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Review Article

Challenges in postdischarge function and recovery: the case of fast-track hip and knee arthroplasty

E. K. Aasvang[1,2,*], I. E. Luna[1,2] and H. Kehlet[1,2]

[1]Section of Surgical Pathophysiology, Rigshospitalet, University of Copenhagen, Blegdamsvej 9, Copenhagen Ø 2100, Denmark, and [2]The Lundbeck Centre for Fast-track Hip and Knee Arthroplasty, Copenhagen, Denmark

*Corresponding author. E-mail: eske.kvanner.aasvang.01@regionh.dk

Abstract

This narrative review updates the recent advances in our understanding of the multifactorial pathogenesis for reduced postdischarge physical and cognitive function after fast-track surgery, using total hip and knee arthroplasty as surgical models. Relevant factors discussed include the surgical stress responses and potential methods for controlling postsurgical inflammation, pain, and cognitive dysfunction. The continuation of moderate to severe pain in up to 30% of patients for 2–4 weeks calls for better understanding of the underlying mechanisms and development of effective multimodal opioid-sparing analgesic regimens. The need for the development of effective physiotherapy programmes on a patient-specific basis is discussed, along with the need for optimal assessment of postoperative function to guide rehabilitation. Other relevant factors discussed include the role of orthostatic intolerance, sleep disturbances, and blood management, and specific patient populations at risk for adverse outcomes, including psychiatric disorders, to identify and guide future interventions for optimizing functional postdischarge outcomes after fast-track surgery.

Key words: complications; recovery; surgery

Fast-track surgery includes a continuous procedure-specific analysis of the various core components determining recovery and outcome, including the choice of optimal anaesthetic and surgical technique, fluid treatment strategies, pain management, and adjustment of care principles (drains, catheters, monitoring etc.) to identify optimal rehabilitation techniques.[1] These adaptations have, over the last 15 yr, repeatedly been shown to enhance recovery, decrease morbidity, and subsequently, to reduce length of hospital stay (LOS) across surgical procedures and concurrent patient co-morbidities.[2 3] Total hip and knee arthroplasty (THA and TKA, respectively) are high-volume model procedures of fast-track programmes where LOS has been reduced from 4–12 to 1–3 days,[3–6] predominantly with discharge directly to home. Consequently, current efforts are being made to develop strategies for same-day THA and TKA procedures,[7] but the potential short-term benefit of a further few days of reduction in LOS should be weighed against a potentially limited number of patients, including the organizational task and the risk of unmonitored complications.[7] However, despite the overall superior results from fast-track THA and TKA, 5–15% of patients report complications, such as persistent postoperative pain, postoperative cognitive dysfunction (POCD), continued or increased use of analgesics, and limited physical function.[8–11] Thus, the future challenges should focus not only on further LOS reduction, but on identifying and further reducing the decline in postdischarge physical and cognitive function, and the surgical and medical complications in high-risk patients.[1 5 12 13]

This narrative review updates recent advances in our understanding of the potential multifactorial pathogenesis for reduced postdischarge function after fast-track surgery, including the surgical stress responses, pain, psychology, physiotherapy and rehabilitation, anaesthesia, analgesia, sleep, and anaemia, to identify and guide future interventions for optimizing functional outcome 1–3 months after surgery, using THA and TKA as surgical models. The authors reviewed recent articles primarily focusing on subacute function (physical and cognitive) after fast-track

THA and TKA, and potential interventions that may improve these outcomes.

Surgical stress response

Increased inflammation not only sensitizes nociceptors with subsequent increased pain, it also results in immune, endothelial, and other organ dysfunctions, leading to fatigue, sleep disturbances, and increased risk for POCD.[14 15] In addition, preoperative inflammation is prevalent in osteoarthritis patients before THA and TKA,[16] evidenced by pressure hyperalgesia.[17] Consequently, reducing preoperative local inflammation may reduce the risk for acute and late persistent postoperative pain. Although there are inconsistencies in whether the local[18] or systemic inflammatory response[19] (interleukin-6 or C-reactive protein) relates to pain and self-assessed function, the blood concentrations of inflammatory mediators peak on the second postoperative day in TKA and third day in THA with relation to recovery.[20] Recent studies suggest that mass cytometry of whole-blood samples may offer a comprehensive assessment of the immune system of potential value for future individualized treatment of patients at risk.[21] Therefore, controlling inflammation in the postoperative phase could theoretically reduce adverse outcomes. Currently, two treatments may have clinical interest, such as systemic or local glucocorticoids and statins.[22] Recent data on high-dose methylprednisolone in TKA (125 mg before surgery) showed significant pain reduction for 2.5 days after surgery, with less fatigue and nausea,[23] and with similar findings, although less prominent, in THA.[24] Furthermore, three repeated doses of 100 mg hydrocortisone (2 h before and 8 h apart) in TKA patients, resulted in significantly reduced concentrations of interleukin-6 and desmosine and reduced pain and fever until 24 h after surgery.[25] These findings call for studies on the optimal effective dosage and duration in the subacute and late recovery phase.

Pain and analgesia

Moderate to severe pain occurs in 30–40% of patients 2 weeks after surgery,[26 27] with a well-documented transition to persistent pain in 15% after TKA and 5% after THA,[28] and an overall increased analgesic consumption 1 yr after surgery in 47% of TKA patients,[9] challenging the consensus of pain relief after lower limb arthroplasty. Before surgery, knee osteoarthritis patients have decreased pressure pain thresholds (hyperalgesia)[29] and thermal hyperalgesia, which overall is decreased after 1 month[29] but persists in a subgroup of patients with persistent postoperative TKA pain.[30] However, the sparse data on the location and underlying mechanisms for subacute arthroplasty pain[31] call for more detailed studies on the transition from acute and subacute to chronic pain; to guide future interventions, such studies must include detailed psychosocial assessment.[32]

Pain has a direct negative impact on physical activity, sleep, and cognitive function and results in an increased use of analgesics.[8 17] Thus, improving pain control is pivotal in maintaining and improving function after THA/TKA. Analgesic strategies should be opioid sparing, including paracetamol and non-steroidal anti-inflammatory drugs or cyclooxygenase-2 inhibitors to facilitate rehabilitation and reduce opioid-related side-effects (impaired sleep quality, dizziness and increased tendency to fall, POCD, apnoea, nausea, and obstipation). However, the available literature on analgesia after THA[33] and TKA[17] does not allow for specific recommendations on analgesic strategies for improving postdischarge function, and better designed studies on optimal multimodal analgesic techniques are required. In this context, preoperative identification of patients at risk for high-intensity postoperative pain would potentially allow for targeted intense analgesic regimens,[26 34] either by aiming to reduce the preoperative pain from joint inflammation[16] or by more invasive techniques (e.g. local nerve blocks) in high-risk patients. In conclusion, despite availability of several analgesic techniques (opioids, ketamine, non-steroidal anti-inflammatory drugs, paracetamol, gabapentinioids etc.),[17] there is an unacceptable high frequency of moderate to severe pain weeks to months after lower limb arthroplasty, in particular TKA, calling for further development.

Anaesthesia

Central neuraxial anaesthesia has been considered superior to general anaesthesia in THA and TKA with regard to postoperative complications, but results are potentially biased by older studies comparing outdated general anaesthetic agents with neuraxial blocks[35] or studies are register based with potential selection bias. Recent preliminary data suggest that modern total i.v. anaesthesia including propofol and remifentanil may be comparable with spinal anaesthesia with regard to acute pain and function in a fast-track set-up,[36 37] although these preliminary data need confirmation from larger trials on complications, especially in patients with co-morbidities.

Assessment of activity and physical function *vs* patient-reported outcomes

Physical function after THA and TKA depends on when and how it is measured. Overall, functional status declines immediately after THA and TKA, with gradual improvement over time until 1 yr after surgery, when measured by standardized functional tests.[38] Patient-reported outcome measures may be prone to bias, because the rapid improvement of function by patient-reported outcome measures[39] is not supported by objective measures (actigraphy or functional tests) of activity and functional capacity.[40 41] Studies including both subjective and objective functional tests show that the two dimensions seldom correlate,[42] supporting the need for consensus on what dimensions should be assessed to allow for a global assessment of function and comparison across studies. Actigraphy studies have already identified a subgroup of patients with continuous impaired activity, and future studies on the underlying pathophysiological mechanisms are needed.[8 40 43] Such studies should include patient-reported outcome measures but also functional tests as an objective way to assess patients' activity after discharge.[8]

Physiotherapy

A significant loss of quadriceps muscle function occurs by 2–3 days after THA and TKA, leading to reduced function and need for rehabilitation.[44] Possible pathophysiological mechanisms include pain, oedema, use of a tourniquet, inflammation, and inhibitory reflexes,[45 46] where elderly patients in particular may be at higher risk because of significantly slower recovery of muscle strength.[47] As a consequence of the observed loss of muscle strength, physiotherapeutic interventions have been attempted. Unfortunately, although rational, prehabilitation has been disappointing in affecting postoperative outcomes in TKA.[48 49] Likewise, recommendations on postoperative TKA rehabilitation are flawed by the overall poor quality of studies,[50 51] and even the effects of early initiation of a 7 week progressive strength

programme after THA and TKA are not convincing.[52 53] In THA, exercise improves muscle strength regardless of home or outpatient training,[54] but without evidence for specific superior training modalities. Together, the available data suggest that the focus should lie on identifying and addressing mechanisms for reduced activity and muscle strength (e.g. pain, fatigue, inhibitory reflexes) and identification of the patient who may or may not benefit from a rehabilitation programme.

Orthostatic intolerance

Orthostatic intolerance occurs in ~20% of patients 24 h after surgery, with subsequent difficulties in early mobilization and increased risk for impaired recovery and increased morbidity.[55] The underlying pathogenic mechanisms may not be related to hypovolaemia, but rather baroreceptor or autonomic nervous system imbalance,[56] and warrant further investigations and interventions.

Hip *vs* knee arthroplasty

Caution should be exercised when including THA and TKA in the same trials unless the number of patients allows for predefined stratification, because the site of arthroplasty is an independent factor for recovery, with better function in THA patients after 9–11 weeks.[57] Furthermore, the risks and intensity of acute and persistent pain,[58] psychological variables,[41] and endocrine[19] and inflammatory responses[20] are different for the two procedures, suggesting different underlying pathological mechanisms.

Delirium and cognitive dysfunction

Postoperative delirium is reported in 2–10% of patients after THA and TKA, but may be less frequent after fast-track THA and TKA.[59 60] Postoperative cognitive dysfunction occurs in 20–40% of patients in non-fast-track surgical programmes,[61 62] but in only ~8% of patients a week after fast-track THA/TKA.[63] Postoperative cognitive dysfunction is a complex result of predisposing factors that may include pain, age, sleep problems, reduced preoperative cognitive capacity, inflammation, and opioid use.[61 63] In addition, intraoperative cerebral desaturation of >10% has been suggested to predict an increased risk for POCD after THA.[64] In summary, future studies with an optimized design to reduce pain, inflammation, and sleep disturbances (see below) are required to reduce delirium and POCD further.

Sleep

In fast-track THA and TKA, with spinal anaesthesia and opioid-sparing multimodal analgesia, rapid eye movement (REM) sleep recorded before surgery, on the first postoperative night in hospital, and when home on the fourth postoperative night was severely impaired during the early postoperative period, compared with preoperative REM sleep,[65] but recovered when home on the fourth night. However, other studies have shown increased daytime sleep and decreased activity for at least the first 9 days after fast-track THA and TKA.[8] The disrupted sleep pattern may exacerbate pain,[66 67] which again impairs sleep, leading to a vicious circle of increased nociception. Thus, restoration of sleep seems crucial to reduce pain and promote recovery. Unfortunately, a single dose of zolpidem on the first postoperative night did not alter REM sleep architecture assessed by somnography after fast-track THA and TKA, although improved subjective sleep quality and reduced fatigue and arousals were found.[68] These findings call for investigations of more prolonged hypnotic treatment, especially in relation to postdischarge function (physical and cognitive), pain, and opioid use.[38] Sleep apnoea occurs in ~20% of the THA/TKA population, although undiagnosed at the time of surgery in the majority of patients.[69] Sleep apnoea and subsequent hypoxia increase cardiovascular morbidity and mortality and the risk of cerebral dysfunction in subgroups of patients,[70 71] and studies on the role and effect of interventions in high-risk patients are called for in a fast-track setting.[72]

Psychology and expectations

Preoperative pain catastrophizing, anxiety, and low self-estimated mental health have consistently been found to be associated with acute pain and functional outcome in TKA,[26 73 74] but with conflicting evidence in the THA population,[41] whereas depression may be an independent factor for persistent pain after both THA and TKA.[58 73] This calls for specific interventional studies to modify preoperative anxiety and depression to reduce pain and increase function. In this context, a recent randomized controlled trial of perioperative administration of escitalopram to patients with preoperative high-pain catastrophizing scores may suggest an analgesic effect for the first postoperative week, which calls for further studies on timing and dosing of such treatment.[75]

The majority of patients have high expectations regarding the outcome of surgery,[72 76] with subsequent disappointment if unmet. Interestingly, a relation between self-perceived function and objective improvement in functional capacity or activity may be questionable,[77 78] especially during the first postoperative months, suggesting that better tools to capture patients' expectations and subsequent education of patients in realistic goals and outcomes are needed to maintain motivation for training and improvement.

High-risk patients and complications

Fast-track THA and TKA have been proved safe for the majority of patients,[4–6] including older patients[79] and those with preoperative co-morbidities, such as smoking and alcohol abuse,[80] cardiopulmonary diease,[81] and diabetes.[82] Furthermore, there is growing evidence of a reduction of specific complications in fast-track THA and TKA, such as the risk of thromboembolic complications, myocardial infarction, and cardiac arrest.[5 83 84] However, further identification of specific high-risk patients is required, and recent data suggest patients with medically treated psychiatric disorders[85 86] or chronic renal failure to be at specific risk for complications and mortality.[87] Complications should be detailed and classified as 'surgical morbidity' (hip displacement, knee manipulation, prosthesis infection) or 'medical morbidity' (anaemia, cardiac arrhythmia, thromboembolism, pneumonia, pain),[88] and ideally, a standardized complication index should be used to allow comparison across studies.[89] Another area of research into complications includes the risk of postoperative urine retention, where some epidemiological studies have shown that ~40% of patients are subjected to intermittent urinary catheterization, which may cause urinary tract infections, with increased risk for prosthesis and wound infections and kidney injury.[90] However, recommendations on how to prevent and treat postoperative urine retention (bladder volume, pharmacological) are not evidence based.[91] Finally, preoperative anaemia is frequent (15–40%) in the lower limb arthroplasty population, with increased risk for prolonged LOS, 90 day re-admission, and blood transfusion,[92 93] which calls for evidence-based blood management and prevention programmes.[93]

Table 1 Fast-track total knee and hip arthroplasty status

Length of hospital stay 1–3 days
No age or functional restrictions
No co-morbidity restrictions
Reduced cardiac morbidity and mortality
Reduced need for antithrombotic prophylaxis
Reduced postoperative delirium and cognitive dysfunction

Table 2 Challenges in fast-track total knee and hip arthroplasty

Pre- and postoperative reduction of inflammatory response
Reduction of subacute and persistent pain
Optimizing opioid-sparing analgesic strategy
Reduction of postoperative impairment of physical activity and function
Further reduction of postoperative cognitive dysfunction
Identification of high-risk patients for complications
Psychiatric disorders
Chronic renal failure
Orthostatic intolerance
Anaemia and transfusion thresholds
Postoperative urine retention and urinary bladder catheterization
Feasibility of same-day surgery
Type, timing, and duration of physiotherapy
Improving sleep quality and architecture

In summary, this review has highlighted challenges in fast-track surgery, with a focus on THA and TKA (Table 1). Despite the reduced LOS and morbidity from optimized fast-track programmes, the future challenges should not be on further reducing LOS but instead should focus on the pathophysiological mechanisms of recovery and the potential for optimization of postdischarge functional outcomes (Table 2).

Authors' contributions

Conceiving the idea for the manuscript, collecting data and writing the manuscript: all authors.

Declaration of interest

None declared.

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