Chapter

Fast Track Arthroplasty Using Local Infiltration Analgesia

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Abstract

Fast track arthroplasty is a holistic approach to patients who undergo total hip and knee arthroplasty, a journey or care that begins with setting patient's expecta-tion, optimising medical status, using intraoperative local anaesthetic infiltra-tion, decreasing narcotics usage either in spinal or post-operative medication, discourag-ing usage of patient controlled analgesia or urinary catheters, encouraging day of operation mobilisation and optimising post-operative physiotherapy protocols. The use of local infiltration analgesia (LIA) is a good alternative compared to other traditional pain management techniques. The purpose of adoption of LIA technique is to provide comfort from the trauma associated with hip and knee arthroplasty particularly for the first 36 h post-operatively, during the time of high post-operative pain, to facilitate increased post-operative mobilisation and function. LIA is safe and effective to achieve good outcomes, early mobilisation and decreasing length of stay without jeopardising clinical outcomes. This chapter discusses LIA and its multimodal approach to analgesia, regional anaesthesia and early mobilisa-tion that improves overall patient experience and satisfaction. The chapter discusses LIA techniques, wound catheter placement, and postoperative protocol to achieve fast track hip and knee arthroplasty.

Keywords: local infiltration analgesia, fast track arthroplasty, rapid recovery arthroplasty, enhanced recovery after surgery, total hip arthroplasty, total knee arthroplasty

1. Introduction

Hip and knee joint arthroplasty are effective in reducing pain and improving function and quality of life in patients with osteoarthritis or other destructive joint disease [1, 2]. This brings an increasing demand on healthcare systems to facilitate smooth recovery, not troubled by nausea or the adverse effects of narcotics. Acute pain leads to decreased mobility, increased length of stay, and an increased need for inpatient rehabilitation, chronic pain, subsequently leading to dissatisfied patients and increasing burden on healthcare resources [3–5]. Utilising an optimum analgesic protocol is challenging; outweighing the benefits and risks of each protocol is key in improving clinical outcomes and patient satisfaction.

Rapid recovery following elective hip and knee arthroplasty has been adopted with consistent patient satisfaction without jeopardising clinical outcomes [6–9]. Several modalities for peri-operative analgesia have been used such as

patient-controlled analgesia (PCA), systemic opioids, spinal anaesthetic, epidural catheter, and local anaesthetic blocks. These all carry associated risks and benefits which must be weighed.

The use of local infiltration analgesia (LIA) is a technique adopted in lower limb arthroplasty to improve post-operative pain. LIA is a technique described initially in literature by Kerr and Kohan who used a multimodal approach to relieve pain [10]. A cocktail of locally injected anaesthetic and direct acting analgesics create a prolonged analgesic effect post-operatively reduces the requirement of opioid analgesia and thus reducing nausea and increasing mobility.

This chapter discusses LIA and its multimodal approach to analgesia, regional anaesthesia and early mobilisation that improves overall patient experience and satisfaction. The chapter discusses LIA techniques, wound catheter placement, and postoperative protocol to achieve fast track hip and knee arthroplasty.

2. Local infiltration analgesia mixture

The local anaesthetic cocktail usually comprises of multiple active ingredients. The dose and volume of this cocktail is dependent on many factors including body mass index (BMI), renal function and patient's specific comorbidities. Local anaesthetic mixture has been validated in previous studies which showed that LIA is safe and effective in total hip and knee arthroplasty [11–13].

The anaesthetic mixture initially described by Kerr & Kohen in 2008 contained 2.0 mg/mL ropivacaine, 30 mg ketorolac and 10 μg/mL of adrenaline totalling 150–170 mL in knee arthroplasty and 150-200 mL in hip arthroplasty [10]. Ropivacaine was reduced to 250 mg if a patient was less than 55 kg, older than 85 years or had an American Society of Anaesthesiology (ASA) class of 3 or more. In this description, ketorolac was omitted in patients with poor renal function.

According to a study conducted in Ballarat, Victoria in 2020, they used a LIA cocktail derived from Kerr's protocol. Their mixture consisted of 350 mg of ropivacaine, 30 mg ketorolac, 4 mg dexamethasone and 0.5 mg adrenaline [14]. The catheter top-up was injected in the morning post-operative with dose of 20 mL including 100 mg ropivacaine, 4 mg dexamethasone, 30 mg ketorolac, 0.5 mg adrenaline (adrenaline given for total hip arthroplasty (THA) only and not total knee arthroplasty (TKA)) and normal saline. The study showed shorter length of stay, decreased incidence of discharge to rehabilitation, and reduction in healthcare cost without negative impact on patient outcomes when compared to the national average outcomes published in Royal Australasian College of Surgeons Variance Report in 2017. PCA (patient-controlled analgesia) was not used.

In a THR study, Busch et al. used a 100 mL mixture of local anaesthetic comprised of 400 mg of ropivacaine, 30 mg of ketorolac, 5 mg of morphine and 0.6 mL of epinephrine [15]. They found that their patients who received LIA, when compared to those who did not receive, had better pain and satisfaction scores, their PCA use was minimised, and their length of stay (LOS) decreased. Krenzel et al. performed a double-blinded randomised control study for patients with TKA that compared a 20 mL solution of 100 mg ropivacaine against 20 mL of saline placebo [16]. They found that patients received LIA had better pain scores and straight leg raise earlier. The systematic review conducted by Marques et al. used a combination of a local anaesthetic (ropivacaine or bupivacaine), ketorolac and epinephrine [17].

The factors that might impact LIA mixture include surgeon and anaesthetist preferences, low BMI, age, comorbidities, and allergies. Pantoprazole, a proton

pump inhibitor, offsets the multiple risks that contribute to gastrointestinal bleeding or peptic ulcer disease in the perioperative period. These factors should be discussed and altered pre-operatively, and still enlist fast track protocol.

2.1 Safety of local anaesthetic

Local anaesthetic agents are toxic at certain levels in systemic circulation. With any use of local anaesthetic, care must be taken to ensure LIA mixture is not injected directly into the patient's circulation. Local anaesthetic will inevitably be transported into circulation at a small concentration. However, it has been shown that the volume of local anaesthetic used in LIA technique is safe, and their levels in blood tests show sub-toxic concentration [18–20].

Fenten et al. took multiple plasma samples after LIA and torniquet release for TKA (at 20, 40, 60, 90, 120, 240, 360 minutes and 24 hours) [18]. The mix comprised of 200 mL 0.2% ropivacaine and 0.75 mg epinephrine 1:1000. Maximum ropivacaine concentration (total and unbound serum concentration) remained well below the assumed toxic threshold at all serum plasma samples. Stringer et al. studied LIA with the use of pain pump infusions for 48 hours post-operatively and measured ropivacaine concentration in THA and TKA patients [20]. The mixture contained 350-400 mg ropivacaine and defined their safe threshold concentration of 1–3 microg/mL intravascularly. Their intra-articular pain pump infusion commenced 12 hours post-operatively. Ropivacaine concentration was below 2 microg/mL with LIA intraoperatively. Once intra-articular pain pump infusion commenced, peak ropivacaine concentration reached 0.65–4.36 microg/mL, however none of their patients experienced clinical signs of toxicity.

2.2 Adrenaline

The inclusion of adrenaline in LIA cocktail is safe, but it is not well understood whether including it improves outcomes. Adrenaline works as vasoconstrictive agent which prolongs the local anaesthetic effect [21]. However, there is a concern in the recent literature for the usage of adrenaline and its impacts on vasoconstriction and skin necrosis [21, 22].

Van Der Zwaard et al. studied 502 TKA and unicondylar knee replacements, and compared one group of LIA with ropivacaine only with the other group of ropivacaine and epinephrine [23]. They found there was no difference in pain scores between the two groups. The authors of this chapter found the usage of adrenaline in a staged injection technique has benefits. Adrenaline prolongs the effect of local anaesthetic and decrease bleeding which mitigates swelling and haematoma formation, subsequently facilities early mobilisation. We recommend proximal infiltration deep to the deep fascia rather than injecting the skin and subcutaneous in TKR to avoid skin necrosis.

2.3 Corticosteroids

Inclusion of corticosteroids in the local mix is controversial. Periprosthetic infection is a dreaded complication with significant implications for the patient and is of concern with use of corticosteroids given the drug's immunosuppressive properties. Steroids prolong the duration and efficacy of the local mix [24]. A randomised control trial (RCT) showed that adding corticosteroid to the local anaesthetic cocktail improved 24 hour post-operative pain with no increased complications for 12-months, including deep infections [25].

3. Comparative regional anaesthesia options

Several pain management methods are used after TKR and THR such as PCA, narcotics, epidural analgesia, and peripheral nerve block. However, those methods are associated with complications; continuous epidural infiltration and femoral and/or sciatic nerve block improve postoperative pain control and reduce consumption of narcotics but at the expense of other potential problems such as epidural bleeding (with prophylactic anticoagulation therapy), infection, urinary retention, diminished muscle control and nerve damage [26–31]. PCA administration of opioids is often associated with nausea and vomiting, respiratory depression, drowsiness, pruritus, reduced gut motility, and urinary retention. Continuous intra-articular infusion of analgesics is associated with large effusion of surgical wound [15, 26]. Even though those pain management methods have reduced the acute phase of postoperative pain to some extent, they do not address the major concerns of venous thromboembolism (VTE) and hospital-acquired infections.

3.1 Intrathecal morphine

Intrathecal morphine has emerged as an alternative approach to managing post-operative pain following THA and TKA. Intrathecal administration of morphine would manage pain experienced by a patient with lower limb surgery and is commonly used for other procedures such as intra-abdominal and caesarean operations. However, the risks might be respiratory depression, bradycardia and hypotension, seizures, and urinary retention [32].

Both intrathecal morphine and LIA minimise the need for systemic opioid usage and improve patient outcomes. A large meta-analysis performed by Qi et al. compared intrathecal morphine to LIA in patients with THA and TKA [33]. Patients receiving LIA required less systemic opioids (13.52 mg) and had better visual analogue score at rest and mobility at 72 hours, and lower incidence of nausea or vomiting post-operatively.

3.2 Epidural anaesthesia

The epidural catheter is another option for managing pain in THA and TKA patients. Although less commonly used, it is a good way to manage pain and avoid use of oral opioids. While effective, it also carries certain risks including urinary retention, neurological deficits and epidural hematoma, and has a number of contraindications [34]. Berninger et al. in their study found that no difference in pain among different combination of anaesthesia and nerve blocks, however they found that the group that included LIA had higher mobilisation and better muscle strength in the early post-operative phase [35].

3.3 Peripheral nerve block

Peripheral nerve blocks are another widely accepted method for analgesia peri-operatively and post-operatively for THA and TKA. The blocks minimise pain experienced by the patient whilst being more specific than systemic opioids or intrathecal/epidural analgesia. Peripheral nerve blocks however can cause some delays peri-operatively compared to LIA. A sterile field, commonly with ultrasound needs to be prepared and is performed before or after operation, as compared to LIA which is performed intra-operatively.

A large meta-analysis found that pain six hours post-operatively was better when LIA is used compared to peripheral nerve block, but there was no difference between the two for pain later, opioid consumption, length of stay and complications such as deep infection and VTE [36]. Berninger et al. found that the LIA group had better mobility than those who had peripheral nerve blocks, but other parameters were no different [35]. It can be argued that better pain relief acutely and better mobility post-operatively can reduce risk of complications, such as VTE, and would improve patient satisfaction and outcomes [35].

Two common peripheral nerve blocks used for TKA are femoral nerve block and adductor canal block. Kim et al. in their randomised trial, patients underwent TKA received either an adductor canal block or a femoral nerve block, and measured quadricep strength and pain scores at different time frames [37]. They found that the adductor canal group had better quadriceps strength in the 6-to-8-hour post-operative window compared to the patients receiving femoral nerve block, and pain was no different. Quadriceps strength and pain was no different after 24 hours post-operatively. A key fundamental to Fast Track Arthroplasty is early mobilisation and return to function; avoiding motor blockade would assist a patient to functionally progress earlier.

3.4 Complementary patient-controlled analgesia (PCA)

PCA is a commonly used pain management technique that individualises patient need for analgesia and aims to give patients control over their pain management; this helps determine the required oral analgesia. Pandazi et al. performed a randomised controlled trial; two of the included groups were LIA with PCA as rescue versus PCA alone in patients receiving THA [38]. The LIA group was shown to have significantly better pain scores at rest and when mobilising, and had less overall morphine consumption, with no difference in adverse events.

PCA combined with LIA can help manage pain post-operatively for patients with THA and TKA. For some patients however, adding another intravenous line can impede mobility – the enhanced recovery after surgery (ERAS) aims to mobilise patients as soon as possible. A multi-modal approach to analgesia should be utilised, with LIA providing a useful option in a patient's management.

4. Fast track hip and knee arthroplasty is not a new idea

The use of fast track or rapid recovery arthroplasty has been successfully implemented within multiple health systems in many different countries globally over the past 10–15 years [14, 39–43]. To successfully implement fast track arthroplasty, the care pathway involved is complex and multidisciplinary. Goals include ensuring correct indication for surgery and candidate selection, pre-operative optimisation, safe and evidence-based peri-operative management, good functional outcome and high patient satisfaction [44]. According to the Enhanced Recovery After Surgery (ERAS) Society, there are about 20 components of care involved for implementation of effective protocols, which is undertaken in a multidisciplinary fashion including expertise from anaesthetics, surgery, physical therapy, nursing and nutrition [7]. These protocol has been successfully implemented into multiple surgical specialities including gynaecological oncology, urology, vascular and thoracic surgeries [7]. Along with individual studies, systematic reviews and meta-analysis highlighted the benefits of fast-track arthroplasty for lower limb [6, 7, 9].

Malviya et al. implemented a rapid recovery protocol for hip and knee arthroplasty in May 2008 in the United Kingdom. They found the median LOS decreased from

6 days to 3 days and requirement for blood transfusion reduced from 23% to 9.8%, which was statistically significant. Most notably there was a reduction in 30-day mortality from 0.5% to 0.1% along with reduction in 90-day mortality of 0.8% to 0.2% [42].

A retrospective study conducted by Auyong et al. on 252 patients who underwent rapid recovery protocol, showed a reduced length of stay, improved mobility, reduced overall opioid consumption with no difference in readmission rates or complication rates [39].

In Australia, Christelis et al. in their study on 709 patients compared a pre-ERAS and post-ERAS cohort. They found the ERAS group had a reduced LOS with no change in complication rates by 6 weeks post operatively, no increase in hospital readmission along with similar pain scores, and higher patient satisfaction at the 6 weeks post-operative mark [40].

Same day discharge arthroplasty has emerged recently that showed cost-effectiveness without jeopardising clinical outcomes [45]. Basques et al. identified several patient characteristics which favoured same day discharge including decreased age, male, lower ASA class, less obese along with lower rates of respiratory disease and hypertension [46].

5. Author's LIA technique

LIA is an effective method of post-operative pain control in hip and knee arthroplasty [11, 14]. This, combined with low- or no-dose opioid spinal anaesthesia, allows virtually avoids urinary catheters and ensures earlier mobilisation. This multi-modal opioid-sparing approach is central to the rapid recovery model of care, allowing safe early mobilisation with minimal pain. With the use of LIA there is the advantage of having no motor blockade [8], allowing the patient to be mobilised day of surgery.

The purpose of adoption of LIA technique is to provide comfort from the trauma associated with hip and knee arthroplasty particularly for the first 36 h post-operatively, during the time of high post-operative pain, to facilitate increased post-operative mobilisation and function. Further benefits for the use of LIA include no motor blockade also enabling mobilisation, along with reducing the requirement for systemic agents including opioids with associated negative side effects like nausea, vomiting and drowsiness [8, 14]. We have not observed local anaesthetic toxicity, impaired wound healing or increased risk of infection with the use of post-operative pain catheters inserted intra-articularly [8]. Further detail on evidence surround local anaesthetic toxicity is addressed in Section 2 however, nor have other authors found increased infections in hip and knee arthroplasty [13, 19].

The use of bolus injections via 0.22um filter and wound catheter into the joint on the morning after surgery possibly extravasates into surrounding tissues, especially in hip arthroplasty. However, dispersing the injection over a larger area is probably advantageous relative to local anaesthetic infusion, which may be concentrated at the tip of the wound catheter. Furthermore, it avoids "extra baggage" for the patient to carry.

Our LIA technique augments our multimodal therapy approach. Patients routinely receive paracetamol 1 g qid, meloxicam 7.5 mg bd, for more painful operations (TKA, or posterior approach THA) buprenophine 5ug/hr. patch, and tramadol 50 mg 3/24 prn.

5.1 Intra-operative considerations

LIA administration intraoperatively there are four aspects which need consideration; the components of the drug mixture, the injection of the mixture, the catheter placement and, application of compression bandage for TKA [14]. The details of the drug mixture are discussed in Section 2. Before wound closure, a

catheter is inserted either intra-articular or periarticular for post-operative continuous or bolus application of LIA mixture.

The commonly used catheter is a 16G Tuohy needle, an 18G epidural catheter, and a 0.22-u high-performance antibacterial flat epidural filter (Portex, Smiths Medical) [10, 14, 19]. The use of a antibacterial filter has laboratory experiments show sustained efficacy of their use for 48 h continuous infusion [47] with efficacy in antimicrobial filtration for up to 60 days with low volume and low injection pressures [48]. To date the use of antibacterial filters have been used in several applications like epidural catheters and within LIA for post-operative delivery of anaesthesia with no reported increase in infections.

5.2 Total hip arthroplasty injection technique

A standard approach can be undertaken to local anaesthesia administration intraoperatively can be adopted regardless of approach used (anterior/posterior/lateral). The primary purpose is to provide anaesthesia to all area affected by the trauma of the surgery. The total volume used intraoperatively of anaesthetic mixture is 150-200 mL where three main stages of administration are involved.

- After skin incision typically 50 mL of mixture is used within the subcutaneous tissue and proximal gluteus maximus (posterior approach) or for 25 ml injected in the region of the lateral femoral cutaneous nerve (anterior approach). Administration is undertaken using a 'moving needle' technique.

- After cup implantation injection of 25 ml infero-medial capsule (where innervated by obturator nerve), and a further 25-50 mL injected through the capsule superiorly and anteriorly (posterior approach) or postero-superiorly (anterior approach) is performed. Once the definitive implantation of femoral components, injection of the periarticular tissue is performed with about 50 mL of mixture. Intra-articular epidural catheter is placed through skin and deep fascia with the use of a Tuohy needle where a small volume is injected to ensure no blockages prior to closing the deep structures. 5-10 cm of the catheter is placed intra-articularly. The exit position of the catheter through the skin within 2 cm of the incision allows it to be secured by the wound dressing. Note that particular care must be made during closure to ensure the catheter does not become inadvertently sutured.

This epidural catheter is then attached to either an antibacterial filter if the intention is post-operative bolus application of anaesthetic mixture or continuous elastomeric pain pump.

5.3 Total knee arthroplasty injection technique

As with hip arthroplasty, in knee arthroplasty the aim is to infiltrate local anaesthetic mixture into areas affected by the surgery. General principals can be broken into four main stages.

- Prior to skin incision, a block 10 cm proximal to the patella, just deep to the deep fascia, injection 25 ml from lateral to medial, and a second 25 ml injection medially in the region deep to sartorius. Administration is undertaken using a 'moving needle' technique.

- After femoral bone cuts are made injection through the posterior capsule of the knee with about 25 mL of mixture each side, aiming proximally, and

away from the popliteal artery. Once the definitive implants are inserted structures around medial collateral ligaments, quadriceps, and tibial portion of the iliotibial band. The epidural catheter is placed through the skin, fascia, quadriceps, and joint capsule using a Tuohy needle, then inserting the tip of the wound catheter posterior to the medial femoral condyle. Also, as was mentioned with hip arthroplasty, care must be taken when closing the wound not to catch catheter with sutures which will impede catheter removal.

- The remaining mixture is used for infiltration into the synovium and capsule along with surrounding tissue in layers during closure.
- Compression bandages are then applied once the wound is dressed.

An alternate catheter placement can be within the adductor canal, performed intraoperatively. Adductor canal catheter placement may be performed under direct visualisation on subvastus approach. In recovery, ice pack should be applied hourly for 20-minute intervals for the first four hours to prevent swelling and assist in pain control.

5.4 Post-operative

5.4.1 Continuous infusion vs. bolus in LIA

The evidence favouring continuous, or bolus post-operative catheter regimes is limited. Early development by Kerr & Kohen used a bolus protocol in THA and TKA, along with other published protocols [10, 14, 42, 49]. Ballarat experience in their study published in ANZ Journal of Surgery in 2020 supported that bolus injection demonstrated better outcome. However, there is also evidence to support the use of continuous infusions of anaesthetic mixture delivered by elastomeric pump devices post operatively which has also shown success [50–52]. Typically, the infusion rate of 5 ml per hour for 48 hours if continuous infusion is used.

Our preference is 25 ml LIA cocktail without adrenaline is injected in the morning after surgery as a bolus.

5.4.2 Post-operative bandage

Compressive bandage applied post-operatively prolongs the local anaesthetic within the peri-articular tissues after TKA. An elastic binder compressing a sponge on the hip wound could be used but is not common practice and there is no evidence for efficacy. The bandage should be placed to have enough venous compression but not arterial compression [10].

A compression bandage is applied post operatively over the whole leg, from toes to high thigh, in three layers; one layer of soft padding, one layer of crepe bandage, and outer layer of elastic adhesive bandage as recommended by Kerr and Kohan in 2008 [10]. Another study confirmed the benefits of the compression bandage in TKA and demonstrated the improvement of LIA with compression bandage [53]. The compression dressing is removed 24–48 hours post operatively.

6. Pillars of fast track Arthroplasty

In recent times, many health care systems globally have undergone revision of their hip and knee arthroplasty pathways [40, 54]. The concept of ERAS, ‘rapid recovery’ or

'fast-tracking' aims to reduce operation-related physiological and psychological stress as well as enhance early mobilisation and reduce recovery time [44]. Implementation of this rapid recovery model has resulted in reduced length of stay with no increase in hospital re-admissions [40, 43]. In recent times, many health care systems globally have undergone revision of their hip and knee arthroplasty pathways [40, 54]. The concept of ERAS, 'rapid recovery' or 'fast-tracking' aims to reduce operation-related physiological and psychological stress as well as enhance early mobilisation and reduce recovery time [44]. Implementation of this rapid recovery model has resulted in reduced length of stay with no increase in hospital re-admissions [40, 43].

Three stages are identified in a patient's journey: pre-operative, peri-operative and post-operative. Pre-operative patient education is a recognised cornerstone in rapid recovery programs [54], with particular attention paid to patient expectation management regarding post-operative pain and LOS. Simultaneously, pre-operative anaesthetic review allows assessment and modification of patient risk factors that have been shown to reduce length of stay in hip and knee arthroplasty patients [55].

6.1 Preoperative

Rapid recovery protocol begins at the pre-admission stage. On presentation to pre-admission clinic, patients require education on appropriate expectations regarding their operation and post-operative course. An assessment tool in assisting prediction on length of stay and discharge destination (i.e. home or rehabilitation facility) is the Risk Assessment and Prediction Tool (RAPT) which has been previously validated [56, 57]. This tool is a score from 0 to 12, the higher the score the better, where points are given based on age, gender, average walking distance, requirement for walking aids, community, and home supports. With RAPT score < 6 the patient will likely require rehabilitation, between 6 and 9 the patient will likely be discharged home and with a score greater than 9 the patient will likely be discharged post-operative day 1 [57].

There is minimal evidence relating to the impact of preoperative patient education where a Cochrane review by McDonald et al. found preoperative education had no measurable impact on preoperative anxiety or surgical outcomes including pain, function and adverse events [58]. McDonald et al. however noted that there was much heterogeneity and low-level evidence within included studies and preoperative education may benefit patients with depression, unrealistic expectations, anxiety or those with limited social support [58]. The authors believe that setting expectations preoperatively is extremely important for patients prior to their day of surgery where they understand arthroplasty will involve pain which cannot be completely removed, they will be mobilised day of operation, and the primary goal will be discharged home once they are deemed safe. Patients should be prepared to go home post-operative day one.

Pre-admission optimisation is another essential factor when preparing for hip and knee arthroplasty. Assessment and optimisation of risk factors including smoking, alcohol consumption, anaemia, nutritional and metabolic status, and low physical activity has been shown to have a positive impact on length of stay and post-operative complications [59]. Smoking has been shown to increase early post-operative complications, however there is level 2 evidence showing that cessation 4 weeks or greater preoperatively can improve post-operative complications especially related to wound healing [8]. Preoperative optimisation within fast-track protocols has also been shown to reduce the number of patients with a delayed recovery [59].

6.2 Perioperative

There are several factors that are considered in fast-track arthroplasty regarding preparation for surgery including fasting duration and carbohydrate loading.

Although now relatively common practice, anaesthetic guidelines no longer recommend prolonged fasting status, rather a 2 hour clear and 6 hour solid fasting status prior to surgery [60]. Although a component of fast-track/ERAS protocol, carbohydrate has mixed evidence on impact of clinical outcomes in hip and knee arthroplasty even though there some studies have shown positive impact on post-operative hunger, pain, glucose metabolism and insulin resistance [8].

Standardised anaesthesia is another component included in ERAS protocols with mixed evidence regarding superiority between neuraxial anaesthesia/regional and general anaesthesia [7, 8, 11]. Several studies showed the benefit of neuraxial/regional anaesthesia including reduced pulmonary compromise, pulmonary embolism, need for transfusion, renal injury, infection, length of stay and 30-day mortality [61, 62]. Alternatively, a systematic review and meta-analysis by Johnston et al. found no difference between neuraxial and general anaesthesia [63]. In general, the aim with fast-track arthroplasty is to reduce systemic opioid use. This avoids associated side effects of opioid analgesia which can inhibit engagement in post-operative recovery by adopting effective multimodal analgesia and anaesthesia.

6.2.1 Tranexamic acid

There is potential for large blood loss with hip and knee arthroplasty which in turn can prolong hospital stay, increase risk of transfusion, renal failure and increase risk of deep infection. The inclusion of tranexamic acid in hip and knee arthroplasty is effective and safe medication which reduces blood loss with no increased risk of thromboembolic events [7, 8].

6.2.2 Post-operative nausea and vomiting

Post-operative nausea and vomiting (PONV) can be extremely distressing for patients which consequently impact their post-operative course. Risk factors include narcotics, inhalational anaesthesia, female sex, non-smoking status, history of motion sickness or previous PONV and predicted requirement for post-operative opioids [7]. Active screening and prophylactic treatment for at risk individuals is recommended, but our experience with Total Intravenous Anaesthesia (TIVA) or at least minimising inhalational anaesthesia suggests nausea and vomiting to be less common than it once was.

6.2.3 Active intraoperative warming

Maintaining normothermia must be a component of anaesthetic care for joint arthroplasty. When normothermia is maintained, it reduces infection, cardiac complications, transfusion requirements and coagulopathy [7]. With joint arthroplasty, aggressive warming has been shown to reduce intraoperative blood loss in total hip arthroplasty and reduce opioid requirements along with improved patient satisfaction in total knee arthroplasty [7]. Several techniques have been described to assist in maintain normothermia including warm IV fluids and irrigation fluid, prewarming and humidification of anaesthetic gases along with forced air-warming blankets and devices [8].

6.2.4 Avoid urinary catheters

With the use of low dose or no opioid spinal anaesthetic, urinary catheters are unnecessary for the majority of patients, avoiding bacteraemia which may increase

risk of prosthetic joint infection [64]. A large RCT performed within a hip and knee arthroplasty ERAS program showed that increasing a catheterisation threshold from 500 ml to 800 ml over halved the incidence of catheterisation without increase in urological complications [64]. Routine use of urinary catheters is not recommended as per ERAS consensus statement for hip and knee arthroplasty and if used should be removed within 24 hours of insertion [8]. The catheter adds another line or attachment to the patient which increases risk of fall and does not facilitate early mobilisation. Lines should be removed as soon as possible to improve patients' psychological state and avoid any impediment to mobilisation. This not only pertains to urinary catheters but also applies to PCA and other IV lines unless required.

6.2.5 Surgical factors

Surgical approaches may play a role in ERAS THA and TKA however, the advantages or shortcomings between different approaches in both hip and knee arthroplasty in controversial in the literature. This will not be discussed in details, however, there is no conclusive evidence that surgical approach affect post-operative outcomes [8].

Tourniquet free TKR has recently gained popularity, a systematic review with meta-analysis conducted by Smith and Hing showed tourniquet does reduce intraoperative blood loss however increases rates of haematoma, blisters, superficial wound complications, VTE and pulmonary embolism [65]. Furthermore, the use of knee tourniquet has been shown to negatively affect strength with no impact on range of motion [8]. We do not use a tourniquet. We do not apply but not inflate the tourniquet as this technique often creates a venous tourniquet, making surgery more difficult.

The use of the routine post-operative drain shows no improvement for complications including wound infections, haematomas and healing complications [8] and may increase blood loss and transfusion rate [66]. We do not use drain tubes for primary arthroplasty.

6.3 Post-operative

During the post-operative period, the primary aim is to ensure the patient is at full function as soon as possible. This is assisted by ensuring there is adequate analgesia, and the patient is mobilised at the day of operation. Patients are deemed safe for discharge when satisfy the following criteria.

- Medically stable and well; bladder and bowels working and tolerating food and drink
- Pain controlled
- Safe mobilising which is assessed by physiotherapy
- Safe discharge destination with appropriate support
- Medications arranged
- Appropriate follow-up arranged.

Appropriate education for ongoing rehabilitation is crucial to ensure that they will continue to progress their mobility, strength and range of motion [8].

6.3.1 Block (wound) catheter management

The use of the wound catheter post operatively has varied between different protocols in the literature [11, 12]. The method initially described by Kerr & Kohen was a 50 mL top-up of the anaesthetic mixture used intraoperatively 15–20 hours post operatively with 15 mL injected primarily then the remaining injected as the catheter was removed [10]. Nassar et al. describe a top-up with their anaesthetic mixture 18–24 hours post operatively where 20 mL was injected then the catheter was removed [14].

Alternative protocols which have been used include continuous infusion of 250 mL ropivacaine 0.2% over 48 hrs at which case the catheter is removed. If bolus regimes are used the doses involved the first bolus 12 hours post-operatively and the last (second) bolus at 24 hours post-operatively, each under aseptic technique then removal of the catheter where each injection contains 10 ml of 1% ropivacaine, made up to 20mLs with 0.9% saline.

6.3.2 Mobilisation and function

Early mobilisation is a core component to fast-track arthroplasty protocols. Multiple studies have shown that early (ideally day of operation) mobilisation post-operatively reduced length of stay, thromboembolic risk, and mortality [42, 67]. A systematic review and meta-analysis of 5 RCTs performed by Guerra et al. showed that early mobilisation was associated with reduced length of stay by 1.8 days with no increased incidence of negative events or complications [68]. Consequently, all patients should be mobilised with physiotherapy on the day of their operation and if this is not possible due to a late return to ward, at a minimum they must be transferred to sit out of bed. With the use of LIA there is the advantage of having no motor blockade [8] which further facilitates early mobilisation. In fact, day of surgery mobilisation in TKA has been shown to reduce LOS and improve the likelihood of discharge home rather than to a rehabilitation facility [69]. A haemoglobin level is not required prior to mobilisation, and mobilisation must not be delayed awaiting routine blood results. If there are symptomatic concerns, then an urgent medical review should be requested. To further encourage mobilisation simulating home life is encouraged by having all meals, including the first meal, sitting out of bed along with mobilising to bathroom to open bladder or bowels instead of using bedpans or commodes.

The use of corticosteroids is controversial due to the theoretical risk of infection. As mentioned in Section 2.3 there is no increased risk associated with corticosteroid use of periarticular injection. A systematic review and meta-analysis by Yue et al. showed corticosteroid (dexamethasone 0.1 mg/kg) had reduced PONV and pain within 24 hours post operatively [70]. They also showed systemic steroid use had faster functional rehabilitation with no increased risk of infection however, there was increased rates of high serum glucose levels post-operative [70]. Thus, improved patient well-being and analgesia will encourage early mobilisation and facilitate in early discharge and improved post-operative function.

Early mobilisation does not include sitting. We strongly reinforce to our patients that if not mobilising, it is better to lay down than to sit down. Sitting and using a footstool is not helpful, the wound is too low relative to the heart, the veins are potentially occluded in the groin. We recommend patients minimise sitting to 5-10 minutes at a time - it is better to lay on the bed or lounge suite than allow the leg to become swollen. We use 20 mmHg compression stocking during daylight hours. This approach we expect will diminish the readmisssions after arthroplasty caused by swelling, pain, and potentially thrombosis.

6.3.3 Post-operative analgesia

Multimodal analgesia is a well proven analgesia technique within hip and knee arthroplasty [7, 8, 11, 12]. It targets pain through multiple different mechanisms of action to reduce sensation of pain while also reducing the side effects of any one agent. This has also been shown to limit requirement on opioid analgesia which reduces risk of short term side effects like nausea, vomiting, respiratory depression along with long term addiction and development of chronic pain [8]. This involves the use of paracetamol and non-steroidal anti-inflammatory drugs (NSAIDs) along with supplementary opioid analgesia [7, 8], although some of us (DJM) prefer tramadol 50 mg 3/24prn avoiding oxycodone in the vast majority of patients. There has also been evidence for the use of gabapentinoids post operatively that reduce post-operative opioid consumption, pruritus and nausea after joint arthroplasty along with improving sleep however no clear evidence on their role in post-operative pain [8].

6.3.4 VTE prophylaxis

The rate of symptomatic VTE after total hip and knee arthroplasty is approximately 1.9%, with a significant increase of greater than 40% in times where no chemical thromboprophylaxis was used [71, 72]. The National Institute for Health and Care Excellence (NICE) guidelines certifies the use of aspirin, low molecular weight heparin (LMWH), dabigatran, apixaban and rivaroxaban for reducing the incidence of VTE after total knee arthroplasty [73]. In THR, these guidelines support the use of LMWH, dabigatran, apixaban or rivaroxaban [73], with aspirin is not inferior to the other chemical VTE prophylactic agents [74].

Combination of chemical and mechanical thromboprophylaxis is required post-operatively. Ultimately, early mobilisation is significantly influential in reducing the risk of VTE after lower limb total joint arthroplasties, as well as reducing the use of indwelling catheters [75, 76].

We stratify our patients - in easily mobilised patients without other indications for anticoagulants, or past history of thromboembolic disease, we use aspirin 100 mg EC daily, and early mobilisation.

6.3.5 Aim to discharge directly home

Patients will be encouraged to discharge home rather than to inpatient rehabilitation unless indicated by medical issues or limited social supports as per RAPT score. In TKA, home discharge is not inferior to discharge to inpatient rehabilitation which is does not improve functional or patient-reported outcomes [77]. Similarly, inpatient rehabilitation after THA does not reflect any improvement in patient-reported hip pain and function compared to those discharged directly home [78].

7. Keys to success

7.1 Preoperative

- Setting patient expectations
- Use Risk Assessment and Prediction Tool (RAPT) to help predict discharge destination
- Medical optimisation

7.2 Perioperative

- Standardised practice
- Spinal with no (or low) intrathecal morphine
- No blocks that may affect quads, no fascia Iliaca block or femoral block.
- LIA cocktail infiltration
- Wound intra-articular catheter for postoperative cocktail administration

7.3 Post-operative

- Minimal attachments: no urinary catheter or no PCA & all drips and lines out within 24 hrs
- Day of operation mobilisation
- Multimodal opioid sparing analgesia

8. Conclusion

LIA is a good alternative compared to other traditional pain management techniques. LIA is safe and effective to achieve good outcomes, early mobilisation and decreasing length of stay without jeopardising clinical outcomes. Fast track arthroplasty is a holistic approach to patients who undergo total hip and knee arthroplasty, a journey or care that starts with setting patient's mind and expectation, optimising medical status, intraoperative LIA infiltration, decrease the usage of narcotics either in spinal or post-operative medication, discourage usage of PCA or IDC, encourage day of operation mobilisation and optimising post-operative physiotherapy protocols, post-operative exercise protocol.

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