



Femoral nerve block- or intravenous- guided patient control analgesia for early physical rehabilitation after anterior cruciate ligament reconstruction in "fast-track" orthopaedics: what is optimal?

DUBRAVKA BARTOLEK HAMP
EDUARD ROD
ANDREJ RADIĆ
DARJA GRANEC
MLADEN RAKIĆ

"St. Catherine" Orthopaedics,
Surgery, Neurology and Physical Medicine
and Rehabilitation Specialty Hospital,
Zabok, Croatia

Correspondence:

Dubravka Bartolek Hamp, PhD, MD
"St. Catherine" Orthopaedics,
Surgery, Neurology and Physical Medicine
and Rehabilitation
Specialty Hospital,
Bračak 8, Zabok, Croatia
E-mail: dubravka.bartolekhamp@inet.hr

Nonstandard abbreviations:

APS acute pain service
CPNB continuous block of peripher nerve
FB femoral nerve block
IV intravenous analgesia
LA local anaesthetic
NSAID non-steroid anti-inflammatory drug
PCA patient control analgesia
PHR physical rehabilitation
PNB block of peripher nerve
RACL anterior cruciate ligament
reconstruction

Received May 15, 2013.

Abstract

Background and purpose: "Fast-track" orthopaedics characterizes early start of physical rehabilitation (PHR). Quality of mobilization depends on pain therapy success and preservation of motor function and muscle strength. Patient-control-analgesia (PCA), as an upgrade of continuous intravenous (IV) or regional analgesia (FB) makes the modern base in treatment of acute pain. The aim of the study was to determine more effective post-operative PCA-analgesia (IV-PCA vs. FB-PCA) for early PHR in "fast-track" orthopaedics. **Materials and Methods:** Prospective, observer-blinded study included 40 adults (bought gender, ASA I/II) scheduled for anterior cruciate ligament reconstruction (RACL). Spinal anaesthesia (12.5 mg, 0.5% levobupivacaine; G27-Pencil-Point) was performed in all patients. Patients were divided in two equal groups. In Group IV-PCA intravenous (fentanyl 0.5-1 µg kg⁻¹h⁻¹), and in Group FB-PCA regional (femoral block: 0.125% levobupivacaine, 8 ml h⁻¹) PCA-analgesia (Group IV-PCA: fentanyl 10 µg/8min/x6max; Group FB-PCA: 0.125% levobupivacaine, 8ml/30min/x3max) was established after surgery. Pain score (VAS) was assessed during 24-hours and accepted as satisfactory by ≤3. Diclofenac 75 i.v. was given in two doses, immediately and 12 hours after surgery. Paracetamol 1g was added intravenously if VAS was ≥4. Start of early PHR was planned six hours after surgery. **Result:** FB- and IV-PCA provided equally effective analgesia during first 24-hours after RACL (VAS≤3). Early PHR was possible 6-hours after surgery in 85% of Group FB-PCA (Group IV-PCA=20%) (P=0,0001) due to significantly lower VAS 0,7+/-0,2 (Group IV-PCA=3,0+/-0,2) (P<0,0001). Residual motor block, presented in three patient (15%) with FB-PCA, disabled the onset of PHR. Additional analgesic dose was more need in Group IV-PCA (40%) (Group FB-PCA=10%) (P<0,0001). **Conclusion:** FB-PCA allows more successful pain-free early PHR for orthopaedics "fast-track" ACL reconstruction compare to IV-PCA, excluding 15% of the FB-PCA patients in whom residual muscle weakness was present.

INTRODUCTION

"Fast-track" orthopaedic surgery integrates surgical, anaesthesia and rehabilitation methods in unique protocol to achieve patient rapid recovery, early mobilisation and fast hospital discharge (1, 2). Minimally

invasive surgical techniques, adjusted program of physical rehabilitation (PHR) and structured approach to the acute pain treatment build the base of "fast-track" orthopaedics (3, 4).

Anterior cruciate ligament (ACL) reconstruction is elective, outpatient procedure where postoperatively pain intensity (Visual Analogue Score; VAS 4-7) requires complex multimodal analgesia approach. Curatolo M (5) suggest two current concepts of analgesics combination for "fast-track" ACL reconstruction: 1) intravenous opioid (morphine) and NSAID or acetaminophen, and 2) regional analgesia technique (neuroaxial or peripheral nerve block) supplemented by NSAID or acetaminophen intravenously (A: level of evidence). Combination of NSAID and tramadol (or dextromethorphan) indicated reduced analgesia benefit (C: level of evidence). Ideally, multiple non-opioids drugs (COX-2 inhibitors and gabapentin), could be combined to achieve optimal opioid-free pain relief (A: level of evidence)(5). Some authors combine these drugs with intra-articular local anaesthetic infiltration (20 ml of 0.5% bupivacaine with 10 mg of morphine (Level I of evidence)(6) after tourniquet releasing (7) or preoperatively (8 ml of 0.5% bupivacaine and 0.1 mg of fentanyl)(8, 9). Intra-articular knee analgesia is simple and outstanding of performance (10) but its application is avoided because of adverse effects of local anaesthetics (bupivacaine, lidocaine) on the cartilage of the knee joint (11).

Both proposed analgesia methods include pro- at contra- facts. Intravenous opioid analgesia improves success postoperative pain relief with good condition for early PHR but with high incidence of dose-related side effects (nausea, vomiting, urinary retention, sedation, hypoventilation, ileus) and consequently developed acute opioid tolerance and hyperalgesia (12). Peripheral nerve blocks (PNB) analgesia improves better pain control, reduce opioid-related side effects and enable safer "fast-track" recovery process compare to intravenous analgesics (13, 14). On other side, PNB may be accompanied by muscle weakness, due to consequent motor blockade of peripheral nerve what disables the start of PHR (15).

What can improve the bought analgesia options for "fast-track" ACL reconstruction? Following the recent protocols (16), multimodal ("balanced") and patient control (PCA) analgesia make the gold standard of "fast-track" surgery. In multimodal analgesia, more than one analgesics or technique with additive or synergistic analgesics effects are used to reduce analgesics-related side effects (17). Intravenous or perineural PCA analgesia contribute to the overall reduction of consumed doses of analgesics to the individual needs of patients and bought technique may better optimize patient conditions for PHR.

The aim of this study was to assess the optimal multimodal analgesia approach after RACL "fast-track" surgery for early PHR: intravenous opioid- vs. femoral nerve block- guided patient control analgesia (PCA).

MATERIALS AND METHODS

Prospective, observer-blinded study started after approval of Ethics Committee. The study included 40 adults (32–51 age; bought gender; ASA I/II) scheduled for elective RLCA surgery in spinal anaesthesia (12.5 mg, 0.5% levobupivacaine; G27-Pencil-Point). Premedication (midazolam 20 $\mu\text{g kg}^{-1}$ intravenously) was applied 15 min before initiation of anaesthesia procedure.

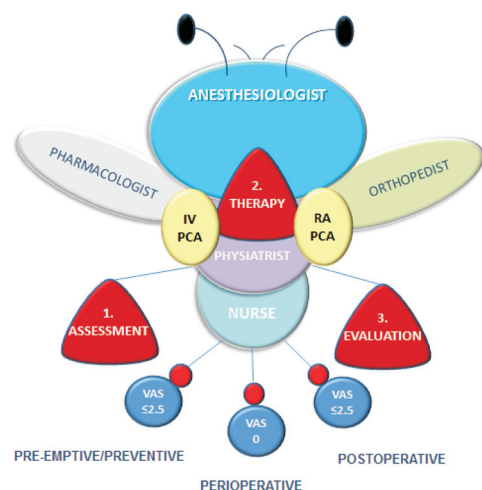
Patients were divided in two equal groups. In Group IV-PCA basal infusion of intravenous opioid (fentanyl 0.5–1 $\mu\text{g kg}^{-1} \text{h}^{-1}$) was started immediately after surgery. In Group FB-PCA basal infusion of perineural local anaesthetic (femoral nerve: 0.125% levobupivacaine, 8 ml h^{-1}) was applied in addition to single-shot analgesia (sciatic nerve: 0.125% levobupivacaine, 20 ml). PCA-analgesia was established in bought study groups after surgery. Settings for PCA mode were: in Group IV-PCA 10 μg of fentanyl on demand, with lock-out of 8 min and 6 requests maximal in one hour, and in Group FB-PCA 8 ml of 0.125% levobupivacaine on demand, with lock-out of 30 min and 3 requests maximal in one hour.

Pre-emptive/preventive analgesia (paracetamol 1g i.v.) was applied 30 min before start of surgery if VAS score was >3 .

Additional intravenous analgesia was provided by diclofenac (75 mg, immediately and 12 hours after surgery) independently from VAS score, and paracetamol (1g up to four times in 24 hours) if VAS was = 4.

Multidisciplinary acute pain service (anaesthesiologist, physiatrist, and surgeon) supervised analgesic therapy, pain intensity and optimal time for the start of physical rehabilitation independently from study design and protocol (Schema 1). Pain was assessed by visual analogue pain scale (VAS) before and during 24 hours after surgery. VAS ≤ 3 was accepted as satisfactory analgesia.

Physical rehabilitation was conducted in two phases: Phase A=immediately-static methods ("The GameReady" to providing cold and knee compression, reducing pain



Scheme 1: Multi-disciplinary Acute pain Service (APS)

TABLE 1
Procedural characteristics of the study groups

		Group IV-PCA	Group FB-PCA	P value
		i.v.	regional	
		fentanil (1µg kg ⁻¹ h ⁻¹) PCA (10 µg/ 8 min/ x 6 max) (N=20)	0.125% levobupivacaine (10 ml h ⁻¹) PCA (8 ml/ 30 min/ x 3 max) (N=20)	
Demographic data	Age (years)	42±9	36±3	0,0742
	Gender (F:M)	0,45	0,5	0,6697
	ASA (II:I)	0,32	0,4	0,6122
	BMI (kg/m ²)	23±0.7	21±2	0,1050
	Hight (m)	1,75±7	1,78±2	0,9854
	Weight (kg)	73±6	68±10	0,0627
Duration of suergery	(hours)	2,5±0,9	2,1±0,7	0,1221
Spinal anasthesia duration		3,8±0,5	4,2±1,0	0,1179

and swelling, and "Kinetek"- allows passive joint stretching by previously entered parameters which adjusts the degree of movement) and Phase B=6 hours after surgery-dynamic methods (getting up, walking on crutches, individually tailored relieving exercises). Static methods of PHR have been applied in all patients in bought study groups. Dynamic methods of PHR were introduced after individual clinical assessment of patients and under stabile vital condition by VAS ≤3. PHR did not start if total absence of pain (VAS 0) was assessed. It was began when correction in analgesia therapy lead to increase the patient pain sensation to at least of its minimum value (VAS 1).

PCA was discontinued eight hours before patient discharge in bought study groups. At this time, diclofenac second dose was already added. Paracetamol 1 g intravenously was applied only if VAS increases above 3.

Date was analysed by "Interactive Statistical Calculation Pages" software; <http://statpages.org>.

RESULTS

Study groups were comparable to demographic data. Average age of patients ranged between 33–51 years. Gender (F:M)(0.45-0.5) and ASA risk (II:I)(0.32–0.4) ratio was equally represented in- and between- study groups. Mean body mass index (BMI) was under normal weight range (21–23 kg m⁻²) in all patients (Table 1).

Duration of ACL reconstruction was almost the same in two groups (Group IV-PCA 2.5 vs. Group FB-PCA 2.1 hours)(P=0.1221). Recovery after spinal anaesthesia, including sensor and motor function, appears after 3.8 (Group IV-PCA) and 4.2 hours (Group FB-PCA) and did not differ among study groups (P=0.1179).

Femoral nerve block- and intravenous-PCA analgesia provided effective analgesia during first 24-hours after ACL reconstruction (VAS≤3). Significantly lower mean VAS was detected in FB-RCA (0,7+/-0,2 vs. 3,0+/-0,2 in Group IV-PCA)(P<0,0001)(Figure 1).

The maximal daily VAS scores were detected 8 hours after surgery (and 2-hours after PHR) in bought groups and was significant lower in Group FB-PCA (1.5+/-0.5 vs. 4.1+/-7 in Group IV-PCA)(P=0.0001).

Early PHR was possible 6-hours after surgery in 85% of Group FB-PBA (Group IV-PCA=20%) (P=0,0001) (Figure 2).

Additional analgesic dose was more needed in Group IV-PCA (40%) (Group FB-PCA=10%) (P<0,0001) (Table 2). Difference between planned and consumed daily dose of analgesics was less in IV-PCA Group (44%, vs. 86% in Group FB-PCA)(P=0.0001).

Pre-emptive/preventive i.v. or regional analgesia had success in pain reduce before surgery but, followed by

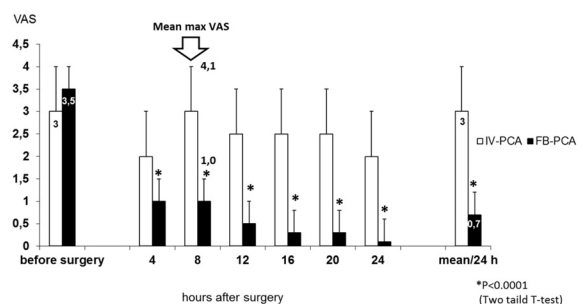


Figure 1. Post-operative acute pain score (VAS) during intravenous (IV-PCA) and femoral nerve block (FB-PCA) analgesia

TABLE 2
Characteristics of analgesia

	Group IV-PCA	Group FB-PCA	P value
Pre-emptive	8 (40%)	9 (45%)	0,3571
Additional	8 (40%)	2 (10%)	0,0001*
PCA duration (hours)	16±2	15±2	0,1221
Consumption (mg/24 hours)	Maximal planed	3,6	174
	Mean request for demand dose	14	2
	Continuous dose	1,1	130
	Total consumed dose	1,6	130
	Δ planed/consumed (%)	44	86

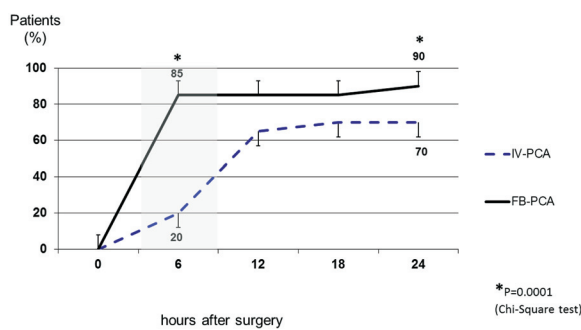


Figure 2. Start of early physical rehabilitation with fentanyl (IV-PCA) and perineural femoral block FB-PCA analgesia after ACL reconstruction

spinal anaesthesia, did not approve its efficiency after surgery neither in Group IV-PCA or FB-PCA.

Slight adverse effects were more frequently presented during IV-PCA but only in first 6-hours after surgery (80%) to compare FB-PCA analgesia (15%) (Table 3) (Figure 3).

In the study groups, no serious complication was observed, related to analgesic's therapy. Residual motor

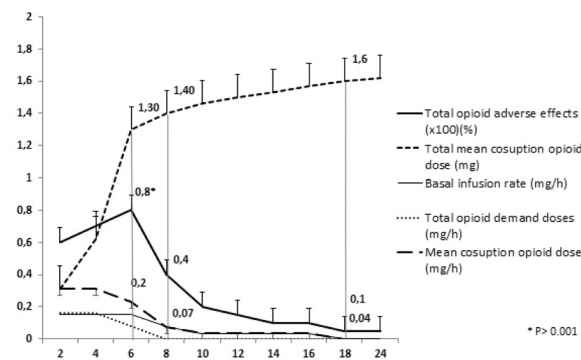


Figure 3. Frequency of fentanyl adverse effects during IV-PCA analgesia in correlation with mean consumption dose (mg⁻¹)

block, presented in three patients (15%) with FB-PCA, disabled the onset of early PHR on the surgical day. In opioid PCA treated patient, dynamic physical rehabilitation started successful in mostly patients at the first post-operative day (24 hours after ACL procedure).

DISCUSSION

Efficient acute pain treatment after RACL surgery is possible with structured and uniform protocols of anaesthesia and analgesia guided by the hospital Acute Pain Service (APS) where continuous assessment of pain is present (18). Perineural or intravenous patient control analgesia (PCA)(19), followed by quality pain assessment and therapy adaptation is integral part of current acute pain management.

Quality physical rehabilitation after "fast-track" ACL reconstruction depends on pain relive success, presence of analgesics adverse effects and stabile vital condition of patient (20). More than 40% of these patients experience moderate (VAS 4-6) to severe (VAS 7-8) pain in first hours postoperatively what inhibits the patient's desire to move and justified to use strong analgesics. On the other side, the presence of muscle weakness due to continuous peripheral motor nerve block (CPNB) analgesia prevents patients actively, rising and delay their recovery and rehabilitation.

In meta-analysis of randomized clinical trials, CPNB provides superior postoperative analgesia (maximal VAS= 2.8–3.8) compare to continuous use of opioid (5.4-6.4) in first 24 hours (21). We supposed that maximal 24-hours VAS was lower in our bought study groups (FB-PCA=1.0, IV-PCA=4.1) due to preoperatively application of sciatic nerve block in single-shot mode in FB-PBA group and use opioid fentanyl instead morphine in IV-PCA group. Side effects compared to opioid analgesia reported by Richman JM were less with CPNB than opioid analgesia (POVN 21 vs. 49%, sedation 27% vs. 52%, pruritus 9.7 vs. 27%) (21). In the same meta-analysis, motor weakness was reported in 31% of 70 patients where continuous PNB analgesia was used. Although, its frequency was only 15% in our FB-PCA group of 20 patients, the data from meta-

TABLE 3

Adverse effects during intravenous-opioid and perineural-femoral patient guided analgesia

ADVERSE EFFECTS DURING ANALGESIA (6 hours after surgery)	Group IV-PCA N (%)	Group FB-PCA N (%)	P value
PONV	3 (15%)	0 (0%)	
Sedation (Ramsay sedation score > 3)	1 (5%)	0 (0%)	
Dizziness	2 (10%)	0 (0%)	
Weakness	7 (35%) (general)	3 (15%) (local)	
Hypotension	3 (15%)	0 (0%)	
Respiratory depression	0 (0%)	0 (0%)	
Total	16 (80%)	3 (15%)	0,001

-analysis is more objective considering the total number of patients included in the study at this moment.

Total consumption of local anaesthetic dose is significantly lower after FB-PCA analgesia than continuous infusion mode with identical analgesic effect. This allows faster motor recovery and prevention of muscle weakness after discontinuation of analgesia (22). Our total consumption dose of levobupivacaine in FB-PCA after RACL was 150 mg in 24 hours what was comparable with Contreras-Domínguez VA data (170 mg bupivacaine in 24 hours) (22). Success pain relief, minimal adverse effects, fast motor recovery and lower incidence of adverse effects associated with FB-PCA analgesia make it the method of choice in "fast-track" ACL reconstruction (23).

Capdevilla X reported that 11% of patients, despite the use of CPNB noted the wound pain 24–48 hours postoperatively and 17–22% of them required opioid analgesic 7 days after surgery (13). In our study we used fentanyl rather than morphine because of its high lipid solubility that resulting in rapid onset of analgesia, lower incidence of side effects and low risk of delayed respiratory depression (24, 25). Reasons for activity limitation in our IV-PCA analgesia were primary due to presence of mild opioids adverse effects (PONV 15%, feeling faint (35%) and dizziness 10%). These results were comparable with results of Capdevilla X who used morphine-PCA analgesia after ACL reconstruction (13). In our IV-PCA group adverse effects was presented significantly only during first six hours from the start of therapy. These data was in correlation with frequently need for fentanyl demand doses during first two hours retrospectively. After reaching the optimal analgesic doses, requests for demand doses decreased and consequently their concomitant effects. Total opioid consumption significantly decreased in the remaining of 24 hours.

Maximal pain experience in our IV-PCA group was higher from the range designate to start of PHR start (VAS 4 vs. =3) during the opioid utilisation interval and this was the second reason for postponing the early PHR.

In our study group IV- and FB-PCA analgesia was combined with non-opioid drugs (diklofenac and para-

cetamol) that decreased dose and minimized opioid and local anaesthetic side effects of primary therapy.

CONCLUSION

Multimodal analgesia in combination with femoral nerve block-PCA analgesia represents a key of current and successful "fast-track" ACL reconstruction by minimizing postoperative pain, opioid-related organ dysfunction and facilitating the recovery process from anaesthesia.

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