Original article

Postoperative pain control by intra-articular local anesthesia versus femoral nerve block following total knee arthroplasty: Impact on discharge

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A B S T R A C T

Introduction: The goal of this retrospective study was to compare pain control following total knee arthroplasty (TKA) on a perioperative protocol of local anesthesia (LA) versus the more classical femoral nerve block (FNB) technique.

Hypothesis: Fitness for discharge would be achieved earlier using the LA protocol.

Materials: Ninety-eight consecutive TKA patients operated on by a single surgeon were included with no selection criteria. In the study group (49 patients), 200 mL ropivacaine 5% was injected into the surgical wound and an intra-articular catheter was fitted to provide continuous infusion of 20 mL/h ropivacaine for 24 h. The control group (49 patients) received ropivacaine FNB. Discharge fitness (independent walking, knee flexion > 90°, quadriceps control, pain on VAS ≤ 3) and hospital stay were assessed.

Results: Discharge fitness was achieved significantly earlier in the study group (4.2 ± 2.6 versus 6.7 ± 3.2 days; P = 0.0003), with significantly shorter mean hospital stay (6.1 ± 3.4 versus 8.8 ± 3.5 days; P = 0.0002). The complications rate did not differ between study and control groups.

Discussion: Although retrospective, this study indicates that the LA protocol improves management of post-TKA pain and accelerates rehabilitation, thereby, reducing hospital stay. The acceleration effect may be due to the absence of quadriceps inhibition.

Level of evidence: Level III – Case control study.

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1. Introduction

The present economic context and rising health costs are incentives for optimizing the efficiency of care. Reduced hospital stay reduces stay-related costs. Optimized pain control following total knee arthroplasty (TKA) accelerates rehabilitation and discharge home [1,2].

Multimodal pain control procedures associated to accelerated rehabilitation have shown promising results [3]. Associating several analgesic techniques should potentiate impact while limiting adverse effects [3]. Injecting the surgical field with high-dose local anesthetics (LA) has been shown to allow earlier weight bearing while avoiding the adverse motor impact of locoregional and spinal anesthesia [3,4,5].

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The present study assessed the feasibility of a multimodal pain control protocol in a university hospital department with a high TKA turnover. The hypothesis was that fitness for discharge following TKA would be achieved earlier by a multimodal protocol including per and postoperative intra-articular LA infiltration than by postoperative pain control by continuous femoral nerve block (FNB).

2. Material and methods

No specific authorization was required for this assessment of a simple change in procedure.

2.1. Population

All patients undergoing TKA in 2010 and 2011 were included, without selection. Inclusion criteria were operation by a single surgeon (JY), and primary TKA of whatever etiology, excluding
evolutive septic osteoarthritis. There were no cases in which one or other of the protocols (LA or FNB) was medically contraindicated. The following preoperative data were collated prospectively and analyzed retrospectively: age, gender, body-mass index (BMI), Charnley class, ASA class, type of surgery, and type of intraoperative anesthesia.

2.2. Methods

All patients were operated on under general anesthesia (GA) following the guidelines of the French Society of Anaesthesia and Intensive Care (SFAR) [6]. In 2010 (control group), GA was associated to per and postoperative regional anesthesia by FNB. FNB used neurostimulation (minimum intensity, < 0.5 mA; exhaustion, > 0.32 mA), under ultrasound control. A perineural catheter was fitted for 48 h continuous ropivacaine infiltration by elastomeric pump (ropivacainechlorhydrate, Fresenius Kabi, Bad Homburg, Germany; 2 mg/mL, flow rate 10 mL/h).

In 2011 (study group), GA was associated to intra and postoperative LA. All patients were informed as to the novelty of this technique in our department at the time, and provided consent. The operative field (posterior, medial and lateral capsule, collateral ligaments, posterior cruciate ligament if spared, subquadruplietal recess, and arthroscopy and incision edges) was injected at end of surgery with 200 mL ropivacaine (2 mg/mL). An intra-articular catheter was fitted for 24 h continuous intra-articular ropivacaine infiltration by elastomeric pump (2 mg/mL, flow rate 10 mL/h).

Postoperatively, patients systematically received ketoprofen (ketoprofen, Hexal Biotech Forschungs GmbH, Holzkirchen, Germany; 50 mg, q.i.d. for 2 days, except in over 75 year old) and Neurontin® (gabapentin, Pfizer Inc., New York City, USA; 300 mg b.i.d; for 5 days). Classic step 1, 2 and 3 analgesics were provided according to pain expressed on a visual analog scale (VAS) [step 1: Doliprane® (paracetamol, Sanofi-Aventis France, Paris, France); step 2: Acupan® (nepamachlorhydrate, Biocodex, Gentilly, France) and/or Tramadol (tramadol chloride, Grünenthal, Aachen, Germany); step 3: Actiskan®/Skenan® (morphine sulfate, Bristol-Myers Squibb, New York City, USA) and Oxycortin®/Oxynorm® (oxycodeone chloride, Mundipharma, Cambridge, UK)]. Postoperative nausea and vomiting prevention followed SFAR guidelines [7]. Four weeks' thromboprophylaxis used low molecular weight non-fractionated heparin (Lovenox) or oral anticoagulants (Pradaxa or Xarelto) on the anesthetist's decision. In patients preoperatively under anti-vitamin K, treatment was resumed at postoperative day 5.

2.3. Surgical technique

A pneumatic tourniquet was routinely used. The surgical approach was medial parapatellar, releasing the distal 2 cm of the vastusmedialis. A rotating platform total knee replacement with patellar resurfacing (e.motion®, Aesculap, Tuttingen, Germany) was implanted under navigation (Orthopilot®, Aesculap, Tuttingen, Germany). No postoperative drainage was implemented.

2.4. Functional rehabilitation

Immediate free mobilization of the knee within the limits of pain tolerance was authorized systematically. Control patients remained in bed until the motor block resolved, as testified by active knee control in extension, whereupon walking was resumed. Study group patients resumed full weight bearing on 2 crutches on the day of surgery.

Subsequent rehabilitation was progressive but without limitation, to achieve early fitness for discharge, defined as the ability to walk independently with or without crutches, knee flexion ≥ 90°, locking in extension and VAS pain score ≤ 3.

2.5. Follow-up

The following data were collated prospectively in the surgery department and analyzed retrospectively: type of postoperative analgesia, time to standing, time to aided walking, time to independent walking, twice-daily evolution of pain on VAS, analgesic intake, time to active quadriceps locking, time to 90° flexion, hospital stay, discharge destination, complications and surgical revision.

2.6. Statistics

Preoperative data were compared between groups on chi² or Fisher test (categoric variables) or Student's test (numeric variables).

The principal assessment criterion was discharge fitness. Follow-up data were compared between groups on chi² or Fisher test (categoric variables) or Student's test (numeric variables); time intervals were compared between groups by survivorship analysis with log-rank test. Correlations between preoperative variables and the principal assessment criterion were assessed by analysis of variance (categoric variables) or linear correlation coefficient. The significance threshold was systematically 5%.

Preliminary calculation based on estimated time to discharge fitness in a population resembling the present control group determined a sample size of 50 per group as required to obtain a first-order risk of 5% and 90% power.

3. Results

3.1. Population

Ninety-eight patients were included: 37 male, 61 female; mean age: 68.1 ± 10.1 years; mean BMI: 31.4 ± 6.0 kg/m². Forty-nine patients were assigned to the control group and 49 to the study group. Table 1 shows patient characteristics; there were no significant inter-group differences on inclusion data, except for a better mean ASA score in the study group (P = 0.04).

Results are shown in Table 2. Discharge fitness was achieved significantly earlier in the study group (4.2 ± 2.6 versus 6.7 ± 3.2 days; P = 0.0003; Fig. 1), and mean hospital stay was significantly shorter (6.1 ± 3.4 versus 8.8 ± 3.5 days; P = 0.0002). All other intervals (times to standing, walking, control of knee extension, 90° flexion and independent walking) were also significantly shorter in the study group. Fig. 2 shows evolution of pain on VAS: it was significantly lower in the study group at D1 (P = 0.009) and D5 (P = 0.04). In-hospital analgesic intake was greater in the study group (Table 3).

Table 1

<table>
<thead>
<tr>
<th>Patient data.</th>
<th>Control</th>
<th>Study</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>49</td>
<td>49</td>
<td>NS</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>22</td>
<td>15</td>
<td>NS</td>
</tr>
<tr>
<td>Female</td>
<td>27</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
<td>69.7 ± 9.4</td>
<td>66.4 ± 10.7</td>
<td>NS</td>
</tr>
<tr>
<td>ASA score</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 or 2</td>
<td>38</td>
<td>46</td>
<td>0.04</td>
</tr>
<tr>
<td>3 or 4</td>
<td>11</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Charnley score</td>
<td>A</td>
<td>25</td>
<td>NS</td>
</tr>
<tr>
<td>B</td>
<td>23</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>30.6 ± 5.3</td>
<td>32.2 ± 6.6</td>
<td>NS</td>
</tr>
</tbody>
</table>
Table 2
Results.

<table>
<thead>
<tr>
<th>Interval (days) between surgery and:</th>
<th>Control (h.i.)</th>
<th>Study (h.i.)</th>
<th>P (log-rank test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitness for discharge</td>
<td>6.7 ± 3.2</td>
<td>4.2 ± 2.6</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Discharge</td>
<td>8.8 ± 3.5</td>
<td>6.1 ± 3.4</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Standing</td>
<td>1.1 ± 0.9</td>
<td>0.3 ± 0.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Assisted walking</td>
<td>2.4 ± 1.1</td>
<td>1.1 ± 0.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Independent walking</td>
<td>6.0 ± 2.9</td>
<td>3.7 ± 2.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Flexion &gt; 90</td>
<td>5.1 ± 3.0</td>
<td>2.6 ± 2.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Locking in extension</td>
<td>3.1 ± 2.9</td>
<td>1.5 ± 1.1</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

3.2. Complications

Eleven patients showed early complications: 7 in the study group and 4 in the control group (Table 4); this difference was non-significant. There were no infectious complications.

Table 3
In-hospital analgesic intake.

<table>
<thead>
<tr>
<th>Control (units/day)</th>
<th>Study (units/day)</th>
<th>P (Fisher test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>2.7</td>
<td>3.2</td>
</tr>
<tr>
<td>Step 2</td>
<td>1.2</td>
<td>1.0</td>
</tr>
<tr>
<td>Step 3</td>
<td>1.5</td>
<td>3.2</td>
</tr>
</tbody>
</table>

4. Discussion

Time to discharge fitness and mean hospital stay were both significantly shortened, by almost 23 days, in the study group. Reduced hospital stay primarily involves early rehabilitation [2], which is possible if pain control is effective and muscle function conserved [8]. Early mobilization, moreover, by reducing confinement to bed, reduces decubitus-related complications [9–11]. It also seems to have an analgesic effect in itself, triggering nociceptive neuromodulation [12].

GA and FNB are classically associated after TKA [13]. The sensory block allows early mobilization [14,15], but quadriceps inhibition delays resumption of weight bearing. Substituting LA for FNB avoids such adverse motor effects [5], and also the complications induced by peripheral nerve block [16,17], whereas in return catheter-related complications are rare [18]. In the present series, intra-operative LA allowed earlier standing and recovery of autonomy. The absence of quadricipital motor block can be presumed to have been the determining factor: perceived pain differed little between the two groups, although opioid intake was greater in the study group.

Several studies, many of them randomized [1,4,19–31], focused on LA techniques in TKA. Methodology varied, some being placebo controlled [1,19,22,26–28] and others not [23,29,30,32,33]. Intra-articular infiltration modalities (rhythm, location, substances) also varied. Some studies implemented postoperative intra-articular drainage, risking possible loss of anesthetic [5,22,26,31–33]. Only 4 compared GA and FNB [4,24,25,31], and none compared isolated continuous ropivacaine infusion versus continuous FNB, which seems to be the most widespread technique in France [13,34]. The literature reports contrasting or indeed opposing results, and comparison is hindered by the great variety of study designs.

Among the 4 studies comparing LA and FNB by Affas et al. [25], found no significant inter-group difference in pain or analgesic intake over the first 24 h. Carli et al. [24] reported twice as high an analgesic intake in the LA group over the first 2 days, although hospital stay was identical in the two groups. Tofdahl et al. [4] found less subjective pain in the LA group at D1, with identical analgesic intake throughout the hospital stay, the length of which did not significantly differ; quadriceps function, on the other hand, was better in the LA group and walking distance during the first 48 h was longer. Parvatanen et al. [31] reported identical subjective pain and patient satisfaction in the two groups; hospital stay was identical, and function and satisfaction scores were comparable. These various results were close to those of the present study, the originality of which perhaps lies in the principal assessment criterion of fitness for discharge rather than the classical measure of hospital stay, which can be biased by intercurrent factors, such as social problems or rehabilitation centre waiting lists.

The study protocol did not increase the risk of complications, including notably that of sepsis due to postoperative intra-articular injection. These findings agree with others for similar protocols [31,32,35].

LA plasma concentrations were not assessed; other studies, however, reported no toxic levels being reached during continuous intra-articular infiltration [1,18,32,36].

The main study limitation is certainly the retrospective design without randomization. The comparability of the two groups could not be checked. However, the preoperative variables that differed significantly between the two groups, and which might therefore have biased the results, had no significant influence on the principal assessment criterion. This suggests that the bias, although inevitable, was not in fact invalidating: the present study has therefore served as a pilot study for a prospective comparative randomized trial under a Hospital Clinical Research Program (PHRC).
5. Conclusion

Associating LA rather than FNB to GA may accelerate functional recovery and reduce hospital stay after TKA, without increasing the risk of complications.

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

References