral TKA<sup>[22,23]</sup>, and revision TKA<sup>[24]</sup>.

Preoperative anemia in fast-track TKA is associated with an increased risk of receiving transfusion during admission, increased risk of readmission within 90 days from the procedure, and increased risk of LOS of more than 5 days<sup>[7]</sup>.

In a randomized, double-blind, placebo-controlled study, local fibrin sealant in fast-track TKA did not reduced drain output when used with a tourniquet, tranexamic acid, and a femoral bone plug<sup>[6]</sup>. Regarding the role of anesthesia, a study with high grade of evidence compared the effects of general anesthesia (GA) and spinal anesthesia (SA) in patients undergoing fast-track TKA<sup>[4]</sup>. In the GA group LOS was shorter (46 vs 52 h). Moreover, patients in the GA group needed fewer PCA (patient-controlled analgesia) and less morphine, and they were able to walk earlier. In another report more than eighty-five per cent of patients operated with fast-track TKA under low-dose spinal anesthesia were discharged from the post-anesthesia care unit in 15 minutes<sup>[25]</sup>.

The influence of pain on functional recovery after the first postop day in fast-track TKA is small, thereby allowing early rehabilitation and physiotherapy<sup>[9]</sup>. It has been reported that in 5 to 9 days postoperative pain returns to preoperative levels<sup>[10]</sup>. A randomized study compared a multimodal analgesic regimen with PCA<sup>[11]</sup>. Patients in one group received either periarticular injection before wound closure (30cc 0.5% bupivacaine, 10 mg MSO<sub>4</sub>, 15 mg ketorolac) and multimodal analgesics (oxycodone, tramadol, ketorolac; narcotics as needed). In the other group hydromorphone PCA was used. VAS scores, narcotic usage and adverse effects were fewer in the multimodal group. Satisfaction scores were also better.

Some authors have proposed fast-track physiotherapy to diminish the early loss of muscle strength and function after TKA<sup>[12]</sup>. A prospective randomized study included in the Cochrane Library demonstrated that fast-track rehabilitation and physiotherapy after TKA yielded better WOMAC index scores, fewer consumption of analgesic drugs and rate of adverse events, and shorter LOS (6.75 vs 13.20)<sup>[3]</sup>. Implementation of fast-track rehabilitation was highly recommended. Six months after fast-track TKA no differences have been found between a supervised home-training program and a group-based rehabilitation program regarding physical function and quality of life of patients<sup>[5]</sup>.

The risk of clinical deep vein thrombosis (DVT), and of fatal

and non-fatal pulmonary embolism (PE) after fast-track TKA is not higher than after standard TKA<sup>[14]</sup>. In-hospital prophylaxis only has been shown to be safe in fast-track TKA patients with LOS of  $\leq 5$  days<sup>[15]</sup>.

Fast-track TKR with multimodal opioid-sparing analgesia has been associated with lack of postoperative delirium in elderly patients<sup>[16,17]</sup>.

Operations at the beginning of the week and lack of blood transfusion have been associated with shorter LOS (maximum 5 days) but similar readmission rates<sup>[19]</sup>. Fast-track TKA has been successfully implemented in Denmark with a reduction in LOS from 10-11 days on average in 2000 to 4 days on average in 2009<sup>[2]</sup>. Fast-track TKA allowed enhanced recovery and better functional outcomes. That is why fast-track TKA units have been recommended<sup>[1]</sup>.

Fast-track TKA with LOS of  $\leq 4$  days and discharge to home has shown to be feasible and safe, including in elderly patients with comorbidities<sup>[25]</sup>. More than 75% of patients aged over 80 year or with comorbidities had an LOS  $\leq 4$  days. Mortality and readmission rate were 0.22% and 6.6%, respectively, at 30 days and 0.42% and 9.3% at 90 days.

Bilateral simultaneous TKA has been performed as a fast-track procedure with excellent results<sup>[22]</sup>. The results from a study indicated that bilateral simultaneous TKA can safely be carried out<sup>[23]</sup>.

Patients undergoing fast-track revision TKA for aseptic loosening showed similar results that primary TKA regarding LOS, morbidity, and satisfaction<sup>[24]</sup>.

There are some patient's characteristics that influence the result, LOS, and patient satisfaction in fast-track TKA<sup>[13]</sup>. They are: age, sex, co-morbidity, preoperative use of walking aids, pre- and postoperative hemoglobin levels, the need for blood transfusion, ASA (American Society of Anesthesia) score, and time between the procedure and mobilization. It has been reported that fast-track TKA yields similar or better results than the standard classical TKA<sup>[1,26,27]</sup>. Table 1 summarizes main data and results of the review of the literature of fast-track TKA.

## DISCUSSION

The purpose of this article was to review the literature with the aim of answering the following questions: (1) Should fast-track TKA be the default, used unless contra-indicated; (2) Is it justifiable in all kind of patients and circumstances?

The quality of studies reported so far on the topic is poor (low level of evidence, levels III and IV). Most of them are prospective case series (level IV).

A number of topics have been analyzed in the literature of fast-track TKA: the importance of preoperative anemia<sup>[17]</sup>, the potential role intraoperative fibrin sealant<sup>[26]</sup>, the importance of the type of anesthesia<sup>[3,24]</sup>, the role of pain control<sup>[9-11]</sup>, postoperative rehabilitation<sup>[3,5,12,13]</sup>, the risk of postoperative DVT<sup>[14,15]</sup> and postoperative delirium<sup>[16,17]</sup>, the outcome<sup>[1,18]</sup>, the length of stay in hospital<sup>[2,19-21]</sup>, and the role of fast-track in special situations (elderly patients with comorbidities<sup>[25]</sup>, bilateral TKA<sup>[22,23]</sup>, and revision TKA<sup>[24]</sup>.

Preoperative anemia in fast-track TKA has been associated with transfusion and increased postoperative morbidity<sup>[7]</sup>. Local fibrin sealant in fast-track TKA neither reduced drain output nor facilitated early functional recovery<sup>[6]</sup>.

General anesthesia in fast-track TKA yields better results than spinal anesthesia<sup>[4]</sup>. More than eighty-five per cent of patients achieved pre-defined post-anesthesia care unit discharge criteria in 15

minutes<sup>[8]</sup>. A multimodal analgesic regimen on postoperative pain is paramount in fast-track TKA<sup>[11]</sup>.

Fast-track rehabilitation and physiotherapy after TKA yielded better results than standard rehabilitation regarding muscle strength, function after surgery, LOS and consumption of analgesic drugs<sup>[3,12]</sup>. However, no differences have been found between a supervised home-training program and a group-based rehabilitation program six months after the procedure<sup>[5]</sup>.

There are several patient characteristics that influence the postoperative outcome, the LOS, and patient satisfaction in fast-track TKA<sup>[13]</sup>. They are: age, sex, co-morbidity, preoperative use of walking aids, pre- and postoperative hemoglobin levels, the need for blood transfusion, ASA score, and time between surgery and mobilization.

The risk of clinical DVT, and of fatal and non-fatal PE after fast-track TKA are similar to the risk of other published regimens with extended prophylaxis (up to 7 weeks) and hospitalization up to 11 days<sup>[14]</sup>. In-hospital prophylaxis only has been found to be safe in fast-track TKA patients with LOS of  $\leq 5$  days<sup>[15]</sup>.

In elderly patients, multimodal opioid-sparing analgesia is associated with lack of postoperative delirium and a reduction of the prevalence of postoperative cognitive decline after fast-track TKA<sup>[16,17]</sup>. It has also been reported that fast-track TKA yields similar or better results than the standard classical track<sup>[21,26,27]</sup>.

Operations at the beginning of the week and lack of blood transfusion have been associated with shorter LOS. Fast-track TKA can be carried out in unselected without a higher rate of readmissions<sup>[19]</sup>.

Fast-track TKA has been successfully implemented in the orthopedic departments in Denmark<sup>[11,2]</sup>. Reduction in LOS was from 10-11 days on average in 2000 to 4 days on average in 2009. Fast-track TKA resulted in better recovery, lower LOS, and better functional outcomes.

A prospective study on patients' characteristics and comorbidity in unselected patients undergoing fast-track TKA with a follow-up of 90 days showed that more than 75% of those aged over 80 year or with comorbidities had an LOS  $\leq 4$  days<sup>[16]</sup>. Mortality and readmission rate were 0.22% and 6.6%, respectively, at 30 days and 0.42% and 9.3% at 90 days. Readmissions were similar in all kind of patients. Fast-track TKA with LOS of  $\leq 4$  days and discharge to home proved to be feasible and safe, including in elderly patients with comorbidities<sup>[25]</sup>.

Bilateral simultaneous fast-track TKA has been performed with excellent results<sup>[22,23]</sup>. Patients undergoing fast-track revision TKA for aseptic loosening showed similar results than those undergoing primary fast-track TKA regarding LOS, morbidity, and satisfaction<sup>[24]</sup>.

To get quick rehabilitation and discharge, a fast-track TKA unit needs both logistical (homogenous entities, regular staff, high continuity, using more time on and up to date information including expectations on a short stay, functional discharge criteria) and clinical features (multimodal opioid-sparing analgesia, early mobilization and discharge when criteria were met)<sup>[20]</sup>. The aforementioned features expected will reduce LOS, with similar or improved patient satisfaction. The literature supports the implementation of fast-track TKA in nearly all kind of patients and circumstances<sup>[2,14,19,20,22,24,26]</sup>.

In conclusion, fast-track TKR should be used in all kind of patients, although the procedures for patients having different age/gender/preconditions would be different. In fact, preoperative anemia in fast-track TKR is associated with an increased risk of receiving transfusion during admission, increased risk of readmission within 90 days from the procedure, and increased risk of LOS of more than 5 days.

**Table 1** Main data and results of the review of the literature on fast-track total knee arthroplasty (TKA).

Author	Year	Purpose and Methods	N	Results	Conclusions
Husted et al [23]	2006	The authors evaluated LOS for patients operated on with primary TKA in order to focus on the relationship between duration of hospital stay, surgical volume, morbidity and mortality and resources. According to the National Register on Patients in 2004 concerning postoperative length of hospital stay, readmissions (30 days) and mortality (30 and 90 days), departments with short and long hospital stay were compared and potential economical savings were estimated if all departments reduced their stays to match the departments with the shortest hospital stay.	NA	Postoperative hospital stay varied between departments from 4.5 to 12 days. Two-thirds of the departments had stays of more than seven days. A high surgical volume tended to correlate with short hospital stay and reduced mortality. A nation-wide reduction of hospital stay after TKA to five days would free 28,000 hospital beds and produce economic savings of approx. 13 million Euro.	Nation-wide implementation of fast-track TKA would result in a significant decrease in the needed number of hospital beds and generate economic savings with similar or better outcome.
Husted and Holm [25]	2006	This study investigated whether unselected patients operated on with TKA could accomplish a self-developed accelerated track, ANORAK-HH, with a planned length of stay (LOS) of maximum 5 days and patient satisfaction at all parts of the track. 307 patients who sustained 329 hip and knee arthroplasties were included in the study with the main material constituted from 243 primary TKA arthroplasties. ANORAK-HH includes pre-operative patient clinic, patient motivation, dedicated staff, unchanged criteria for discharge and a planned LOS of maximum 5 days. 22 patient characteristics and 11 satisfaction parameters were registered as well as readmissions within 3 months.	307	95% of patients had a LOS of maximum 5 days with a mean of 3.9 days. Median and mean values of satisfaction for the entire track were 10 and 9.4 out of 10, respectively. Participation in patient clinic did not influence LOS or satisfaction.	Operations at the beginning of the week and lack of blood transfusion were associated with shorter LOS. Finally, ANORAK-HH could be effectively accomplished in unselected TKA patients without having an adverse effect on patient readmission rate.
Husted et al [15]	2008	The aim of this prospective study was to identify patient characteristics associated with LOS and patient satisfaction after total hip and knee replacement surgery. Between September 2003 and December 2005, 712 consecutive, unselected patients (440 women) with a mean age of 69 (31-91) years were admitted for hip and knee replacement surgery at our specialized fast-track joint replacement unit. Epidemiological, physical, and perioperative parameters were registered and correlated to LOS and patient satisfaction.	712	92% of the patients were discharged directly to their homes within 5 days, and 41% were discharged within 3 days. Age, sex, marital status, co-morbidity, preoperative use of walking aids, pre- and postoperative hemoglobin levels, the need for blood transfusion, ASA score, and time between surgery and mobilization, were all found to influence postoperative outcome in general, and LOS and patient satisfaction in particular.	The authors identified several patient characteristics that influence postoperative outcome, LOS, and patient satisfaction in our series of consecutive fast-track joint replacement patients, enabling further attention to be paid to certain aspects of surgery and rehabilitation.

Table 1 Main data and results of the review of the literature on fast-track total knee arthroplasty (TKA).

Author	Year	Purpose and Methods	N	Results	Conclusions
Schneider et al [12]	2009	The authors performed a prospective clinical trial to identify predictive factors for successful fast track rehabilitation. 52 THA and 48 TKA 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.	100	Eighty-four percent (n = 44) of THA patients and 73% (n = 35) following TKA achieved the target discharge. Average discharge after THA was 5.4 and 5.5 days after TKA. 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 THA; age, diagnosis, ASA class and preoperative pain medication were influential for TKA. Perioperative complication rates were within or below the national average.	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.
Husted et al [21]	2010	The goal of this study was (1) to identify logistical and clinical areas of importance for length of stay (LOS) by identifying departments with short and long LOS and to evaluate their set-up; and (2) to evaluate patient satisfaction in relation to LOS. Based on the National Register on Patients in 2004 on LOS following THA and TKA, departments with short and long LOS were identified. The three departments with the shortest and the three departments with the longest postoperative hospital stay were chosen for evaluation. The logistic setup and the clinical treatment/pathway were examined with on-location focus interviews to identify logistic and clinical factors acting as improvement or barriers for early rehabilitation and subsequent discharge. Also, the patients from these departments answered a questionnaire regarding satisfaction with components of their stay, co-morbidity, sex and age.	NA	Mean LOS was 7.4 and 8.0 days after THA and TKA, respectively staying from 4.5 to 12 days. Departments with short hospital stay were characterised by both logistical (homogenous entities, regular staff, high continuity, using more time on and up to date information including expectations on a short stay, functional discharge criteria) and clinical features (multimodal opioid-sparing analgesia, early mobilisation and discharge when criteria were met) facilitating quick rehabilitation and discharge. Patient demographics from departments with the shortest stay were similar co-morbidities than patients from departments with longer stays, but were either as satisfied-or more satisfied-with all parts of their stay. There was no difference in staffing (nurses/physiotherapists) between the two types of departments.	Nationwide implementation of fast-track THA and TKA would result in a significant decrease in the needed number of hospital beds with similar or better outcome for the patients. Implementation of updated logistical and clinical features is expected to increase rehabilitation and reduce LOS with similar or improved patient satisfaction. These results support the implementation of fast-track total hip- and knee arthroplasty.
Holm et al [3]	2010	The authors investigated the relationship between early functional mobility and pain intensity in a fast track program after TKA. One hundred consecutive patients operated with TKA in an orthopaedic unit at a University hospital were prospectively studied. Measurements of independence in transfer and ambulation (Cumulated Ambulation Score), pain intensity (Verbal Analog Scale (VAS)), range of knee motion, functional mobility ('Timed Up & Go' (TUG) test), and walking distance were recorded daily from the first postoperative day until discharge.	100	On the first postoperative day, 90% of the patients were able to walk independently with median pain intensity of < or =5 on VAS. Of these, 78% walked > 70 m. All patients walked independently on postoperative Day 2 with pain intensity of < or =4. On the day of discharge, all patients walked with crutches with pain intensity of < or =3, walking distance > 70 m, median range of motion 10-80 degrees, and median test time of the TUG 19.2 s. The length of hospital stay was median 3 days.	Pain has a limited influence on the functional recovery beyond the first postoperative day after TKA, thereby allowing early physiotherapy.
Husted et al [1]	2010	The authors reported their results with short-duration pharmacological thromboprophylaxis combined with early mobilization and reduced hospitalization. 1,977 consecutive, unselected patients were operated with primary THA, TKA, or bilateral simultaneous TKA (BSTKA) in a well-described standardized fast-track set-up from 2004-2008. Patients received DVT prophylaxis with low-molecular-weight heparin starting 6-8 h after surgery until discharge. All re-admissions and deaths within 30 and 90 days were analyzed using the national health register, concentrating especially on clinical DVT (confirmed by ultrasound and elevated D-dimer), PE, or sudden death. Numbers were correlated to days of prophylaxis (LOS).	1977	The mean LOS decreased from 7.3 days in 2004 to 3.1 days in 2008. 3 deaths (0.15%) were associated with clotting episodes and overall, 11 clinical DVTs (0.56%) and 6 PEs (0.30%) were found. The vast majority of events took place within 30 days; only 1 death and 2 DVTs occurred between 30 and 90 days. During the last 2 years (854 patients), when patients were mobilized within 4 h postoperatively and the duration of DVT prophylaxis was shortest (1-4 days), the mortality was 0%. Incident cases of DVT in TKA was 0.60%, in THA it was 0.51%, and in BSTKA it was 0%. Incident cases of PE in TKA was 0.30%, in THA it was 0%, and in BSTKA it was 0%.	The risk of clinical DVT, and of fatal and non-fatal PE after THA and TKA following a fast-track set-up with early mobilization, short hospitalization, and short duration of DVT prophylaxis compares favorably with published regimens with extended prophylaxis (up to 36 days) and hospitalization up to 11 days. This calls for a reconsideration of optimal duration of chemical thromboprophylaxis.

Table 1 Main data and results of the review of the literature on fast-track total knee arthroplasty (TKA).

Author	Year	Purpose and Methods	N	Results	Conclusions
Husted et al [4]	2011	The authors assessed whether patients undergoing revision TKA for non-septic indications might also benefit from fast-track surgery. 29 patients were operated with 30 revision arthroplasties. Median age was 67 (34-84) years. All patients followed a standardized fast-track set-up designed for primary TKA. We determined the outcome regarding LOS, morbidity, mortality, and satisfaction.	29	Median LOS was 2 (1-4) days excluding 1 patient, who was transferred to another hospital for logistical reasons (10 days). None of the patients died within 3 months, and 3 patients were re-admitted (2 for suspicion of DVT, which was not found, and 1 for joint mobilization). Patient satisfaction was high.	Patients undergoing revision TKA for non-septic reasons may be included in fast-track protocols. Outcome appears to be similar to that of primary TKA regarding LOS, morbidity, and satisfaction. Our findings call for larger confirmatory studies and studies involving other indications (revision THA, 1-stage septic revisions).
Husted et al [18]	2011	This study analysed the outcome of 150 consecutive, but selected, bilateral simultaneous TKAs and compared them with that of 271 unilateral TKAs in a standardised fast-track setting. The procedures were performed between 2003 and 2009.	421	Apart from staying longer in hospital (mean 4.7 days (2 to 16) versus 3.3 days (1 to 25) and requiring more blood transfusions, the outcome at three months and two years was similar or better in the bilateral simultaneous TKA group in regard to morbidity, mortality, satisfaction, the range of movement, pain, the use of a walking aid and the ability to return to work and to perform activities of daily living.	Bilateral simultaneous TKA can therefore be performed as a fast-track procedure with excellent results.
Husted et al [19]	2011	To determine clinical and logistical factors that keep patients in hospital for the first postoperative 24-72 hours, the authors performed a cohort study of consecutive, unselected patients undergoing unilateral primary THA (n = 98) or TKA (n = 109). Median length of stay was 2 days. Patients were operated with spinal anesthesia and received multimodal analgesia with paracetamol, a COX-2 inhibitor, and gabapentin-with opioid only on request. Fulfillment of functional discharge criteria was assessed twice daily and specified reasons for not allowing discharge were registered.	207	Pain, dizziness, and general weakness were the main clinical reasons for being hospitalized at 24 and 48 hours postoperatively while nausea, vomiting, confusion, and sedation delayed discharge to a minimal extent. Waiting for blood transfusion (when needed), for start of physiotherapy, and for postoperative radiographic examination delayed discharge in one fifth of the patients.	Future efforts to enhance recovery and reduce length of stay after THA and TKA should focus on analgesia, prevention of orthostatism, and rapid recovery of muscle function.
Bandholm and Khelet [13]	2012	Review	NA	The authors proposed changing the focus to earlier initiated and more intensive physiotherapy exercise after TKA (fast-track physiotherapy exercise), to reduce the early loss of muscle strength and function after surgery	Ideally, the physiotherapy exercise interventions after TKA should be simple, using few and well-chosen exercises that are described in detail, adhering to basic exercise physiology principles, if possible.
Lunn et al [8]	2012	The authors investigated why are patients staying in the post-anesthesia care unit (PACU). All patients operated with primary unilateral total hip or knee arthroplasty (THA or TKA) under spinal anaesthesia were included in this hypothesis-generating, prospective, observational cohort study during a 4-month period. Surgical technique, analgesia, and perioperative care were standardized. Well-defined PACU discharge criteria that had to be met on two successive assessments were evaluated every 15 min until discharge. The primary outcome was time to meet PACU discharge criteria. Secondary outcomes were actual discharge time from the PACU, specific factors detaining patients in the PACU, and potential complications at the surgical ward at follow-up 24 h post-operatively.	163	One hundred sixty-three patients were included in the final analysis (69 THA and 94 TKA). Time to meet PACU discharge criteria was: 15 min for THA and 15 min for TKA. Actual discharge time from PACU was: 25 min for THA and 25 min for TKA. Reasons for not meeting PACU discharge criteria in 15 min were mainly low oxygen saturation and pain. The short stay in the PACU did not impose complications at the surgical ward.	The vast majority of patients (> 85%) operated with THA and TKA under low-dose spinal anaesthesia may achieve pre-defined PACU discharge criteria in 15 min. Large-scale studies should be performed to evaluate safety aspects after short PACU stay.

Table 1 Main data and results of the review of the literature on fast-track total knee arthroplasty (TKA).

Author	Year	Purpose and Methods	N	Results	Conclusions
den Hertog et al [11]	2012	To investigate fast-track rehabilitation concept in terms of a measurable effect on the early recovery after TKA., comparing the fast-track rehabilitation--a pathway-controlled early recovery program (Joint Care®)--with standard postoperative rehabilitation care, after TKA. Overall, 147 patients had TKA (N = 74 fast-track rehabilitation, N = 73 standard rehabilitation).	147	The fast-track rehabilitation patients received a group therapy, early mobilization (same day as surgery) and 1:1 physiotherapy (2 h/day). Patient monitoring occurred over 3 months (1 pre- and 4 post-operative visits). The standard rehabilitation group received individual postoperative care according to the existing protocol, with 1:1 physiotherapy (1 h/day). The cumulative American Knee Society Score (AKSS) was the primary evaluation variable, used to detect changes in joint function and perception of pain. The secondary evaluation variables were WOMAC index score, analgesic drug consumption, length of stay (LOS), and safety.	Patients undergoing revision TKA for non-septic reasons may be included in fast-track protocols. Outcome appears to be similar to that of primary TKA regarding LOS, morbidity, and satisfaction. Our findings call for larger confirmatory studies and studies involving other indications (revision THA, 1-stage septic revisions).
Jakobsen et al [17]	2012	The authors explored the feasibility of progressive strength training commenced immediately after TKA. A pilot study was conducted at an outpatient training facility. Fourteen patients with unilateral TKA were included from a fast-track orthopedic arthroplasty unit. They received rehabilitation including progressive strength training of the operated leg (leg press and knee-extension), using relative loads of 10 repetition maximum with three training sessions per week for 2 weeks. Rehabilitation was commenced 1 or 2 days after TKA. At each training session, knee pain, knee joint effusion and training load were recorded. Isometric knee-extension strength and maximal walking speed were measured before the first and last session.	14	The training load increased progressively. Patients experienced only moderate knee pain during the strength training exercises, but knee pain at rest and knee joint effusion were unchanged or decreased over the six training sessions. Isometric knee-extension strength and maximal walking speed increased by 147 and 112%, respectively.	Bilateral simultaneous TKA can therefore be performed as a fast-track procedure with excellent results.
Krenk et al [16]	2012	The aim was to evaluate the rapid eye movement (REM) sleep duration and sleep architecture before and after fast-track hip and knee replacement with length of stay (LOS) <3 days. The primary endpoint was REM sleep duration on the first postoperative night compared with before operation. Ten subjects (≥60 yr) receiving spinal anaesthesia and multimodal opioid-sparing postoperative analgesia for total hip or knee arthroplasty were included. Ambulatory polysomnography was performed one night before operation at home, continuously during hospitalization, and on the fourth postoperative night at home. Sleep staging was performed according to the American Academy of Sleep Medicine manual. Opioid use, pain, and inflammatory response (C-reactive protein) were also evaluated.	10	The mean LOS was 1.5 (days). The mean REM sleep time decreased from a mean of 18.2% of total sleep time to 1.2% on the first postoperative night; awake time increased from 19.1% to 44.3%; and sleep architecture on the first postoperative night was more disturbed than before operation. Sleep architecture normalized on the fourth postoperative night. There was no association between opioid use, pain scores, and inflammatory response with a disturbed sleep pattern.	Future efforts to enhance recovery and reduce length of stay after THA and TKA should focus on analgesia, prevention of orthostatism, and rapid recovery of muscle function.

Table 1 Main data and results of the review of the literature on fast-track total knee arthroplasty (TKA).

Author	Year	Purpose and Methods	N	Results	Conclusions
Harsten et al [2]	2013	The authors compared the effects of general anaesthesia (GA) and spinal anaesthesia (SA) on the need for postoperative hospitalization and early postoperative comfort in patients undergoing fast-track TKA. One hundred and twenty subjects were randomly allocated to receive either intrathecal bupivacaine (SA group) or GA with target controlled infusion of propofol and remifentanyl (GA group). Primary outcome was length of hospital stay (LOS) defined as time from end of surgery until the subject met the hospital discharge criteria. Secondary outcome parameters included actual time of discharge, postoperative pain, intraoperative blood loss, length of stay in the Post Anaesthesia Care Unit, dizziness, postoperative nausea and vomiting, need for urinary catheterization and subject satisfaction.	120	GA resulted in shorter LOS (46 vs 52 h), and less nausea and vomiting (4 vs 15) and dizziness (VAS 0 mm vs 20 mm) compared with SA. During the first 2 postoperative hours, GA patients had higher pain scores, but after 6 h the SA group had significantly higher pain scores. Subjects in the GA group used fewer patient-controlled analgesia doses and less morphine, and were able to walk earlier compared with the SA group. Subjects receiving SA would request a change in the method of anaesthesia in the event of a subsequent operation more often than the GA subjects.	GA had more favourable recovery effects after TKA compared with SA.
Madsen et al [5]	2013	This study aimed to test whether group-based rehabilitation focusing on strength training, education and self-management is more effective than individual, supervised home-training after fast-track TKA. We allocated 80 participants undergoing primary TKA to either group-based rehabilitation or individual, supervised home-training (40 participants in each group). The group-based rehabilitation consisted of 12 outpatient visits during six weeks including strength and endurance exercises, education and self-management combined with home exercises. The primary outcome was Oxford Knee Score; secondary outcomes were EuroQoL-5 Dimensions QoL and Physical Function of the Medical Outcomes Short Form 36. Tertiary outcomes were pain, knee range of motion, tandem test, Leg Extensor Power, 10-m walking test, 30-sec. and five-times sit-to-stand. Outcomes were assessed four weeks, three months and six months after surgery. In addition, the questionnaires were completed before surgery.	80	The authors found no difference in gain of function or quality of life between the two groups at three and six months follow-up.	Individual, supervised home-training and group-based rehabilitation programmes improved patients' quality of life and physical function equally six months after TKA.
Ibrahim et al [24]	2013	Review	NA		The authors presented an evidence-based summary of common interventions available to achieve enhanced recovery, reduce hospital stay, and improve functional outcomes following THA and TKA. It covers pre-operative patient education and nutrition, pre-emptive analgesia, neuromuscular electrical stimulation, pulsed electromagnetic fields, peri-operative rehabilitation, modern wound dressings, standard surgical techniques, minimally invasive surgery, and fast-track arthroplasty units.

Table 1 Main data and results of the review of the literature on fast-track total knee arthroplasty (TKA).

Author	Year	Purpose and Methods	N	Results	Conclusions
Jorgensen et al [14]	2013	The authors investigated injuries, circumstances, and the timing of fall-related hospital admissions 90 days after fast-track THA and TKA. This was a prospective, descriptive multicenter study on fall-related hospital admissions, in 5145 elective fast-track THA and TKA patients, with complete 90-day follow up through the Danish National Patient registry and medical charts.	NA	Of 83 (1.6%) fall-related hospital admissions, 43 (51.8%) were treated in the Emergency Room and 40 (48.2%) were admitted to a regular ward. The median LOS after surgery was 3 days in fallers versus (vs) 2 days in patients without falls. Injuries were classified as "none" or minor in 39.8%, moderate in 9.6%, and major in 50.6%. Most falls (54.8%) occurred within 1 month of discharge. Falls due to physical activity (12.0%) and extrinsic factors (14.5%) occurred later than did surgery-related falls (73.5%), contributing to 40% of all falls >30 days after discharge. In multivariate analysis, age (odds ratio [OR]: 1.05; 95% confidence interval [CI]: 1.0-1.08) ( $P=0.0001$ ), living alone (OR: 2.09; 95% CI: 1.20-3.62) ( $P=0.009$ ), and psychiatric disease (OR: 2.80; 95% CI: 1.42-5.50) ( $P=0.001$ ) were associated with surgery-related falls, whereas the use of a walking aid (OR: 1.20; 95% CI: 0.67-2.16) ( $P=0.544$ ) and LOS $\leq 4$ days (OR: 1.19; 95% CI: 0.52-1.28) ( $P=0.680$ ) was not.	Hospital admissions due to falls are most frequent within the first month after fast-track THA and TKA. The overall incidence of surgery-related falls amongst these patients is low, declines after the first month, and is related to patient characteristics rather than short LOS. The effect of interventions aimed at surgery-related falls should focus on the first 30 days after surgery and differentiate between the causes of falling.
Jorgensen et al [26]	2013	The authors investigated the incidence of any symptomatic thromboembolic events (TEEs) with only in-hospital prophylaxis if LOS $\leq 5$ days after fast-track THA and TKA. It was a prospective descriptive multicenter cohort study in fast-track THA and TKA from February 2010 to December 2011, with complete 90-day follow-up through the Danish National Patient Registry and patient files. The study was performed in 6 Danish high-volume centres with a similar standardised fast-track setup, including spinal anaesthesia, opioid-sparing analgesia, early mobilisation, functional discharge criteria and discharge to own home. It included 4924 consecutive unselected unilateral primary THA and TKAs in patients $\geq 18$ years with no preoperative use of continuous 'potent' anticoagulative therapy (vitamin K antagonists). Prophylaxis was carried out with low-molecular-weight heparin or factor Xa-inhibitors only during hospitalisation when LOS $\leq 5$ days. Parameters assessed were: Incidence of symptomatic TEE-related, VTE-related and VTE-related mortality $\leq 90$ days postoperatively.	4924	LOS $\leq 5$ days and thromboprophylaxis only during hospitalisation occurred in 4659 procedures (94.6% of total). Median LOS and prophylaxis duration was 2 days (IQR 2-3) with 0.84% (95% CI 0.62 to 1.15%) TEE and 0.41% (0.26% to 0.64%) VTE during 90-day follow-up. VTE consisted of five pulmonary embolisms (0.11% (0.05% to 0.25%)) and 14 deep venous thrombosis (0.30% (0.18% to 0.50%)). There were four (0.09% (0.04% to 0.23%)) surgery-related deaths, of which 1 (0.02% (0.00% to 0.12%)) was due to pulmonary embolism, and 6 (0.13% (0.06% to 0.28%)) deaths of unknown causes after discharge.	The low incidence of TEE and VTE suggests that in-hospital prophylaxis only, is safe in fast-track THA and TKA patients with LOS of $\leq 5$ days. Guidelines on thromboprophylaxis may need reconsideration in fast-track elective surgery.
Jans et al [7]	2014	The authors evaluated the prevalence of preoperative anemia in elective fast-track THA and TKA and its association with risk of perioperative transfusion, prolonged length of hospital stay (LOS), and postoperative readmission. This was a prospective observational database study with data obtained from six high-volume Danish fast-track surgical centers. Preoperative hemoglobin and patient demographics were collected prospectively using questionnaires while outcome and transfusion data were collected using national databases and patient charts. Adjusted risk estimates for transfusion, prolonged LOS, and all-cause readmission according to preoperative anemia status were obtained by multivariate logistic regression.	5165	A total of 5165 THA or TKA procedures were included with a mean patient age of $67 \pm 11$ years and a median LOS of 2 (interquartile range, 2-3) days. A total of 662 patients (12.8%) had preoperative anemia according to World Health Organization classification. Preoperative anemia was associated with increased risk of receiving transfusion during admission (odds ratio [OR], 4.7; 95% confidence interval [CI], 3.8-5.8), increased risk of readmission within 90 days from surgery (OR, 1.4; 95% CI, 1.1-1.9), and increased risk of LOS of more than 5 days (OR, 2.5; 95% CI, 1.9-3.4) after adjustment for preoperative patient-related risk factors.	Preoperative anemia in elective fast-track THA and TKA is independently associated with transfusion and increased postoperative morbidity, supporting the need for preoperative evaluation and treatment.



Table 1 Main data and results of the literature on fast-track total knee arthroplasty (TKA).

Author	Year	Purpose and Methods	N	Results	Conclusions
Lamploet et al [10]	2014	The authors analyzed the effects of a multimodal analgesic regimen on postoperative pain, function, adverse effects and satisfaction compared to patient-controlled analgesia (PCA). Thirty-six patients undergoing TKA were randomized to receive either (1) periarticular injection before wound closure (30cc 0.5% bupivacaine, 10mg MSO4, 15 mg ketorolac) and multimodal analgesics (oxycodone, tramadol, ketorolac, narcotics as needed) or (2) hydromorphone PCA. Preoperative and postoperative data were collected for VAS pain scores, time to physical therapy milestones, hospital stay length, patient satisfaction, narcotic consumption and medication-related adverse effects.	36		The multimodal group had lower VAS scores, fewer adverse effects, lower narcotic usage, higher satisfaction scores and earlier time to physical therapy milestones. Multimodal pain management protocol decreases narcotic usage, improves pain scores, increases satisfaction and enhances early recovery.
Skovgaard et al [6]	2013	In this randomized, double-blind, placebo-controlled study, the authors analyzed the possible effect of fibrin sealant on blood loss and early functional recovery in a fast-track setting. 24 consecutive patients undergoing bilateral simultaneous TKA were included. 10 mL of fibrin sealant (Evicel) was sprayed onto one knee whereas the contralateral knee had saline. Drain output, the primary outcome, was measured from knee drains removed exactly 24 h after surgery. Secondary outcomes (knee swelling, pain, strength of knee extension, and range of movement (ROM)) were evaluated up to 21 days after surgery.	24	The drain output in knees treated with fibrin sealant and placebo was similar (582 mL and 576 mL, respectively). Likewise, no statistically significant differences were found between groups regarding swelling, pain, strength of knee extension, and ROM.	Fibrin sealant as a local hemostatic in TKA showed no benefit in reducing drain output or in facilitating early functional recovery when used with a tourniquet, tranexamic acid, and a femoral bone plug.
Lindberg-Larsen et al [20]	2014	The aim of this nationwide study was to investigate the early morbidity after bilateral simultaneous and staged total knee arthroplasty (TKA) in order to clarify potential benefits of a well-established fast-track regime. The Danish National Patient Registry was searched for all bilateral simultaneous and staged TKA procedures from 2010 to 2011. The staged procedures were defined as two separate procedures done within 0-6 months or within 7-18 months.	157	A total of 157 patients had bilateral simultaneous TKA, 346 patients had bilateral staged TKA within 0-6 months and 292 patients had bilateral staged TKA within 7-18 months. The median length of stay in hospital (LOS) was 4 days (interquartile range, IQR: 3) after bilateral simultaneous TKA versus cumulated LOS of 6 days (IQR: 3) in both of the bilateral staged groups ( $p < 0.001$ ). There were no deaths after bilateral simultaneous TKA versus three deaths (0.9 and 1.0 %) in each of the bilateral staged groups within 90 days of surgery (n.s.). The total readmission rate within 30 days of surgery was lower after bilateral simultaneous TKA (7 %, CI 4.0-12.0) and bilateral staged TKA within 0-6 months (9 %, CI 6.4-12.4) compared with 14 % (CI 11.5-20.1) after bilateral staged TKA within 7-18 months.	The results from this nationwide study indicated that bilateral simultaneous TKA can safely be performed in a fast-track set-up.

## CONFLICT OF INTERESTS

There are no conflicts of interest with regard to the present study.

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