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Analgesia for total knee arthroplasty

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Total knee arthroplasty (TKA) is a surgery that provokes intense postoperative pain and requires specialized care. Delays in postoperative mobilization induce tissue retraction, adherences, and atrophy.[2] As a result, the return to successful function after a TKA requires sufficient analgesia to allow early rehabilitation.[1,2]

In order for a patient to be comfortable postoperatively, the anesthesiologist is expected to provide analgesia that allows early rehabilitation and contributes to the success of the surgical procedure. Management of the patient by the various members of the attending team must be coordinated to allow the multimodal rehabilitation to profit from analgesic techniques.[3] In such a context, locoregional analgesia (LRA) techniques are often used and are an important element of the recovery process. The anesthesiologist in charge of patients undergoing TKA must be familiar with these techniques.

Successful postoperative analgesia requires early patient management that should begin at the time of preoperative consultation. This issue of *Anesthesiology Rounds* illustrates our view of the analgesic management of patients undergoing TKA. The topic is discussed chronologically, indicating the sequence of clinical decisions as they should be made. Innervation of the lower limb, together with the description of the techniques and their safety rules, are essential prerequisites found in numerous reference works and articles and, if necessary, should be consulted by the reader, since the details will not be discussed.[4]

THE ANESTHESIA CONSULTATION

It is important for patients to clearly understand the difference between anesthesia and analgesia techniques because this will help them realize how beneficial LRA can be. The practitioner in charge begins by choosing and explaining the anesthesia technique to be used for TKA. An evaluation of the analgesia possibilities applicable to the patient proceeds through weighing and explaining the risks and benefits associated with each technique. We hope to demonstrate, in this article, the relationship between the benefits of various analgesia techniques, their risks, and the side effects. We will then suggest that, in most cases of TKA, the following techniques should be considered, in order of preference:

- perineural LRA
- epidural analgesia
- periarticular infiltration
- patient controlled intravenous analgesia (PCA).

The practitioner should also assess the possibility of prescribing non-steroidal anti-inflammatory drugs (NSAID) and acetaminophen.

The importance of the anesthesiologist's knowledge of the various features of LRA should already be apparent during the consultation. Great technical skills become useless if LRA is refused by a misinformed patient. Ideally, a patient undergoing major knee surgery should see an anesthesiologist in a preoperative assessment clinic conducted by an anesthesia team who agree on the perioperative management.

PRE-, PERI- AND POSTOPERATIVE LOGISTICS

Adequate scheduling of patients undergoing TKA surgery together with the opportunity to proceed to an LRA technique in a preinduction room, saves time and contributes to the commitment of medicosurgical teams to using LRA. If it is impossible to proceed to LRA in a dedicated induction room, the LRA technique must be seen as part of the operative time as much as any other anesthetic and surgical procedure. The LRA techniques are not a waste of time; therefore, no time pressure should be responsible for cancelling or modifying any technique that was agreed upon during consultation.

PERINEURAL LRA

Lumbar plexus block

Blockade of the lumbar plexus or its components is an essential part of TKA analgesia. It can be done in different ways.

Single-injection femoral block[5] provides analgesia that will last only a few hours.[6,7] However, although not completely useless, this technique is hardly optimal for this type of surgery where intense pain lasts > 24 hours. Therefore, the localization of the femoral nerve should be followed by the introduction of a catheter allowing the infusion of local anesthetics and the maintenance of analgesia for rehabilitation.

The continuous anterior femoral block, maintained postoperatively for 48 to 72 hours, provides better analgesia than PCA and allows for early rehabilitation; it also has fewer side effects and allows shorter hospital stays.[1,2]

Adding a selective single-injection block of the obturator nerve to the continuous femoral blockade done by anterior approach enhances the quality of analgesia during the first few hours. However, it does not modify the quality of rehabilitation.[6]

The continuous block of the lumbar plexus by a posterior approach is appealing because it allows for the coverage of both the femoral and obturator nerves. However, the technical difficulties and safety concerns associated with this approach limit its usefulness. It should only be undertaken by an experienced operator aware of its potential complications. It is a deep block often associated with epidural extensions (5%-30% depending on the series);[9] several authors believe its realisation imposes the same contraindications and restrictions regarding anticoagulant management as epidural anesthesia. The injection of radiopaque dye to localize the catheter is also suggested.

Sacral plexus block

Since a part of the knee's sensitive innervation is tributary of the sacral plexus and its main branch, the sciatic nerve, it may also be useful to block it.

The sciatic nerve block (together with the continuous femoral block) can be useful to a majority of patients undergoing TKA. Two out of 3 patients describe pain in the sacral plexus area.[10] However, systematically blocking the sciatic nerve remains controversial.[11] In fact, sciatic nerve block requires an additional technical step that encompasses further risks; furthermore, the block is not needed by one-third of patients. The sacral plexus block can also mask or delay detection of a surgical lesion of the sciatic nerve.[12] For this reason, some teams prefer to undertake this technique postoperatively, when necessary, once the integrity of the nerve has been confirmed. Although a reasonable approach, it often means that "useful" blocks might not be performed for logistical reasons.

Since the usefulness of the continuous sciatic block is demonstrated up to 36-hr after surgery,[13] an elegant solution is to insert a perineural catheter for the sciatic nerve at the same time and in the same field as the femoral catheter, and use it only if needed. A sciatic nerve catheter can be put in place by a lateral[14] or an anterior[15] approach together with the continuous block of the femoral nerve by anterior approach. Inserting two catheters requires a rigorous management of the volumes and concentrations of local anesthetics in order to prevent toxicity (Table 1).[16,17]

Well-adapted equipment will not hinder the mobility of the patient, even with two catheters in place. The use of two elastomer or battery-powered pumps will provide mobility and lightness.[18]

EPIDURAL ANALGESIA

Epidural analgesia was considered the gold standard for TKA until the introduction of perineural catheters. Perineural catheters are not superior to their epidural counterparts in terms of the analgesia quality obtained. Even the combined use of femoral and sciatic catheters[19] is not superior to epidural analgesia when it comes to pain control or length of hospital stay. On the other hand, the high frequency of side effects associated with epidural analgesia (eg, hypotension and urinary retention), as well as problems related to the management of anticoagulants and the potential risk of perimedullar hematomas they pose, suggest it should not be considered as a first choice. Nevertheless, epidural analgesia is useful in selected cases where insertion of a femoral catheter is impossible, or with patients for

TABLE 1: An example of dose calculation for knee analgesia with two perineural catheters

If **ropivacaine** is chosen, the following doses are recommended.

Initial injections:

Femoral block, **concentration = 5 mg / mL :**
Weight < 55 kg: 0.3 mL / kg (= 1.5 mg/kg)
" > 55 kg and < 75 kg: 20 mL
" > 75 kg: 25 mL

Sciatic block, **concentration = 2.5 mg / mL :**
Weight < 55 kg: 0.3 mL / kg (= 0.75 mg / kg)
" > 55 kg and < 75 kg: 20 mL
" > 75 kg: 25 mL

If the femoral block is performed preoperatively and the sciatic block postoperatively, the local anesthetic peak serum concentration will be lower. This would allow the completion of a femoral block which would be insufficient (with ropivacaine 0.2 or 0.25%).

Follow-up:

Femoral catheter, **concentration = 2 mg / mL:**
Weight < 55 kg: 0.1 mL / kg / h (= 0.2 mg / kg / h)
" > 55 kg and < 75 kg: 7 mL / h
" > 75 kg: 10 mL / h

Sciatic catheter, **concentration = 2 mg / mL:**
Weight < 55 kg: 0.075 mL / kg / h (= 0.15 mg / kg / h)
" > 55 kg and < 75 kg: 5 mL / h
" > 75 kg: 7 mL / h

whom a successful LRA and its morphine-sparing effects are considered more important than the drawbacks related to a bilateral block, urinary retention, and the increased risk of hypotension.

Patient controlled intravenous analgesia (PCA)

This technique should be considered a viable alternative when LRA techniques are contraindicated. In terms of analgesia, rehabilitation, length-of-stay, and side effects, it is less effective than LRA.

Morphine spinal injection

This technique is not as effective for TKA as it is for hip surgery in the doses usually recommended (between 0.1 and 0.3 mg). Its effect is limited to the first 24 postoperative hours[21,22] and is not superior to a single-injection femoral block.[23] Urinary retention is so frequent (36% with 0.2 mg according to Bowrey et al[24]) that the insertion of a urinary catheter is mandatory for most teams who perform it. These factors militate against its use as a routine technique compatible with early rehabilitation.

SPINAL ANESTHESIA RATHER THAN GENERAL ANESTHESIA

Spinal anesthesia is thought to be preferable to general anesthesia for patients undergoing TKA. In addition to being less expensive, spinal anesthesia provides better analgesia in the immediate postoperative period.[25] The progressive reappearance of sensory input allows for a better assessment of LRA failures or weaknesses, before they become uncomfortable for the patient. However, for exceptionally long surgeries (revision of TKA, oncological surgery, etc.), general anesthesia is usually preferred. In these cases, it is mandatory to assess the quality of the perineural blocks before proceeding with general anesthesia in order to obtain an adequate emergence.

Theoretically, the use of combined lumbar and sacral plexus blocks could be sufficient for surgery; however, the potential toxicity of the doses of local anesthetics required is limiting. Furthermore, the obturator nerve is often beyond the reach of the anterior femoral block catheter.[26] This technique then becomes responsible for a significant number of "emergency" general anesthesias that only discredits peripheral LRA techniques in the eyes of patients. For this reason, if the anesthesiologist wishes to use peripheral LRA techniques exclusively during the TKA, he must consider the posterior approach rather than the anterior approach to block the lumbar plexus and its branches. Nevertheless, such a choice should be exceptional for major knee surgery. Moreover, if a posterior lumbar block has been performed, the anesthesiologist should make sure there is no bilateralization before proceeding with spinal anesthesia. In fact, bilateralization (and thus epidural extension) would suggest using general anesthesia.

INFILTRATION OF THE OPERATIVE SITE

Infiltration is a simple technique, easy to perform and well-tolerated by patients. It is often the victim of its simplicity and its true value is not appreciated. However, in a multimodal analgesia context, this technique has proven its efficiency for TKA surgery (Table 2).[27] Single injection is still a problem since its duration is limited, as is the case with perineural LRA. For this reason, some teams insert an intra-articular catheter that allows for continuous infusion[28] or reinjection.[27] However, the catheter does not cover the surgical zone as well as an infiltration carried out by the surgeon during the intervention. The catheter can be used for 24-hour reinjection with clamped drains;[27] it is also worth mentioning that continuous infusion seems less effective.[28] Although the catheter is criticized because of the risks of infection, injection at the time of surgery is nevertheless still very attractive. In a study of 38 patients, Ranawat et al[29] found that single-injection femoral block and infiltration were similar with regards to pain scores. It is possible that the statistical difference between successful femoral blocks

TABLE 2: Infiltration protocol for knee arthroplasty according to Vendittoli et al[27]

Preparation of the infiltration solution	Infiltration protocol
100 mL ropivacaine 0.2% + 7.5 mL ropivacaine 1% + 30 mg ketorolac + 0.5 mg adrenalin (total = 275 mg ropivacaine) In two 60 mL syringes (107.5 ml) 22 gauge needle	Before implantation of the prosthesis Deep tissues: – Collateral ligaments – Posterior capsule – Quadriceps tendon – Patella tendon – Periosteum – Fatty space
50 mL ropivacaine 0.2% + 2.5 mL ropivacaine 1% (total = 125 mg ropivacaine) In a 60 mL syringe (52.5 ml)	Before skin closure – Subcutaneous tissue
16 gauge catheter placed before closure, in the articulation through the vastus lateralis muscle. With antibacterial filter 15 mL ropivacaine 1%	Around 24th hour: Clamping of drains which will be taken out at least 3 hours later. Injection of ropivacaine through the catheter. Removal of the catheter immediately after injection.

No toxic effects of local anesthetics were observed with this protocol and plasma dosages were reassuring.
However, the average weight of subjects included in this study was 87.7 (+/- 14.5) kg.
This protocol should not be performed without adrenalin, which probably slows local anesthetic absorption .
It seems appropriate to adapt dosage to the patient's weight, as in peripheral blocks.
Example: subtract 20 % if weight < 75 kg but > 55 kg (- 10 cc for each syringe)
subtract 30 % if weight < 55 kg (- 15 cc for each syringe).

and infiltrations is lessened by failures of some femoral blocks and by the fact that, unlike infiltrations, femoral blocks do not cover the sciatic area. It has already been mentioned that single-injection femoral block is generally not the preferred analgesia technique for TKA; in fact, it might not be superior to a well-done infiltration. Nevertheless, infiltration should not be overestimated; it should be considered an efficient alternative, associated or not to PCA, but it should not be promoted as a first-line technique.

Localized infiltration in the posterior capsular region is also an analgesic modality to be considered if it is impossible to realize a sciatic block in a patient with a femoral catheter.

ASSOCIATED MEDICATION

Patients undergoing TKA can benefit from multimodal analgesia. Drugs with different but complementary mechanisms of action should thus be associated to LRA.

Acetaminophen

Contraindications to acetaminophen administration are rare. This medication presents few side effects and should be part of most multimodal analgesic approaches.[30]

NSAID

NSAID administration is not always possible because of their various absolute and relative contraindications. Osteosynthesis is slowed down by prolonged administration of strong doses of NSAID, especially those acting on COX-1. However, this effect is probably negligible if these drugs are prescribed for a short time (72 hrs) in the dosages generally used in clinical care.[31] The NSAID prescription and its action on COX-2 modulates the inflammatory response, and decreases the sensitization of the central and peripheral nervous systems. Buvanendran et al[32] found a significant reduction in pain scores and in the consumption of local anesthetics together with a better range of motion and higher patient satisfaction when combining NSAID and patient-controlled epidural analgesia (PCEA) vs only PCEA.

IMMEDIATE POSTOPERATIVE PERIOD

In order to provide optimal analgesia, patients should be returned to their ward only after being properly assessed regarding:

- the relevance of performing a sciatic nerve block or of injecting through a catheter already in place.
- the quality of analgesia provided by the blocks in place.

If a block is inefficient, there should be no hesitation to perform another one (provided the cumulative local anesthetic dosage is respected).

POSTOPERATIVE CONTINUOUS PASSIVE MOBILIZATION

In addition to improving surgical results, passive movements reduce breakthrough postoperative pain that is induced by more active physiotherapy sessions.[33] Sufficient analgesia will allow its early use.

CONCLUSION

The success and prognosis of TKA depend on a coordinated multidisciplinary approach. Analgesia is an integral part of the intervention's success. Under no circumstances should it be neglected because of time constraints. Rather than neglecting a technique because of its logistical difficulties, one should:

- work to improve the preoperative management of patients undergoing TKA (preinduction room or room dedicated to LRA, adapted equipment, etc.)
- work to improve one's LRA technical skills because, as with surgery, practice must complement knowledge.

Well-organized and trained teams strive to offer an optimal analgesia plan without "compromising efficiency in the operating room."[3] The following approach is suggested for patients undergoing TKA and whose condition permits:

- a continuous femoral block during the first 48 to 72 postoperative hours
- a sciatic nerve block with a long-acting local anesthetic or a catheter (which can be injected after assessing the nerve's integrity)
- spinal anesthesia (without morphine)
- urinary catheter only if needed
- acetaminophen administration every 6 hours,
- NSAID during 72 hrs
- if necessary, oral or subcutaneous administration of opiates
- continuous passive mobilization associated with early active mobilization.

Each patient is nevertheless unique, and the suggested analgesia plan has to be adapted to take advantage of all therapeutic options at our disposal in order to attain optimal management.

KEY POINTS

- Analgesic care and locoregional blocks should not be neglected due to lack of time. Good organization and practice are time-saving, so perform locoregional anesthesia when indicated…
- If a femoral block is performed, a continuous technique is better. The addition of a sciatic nerve block (single or continuous injection) is desirable. The catheters should be taken out the 3rd morning after surgery.
- If locoregional anesthesia is contraindicated, technically impossible, or refused by the patient, then articular infiltration can be used. This will reduce postoperative requirements for opiates.
- For specific cases, epidural analgesia is still a viable option.
- LRA techniques are more efficient when combined with acetaminophen or NSAID.

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