

# Total kalça protezinde preoperatif 3-1 bloğun postoperatif ağrı ve tramadol tüketimi üzerine etkisi

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## ÖZET

Bu çalışmada total kalça cerrahisinde preoperatif 3-1 bloğun postoperative ağrı ve hasta kontrollü analjezi ile tramadol tüketimi üzerine olan etkisi çalışıldı. Elektif total kalça protezi ameliyatı geçirecek ASA I-II grubundan 30 hasta çalışmaya dahil edildi. Hastalar rastgele 2 gruba ayrıldı; Grup I: Cerrahiden 30 dk önce 40ml-%0,25 bupivakain ile 3-1 blok yapıp, sonrasında genel anestezi verilen hastalar, Grup II: Cerrahiden 30 dk önce blok lokalizasyonuna basit iğne ponksiyonu yapıp genel anestezi verilen hastalar. Tüm hastalara ameliyat sonunda PCA ile iv-tramadol başlandı. Ağrı, postoperative 0,1/2,1,4,8,12,24 ve 48. saatlerde, istirahat ve harekette, 10 cm'lik VAS skalası ile değerlendirildi. Ortalama intraoperatif fentanil tüketimi I. Gruba, II. Gruba göre daha düşüktü. VAS skorları istirahat ve harekette, I. Gruba II. Gruba göre 3 kat daha azdı (p=0.0001). Total tramadol tüketimi I. Gruba (633.0±119.3 mg), II. Gruba (991.1±41.0 mg) göre daha düşüktü. Hasta memnuniyet skorları I. Gruba, II. Gruba göre yüksekti. Sonuç olarak, elektif TKP ameliyatlarında, 40 ml-%0,25 bupivakain ile preoperatif 3-1 blok uygulamasının, yan etki sıklığını artırmaksızın intraoperatif ve postoperatif analjezik tüketimini azaltarak, efektif postoperatif analjezi oluşturduğu kanaatine varıldı.

**Anahtar Kelimeler:** Total kalça protezi, postoperatif ağrı tedavisi, 3-1 blok, tramadol

## SUMMARY

### *The preoperative analgesic effect of 3-in-1 block on postoperative pain and tramadol consumption in total hip arthroplasty*

We studied the effect of preoperative 3-in-1 block for total hip replacement surgery on postoperative pain and tramadol consumption during patient-controlled analgesia. Thirty ASA I-II patients undergoing elective total hip arthroplasty (THA) were included in the study. Patients were randomly divided into 2 groups; Group I: Patients who received 3-in-1 block with 40 ml of 0.25% bupivacaine 30-minutes before surgery and later received general anesthesia, Group II: Patients who received only a simple needle puncture at the operation site 30-minutes before surgery and later received general anesthesia. All patients received intravenous tramadol at the end of surgery via a PCA device. Pain was evaluated at 0,1/2,1,4,8,12,24 and 48h at rest and on movement of the hip, using a 10cm VAS. The average intraoperative fentanyl consumption was lower in Group I than in Group II. VAS scores were significantly lower in group I, both at rest and during movement at all timepoints over in the first postoperative 12h and also during movement 24h postoperatively. However differences in VAS scores weren't clinically significant after 4 hours. In the recovery room, Group I VAS scores were only a third of Group II, both at rest and movement (p=0.0001). Total tramadol consumption was lower in Group I (633.0±119.3 mg) than in Group II (991.1±41.0 mg). Patient satisfaction scores were higher in Group I than in Group II. We concluded that preoperative 3-in-1 block with 40 ml-0,25% bupivacaine provides effective postoperative pain relief for elective THA, reducing intra-and postoperative analgesic consumption without increase in side effects.

**Key words:** Total hip arthroplasty, postoperative analgesia, 3-in-1 block, tramadol

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## Introduction

Total hip replacement operations are characterized by severe postoperative pain. While 50% of the patients have severe pain even at rest, the pain increases further with movement or reflex spasm in the quadriceps femoris muscle (Ashburn et al.2001). The early initiation of exercise and physical therapy postoperatively is also very important for their rehabilitation (Spetzler et al. 1987). Exercise and physical therapy in the early period can only be made possible through effective analgesia. Various analgesia techniques have been used for pain control following total hip replacement surgery such as intravenous patient-controlled analgesia (iv-PCA) (Spetzler et al. 1987, Singelyn et al. 1999, Weller et al.1991) epidural analgesia (Kampe et al.2003, Bertini et al.1995) and lumbar plexus block (Singelyn et al.1999, Fournier et al.1998, Stevens et al.2000, Biboulet et al.2004). Although iv-PCA leads to better analgesia during rest than intramuscular opioid treatment, it is not adequately effective during movement and is ineffective in preventing the reflex spasm in the quadriceps femoris muscle and in treating already-developed spasm (Metcalf et al.2001). Epidural opioids and local anesthetics either do or do not provide better analgesia than traditional im-opioid or iv-PCA applications (Weller et al.1991, Bertini et al.1995, Singelyn et al.1998). However, while nausea, vomiting, pruritus, urinary retention and respiratory depression are seen more frequently with epidural opioids, problems such as hypotension and motor block can be caused by epidural local anesthetics. In the few studies where 3-in-1 block has been compared to epidural analgesia in hip surgery, it has been shown to be much more advantageous as it provides effective analgesia, is easy to administer and its side effects and associated technical problems are much more infrequent (Singelyn et al.1999, Kampe et al. 2003).

We studied the effect of preoperative 3-in-1 block for THA surgery on intraoperative analgesic requirements and postoperative pain and tramadol consumption during patient-controlled analgesia.

## Methods

This prospective, randomized, blinded study was carried out on 30 patients who were undergoing unilateral THA, after approval by the ethics committee. Written and verbal consent was obtained

from the patients after information was provided on the study. Patients who required emergency surgery, patients younger than 20 or older than 85, those weighing less than 50 kg or more than 110 kg, patients with a history of allergy to local anesthetics, peripheral neuropathy, neurological deficit, abnormal coagulation profile, mental retardation or dementia and those who could not adequately understand pain scoring systems and usage of the PCA device were excluded from the study. All patients were instructed on the usage of the PCA device and the ten-point visual analog scale (0=no pain, 10=worst possible pain) during the preoperative visit and again in the recovery room. Every patients was randomly allocated to one of two groups using computer-generated random numbers. The patients received 10 mg of im diazepam on the night before surgery and 0.5 mg im atropine on the morning of surgery as premedication. Sedation was provided with 0.03 mg/kg iv midazolam following routine monitorization and the patients were assigned into two groups. Group I: Patients who received 3-in-1 block with 40 ml of 0.25% bupivacaine 30 min before surgery and later received a general anesthetic. Group II: Patients who received only a simple needle puncture at the operation site 30 minutes before surgery and later received a general anesthesia.

The 3-in-1 block for group I was performed using Winnie's technique, 30 minutes before surgery. The femoral nerve was localized with the help of the peripheral nerve stimulator (Stimuplex HSN 11 B Braun, Melsungen, Germany AG) with a 100 mm/22 G, blunt-tip peripheral nerve stimulator needle (Stimuplex D B Braun, Melsungen, Germany AG). The presence of continuing contractions in the quadriceps femoris muscle at a value of 0.5 mA was accepted as the optimal position. While the needle was held in this position, 40 ml of 0.25% bupivacaine solution was injected following a negative aspiration. The injection was carried out within a period of two minutes with distal pressure application to increase the spread of the local anesthetic within the psoas sheath. Presence of sensory block in the femoral, obturator and lateral cutaneous nerve dermatomes was tested with the pin-prick test before the general anesthetic was administered by an anesthesiologist blinded to the patient's group . The sensorial distribution areas of the three nerves (femoral nerve: anterior and middle part of the thigh, lateral femoral cutaneous nerve: lateral

and middle part of the thigh, obturator nerve: medial and posterior part of the knee) was divided into ten equal parts and each part was accepted as 10% area. Total sensory block at the distribution of all three nerve distribution areas or total block at the nerve distribution area of two target nerves and more than 80% block at the distribution area of the third target nerve was accepted as a successful block. In Group II, which did not receive a 3-in-1 block, a simple needle puncture was performed at the same localization.

Anesthetic induction was achieved with 2 µg/kg fentanyl, 4-6 mg/kg thiopental, 0.5 mg/kg atracurium in both groups while maintenance was with 1.5 - 2% sevoflurane and 50% N<sub>2</sub>O-50% O<sub>2</sub> mixture at 3 lt min<sup>-1</sup>. Fentanyl was added (1 µg kg<sup>-1</sup> doses at 10 minute intervals) when there was an increase more than 30% from the baseline mean blood pressure or pulse during the surgery. At the end of surgery the patients were extubated and taken to the recovery room. Intraoperative and postoperative assessment was performed by an investigator blinded to the patient's group. The patients' pain was evaluated with VAS as soon as they were responsive to verbal stimuli and PCA was initiated with tramadol. The PCA device (Abbott Pain management provider, North Chicago, USA) was programmed as loading dose: the total of repeated 20 mg bolus doses in every 3 minutes until VAS≤3, basal infusion rate: 5 mg hour<sup>-1</sup>, bolus dose: 20 mg and duration of lock: 15 minutes. Patients evaluated the intensity of their pain with the VAS scale during rest and movement (The leg of the patient who lies in supine position was lifted 2-3 cm by the investigator and than repositioned immediately, while thigh, knee and ankle was in extension.) for a total of 8 times, starting as soon as they responded to verbal stimuli in the recovery room(0) and at postoperative 1/2 1, 1, 4, 8, 12, 24 and 48 hours. VAS≤3 was considered to be an adequate level of analgesia. The bolus dose was increased to 25 mg in patients with VAS>3 and, if it was still not possible to provide an adequate level of analgesia, 0.5 mgkg<sup>-1</sup>-iv meperidine was used as an additional analgesic. Intraoperative fentanyl consumption, the necessary loading dose, the demanded and delivered number of bolus doses and the total tramadol consumption were recorded.

The patients were evaluated for side effects (nausea, vomiting, pruritus, sedation, respiratory

depression, hypotension, bradycardia, hematoma or infection at the injection site) throughout the study. A pulse of less than 50/min was considered bradycardia and a decrease in the baseline mean arterial pressure of more than 30% was accepted as hypotension. Respiration below 8/min was considered respiratory depression. Sedation was evaluated over a score of 0-4 (0:awake; 1:sleepy, can be roused with verbal stimuli; 2:sleepy, can be roused with tactile physical stimuli; 3:sleepy, can be roused with nociceptive physical stimuli; 4:cannot be roused). Nausea was defined as an unpleasant feeling associated with inclination to vomit, and vomiting was defined as the forceful ejection of gastric contents through the mouth. Retching was also recorded as vomiting. Pruritus was defined as an uncomfortable sensation of the skin or mucous membranes that provokes the desire to scratch or rub the affected sites. 10-cm VAS (0 representing no symptom and 10 representing the worst imaginable severity of the symptom) were used to determine the intensity of nausea, vomiting and pruritus. The following treatments were used as rescue medication: 10 mg of iv metoclopramide when 2 or more vomiting episodes occur or nausea VAS score ≥5, 5 mg iv phenylamine when pruritus VAS score ≥5, 0.1 mg iv naloxane in every 2-3 minutes until the patient responded to respiratory depression, 0.5 mg iv atropine for bradycardia, and 500 ml fast crystalloid infusion and if no response, 5 mg iv ephedrine for hypotension.

The patients were asked to evaluate the pain treatment globally at the end of 48 hours over a score of 3 (0=not good; 1=moderate; 2=good; 3=perfect).

Non-parametric tests were used for the statistical analyses of the group comparisons due to the distribution characteristics of the compared variables. The Wilcoxon test was used for inter-group comparisons and a p value < 0.05 was considered significant. The inter-group nominal values and side effects were compared with the Chi square or Fisher's Exact test while the Mann-Whitney U test was used to compare the inter-group numerical values and a p value <0.05 was considered significant. The calculation of sample size for this trial was based upon a preliminary study and previous data. When we performed power analysis depending on description statistics of total tramadol consumption, there was 100% power in case of alpha=0.05.

## Results

There was no difference between the groups as to gender, age, height, weight, ASA, anesthesia duration and operation duration (Table1). There wasn't any insufficient block in group I but only in 2 patients 80% block occurred in the obturator nerve distribution area. Mean VAS scores were significantly lower in group I both at rest and movement during the first postoperative 12h and also at movement 24h postoperatively (Figs.1,2). The group I VAS values were almost a third of group II values for at rest ( $1.6 \pm 0.9$  vs.  $5.7 \pm 0.9$ ,  $p=0.0001$ ) and movement ( $2.3 \pm 1.3$  vs.  $6.5 \pm 1.0$ ,  $p=0.0001$ ) at the recovery room. A VAS value of  $\leq 3$ , accepted as an adequate level of analgesia, was reached at 0 min for rest and movement in group I but only on the postoperative 4<sup>th</sup> hour for group II. The average intraoperative fentanyl consumption, loading dose, requested and administered number of bolus doses and total tramadol consumption was significantly lower in group I than group II (Table2). Additional meperidine was necessary for two patients in group II. The global satisfaction scores were higher in group I than group II ( $p=0.0001$ ) (Figure3). While none of the group II patients assigned a perfect score to the method, 13 patients in group I thought the method was perfect. Side effects encountered during the treatment are presented in Table 3. The most common side effect was nausea in both groups, followed by vomiting. Both nausea and vomiting incidence was higher in group II (Table 3). Two patients from group I and 10 patients from group II required intervention for nausea and vomiting. Sedation was observed in only two patients from group I but in five patients from group II. The sedation scores of group I patients did not go over 1 while those for group II patients did not go over 2. There was no any local anesthetic toxicity in group I

## Discussion

This study demonstrates that for total hip arthroplasty, 3-in-1 block with 40 ml 0.25% bupivacaine results in improved postoperative analgesia with reduced intraoperative and postoperative analgesic requirements.

While 3-in-1 block and other peripheral nerve blocks for anesthesia or analgesia of knee surgery are accepted as an alternative to central blocks together with general anesthesia, the advantages of peripheral nerve blocks and also lumbar plexus block in hip surgery is not well

**Table 1.** Demographical and clinical data for the two groups

	Group I	Group II	P
	n = 15	N = 15	
<b>Sex (F/M)</b>	11 / 4	10 / 5	0.69
<b>Age</b>	$55.7 \pm 10.8$	$58.7 \pm 11.7$	0.40
<b>Weight (kg)</b>	$74.5 \pm 8.6$	$70.2 \pm 9.4$	0.20
<b>Height (cm)</b>	$167.0 \pm 6.9$	$163.6 \pm 6.5$	0.20
<b>ASA (I/II)</b>	14 / 1	11 / 4	0.14
<b>Anesthesia Duration(min)</b>	$136.7 \pm 8.5$	$132.3 \pm 10.9$	0.18
<b>Operation Duration(min)</b>	$129.0 \pm 10.2$	$125.3 \pm 10.7$	0.30

*n: Number, F: Female, M: Male,*

*Group I: Patients receiving preoperative 3-in-1 block; Group II: Patients not receiving 3-in-1 block.*

*ASA: "American Society of Anesthesiologists" physical condition classification.*

**Table 2.** The average intraoperative fentanyl consumption, loading dose, demanded and delivered number of boluses and total tramadol dosage in the two groups (Mean  $\pm$  standard deviation)

	Group I	Group II	P
	n = 15	N = 15	
Intraoperative fentanyl consumption (mg)	$18.3 \pm 32.0$	$94.7 \pm 32.7$	0.001
Loading dose (mg)	$37.3 \pm 18.3$	$82.7 \pm 18.3$	0.001
Number of bolus (demanded)	$20.9 \pm 9.5$	$37.7 \pm 13.8$	0.001
Number of bolus (delivered)	$16.7 \pm 5.7$	$32.7 \pm 2.4$	0.001
Total Tramadol (mg)	$633.1 \pm 119.3$	$991.1 \pm 41.0$	0.001

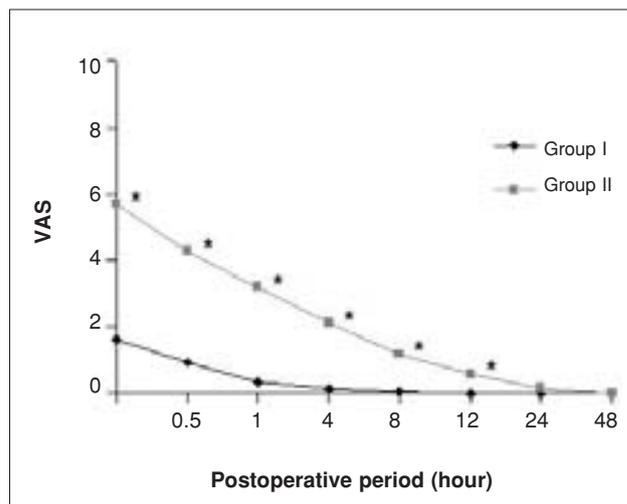
*Group I: Patients receiving preoperative 3-in-1 block; Group II: Patients not receiving 3-in-1 block.*

**Table 3.** Side effects in the two groups (Number of patients)

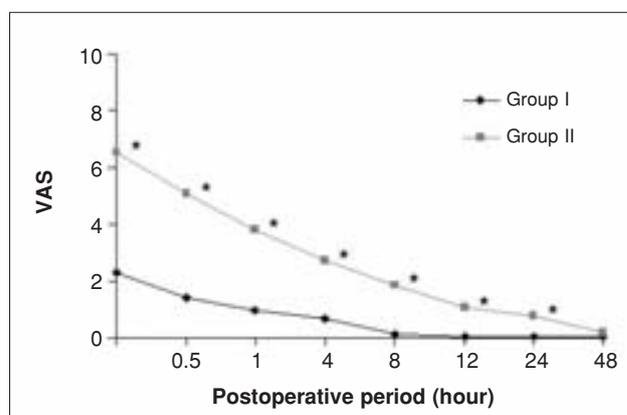
	Group I	Group II	P
Nausea	2 (13,3)	8 (53,3)	0,020
Vomiting	1 (6,7)	7 (46,7)	0,035
Rescue antiemetic	1 (6,7)	10 (66,7)	0,001
Pruritus	0 (0)	1 (6,6)	1,000
Sedation	2 (13,3)	5 (33,3)	0,390

Values are n (%)

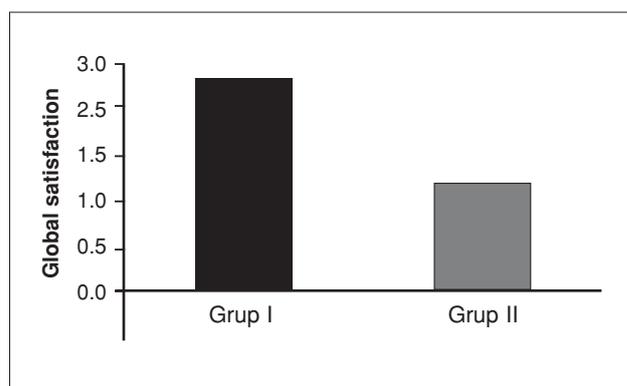
defined and there is only a limited number of relevant studies. The sensorial innervation of the hip comes from the lumbar plexus and sacral plexus (Dyson et al.1995, Birnbaum et al.1997). Although it is not known whether the lumbar or sacral component plays the principal role for the sensorial innervation of the hip, some studies have shown that effective analgesia can be obtained by lumbar plexus blockage by itself (Stevens et al.2000). The lumbar plexus block, first developed by Winnie et al (Winnie et al.1974) can be administered using several techniques (Parkinson et al.1989, Winnie et al.1974, Chayen et al.1976, Hanna et al.1993). We preferred the 3-in-1 block technique in this study as it is easy to use and has a low complication rate. Fournier et al. (Fournier et al. 1998) have investigated the effect of post-induction 3-in-1 block on postoperative diclofenac and subcutaneous morphine consumption and have concluded that it is effective in the early postoperative period. Singelyn et al. (Singelyn et al. 1999) have compared iv-PCA, epidural-PCA and continuous 3-in-1 block and have reported that continuous 3-in-1 block should be preferred as it causes less side effects and technical problems than the other techniques. In another study, Singelyn et al. (Singelyn et al. 2001) have assessed the efficacy of PCA techniques for extended femoral nerve sheath block after total hip arthroplasty and found that, PCA techniques reduced the local anesthetic consumption without compromise in patient satisfaction or VAS scores. In previous study (Singelyn et al.1999) a complication rate of 29% with the 3-in-1 block was found. When compared with single-dose 3-in-1 block, continuous 3-in-1 block leads to an increased rate of complications and also requires special equipment, technical skill and additional time. The increased cost can also be seen as another negative factor. There is also the risk of local anesthetic accumulation and the potential for development of toxicity. We therefore used the single-dose, preoperative 3-in-1 block in our study. The 3-in-1 block is easy to use and has a low incidence of neurological complications; 3/10,309 cases (Auroy et al.2002). We did not encounter any complications or technical difficulties in our study. In a recent study by Biboulet et al. (Biboulet et al. 2004), patients undergoing total hip arthroplasty were randomized to either no blocks (PCA with morphine), femoral nerve blocks (FNB), or psoas compartment blocks (PCB). They concluded that PCA is an efficient and safe analgesia technique, but FNB (provided



**Figure 1.** Mean VAS values during rest. Group I: Patients receiving preoperative 3-in-1 block; Group II: Patients not receiving 3-in-1 block. \*  $p < 0.001$ ; between groups



**Figure 2.** Mean VAS values during movement. Group I: Patients receiving preoperative 3-in-1 block; Group II: Patients not receiving 3-in-1 block \*  $p < 0.001$ ; between groups



**Figure 3.** Mean global satisfaction scores. Group I: Patients receiving preemptive 3-in-1 block; Group II: Patients not receiving 3-in-1 block ( $p = 0.001$ ).

no analgesic advantage, except just after the extubation) and PCB (only during the 4 postoperative hours, and this benefit could be offset by a high rate of potentially dangerous epidural diffusion) should not be used routinely after total-hip arthroplasty.

We continued the 3-in-1 block, with the PCA method for postoperative analgesia. We chose tramadol as it causes significantly less respiratory depression, nausea, vomiting and constipation than morphine and for its hemodynamic stability. The loading dose was not standard in our study and was calculated for each patient (20 mg every 3 minutes until VAS $\leq$ 3). We had two aims when administering the loading dose in a fractionated manner and as required for each patient. First of all we wanted to understand whether the preoperative 3-in-1 block had any effect on the postoperative pain scores and loading dose besides the intraoperative analgesic requirement. We did observe an 80% decrease in intraoperative fentanyl consumption in the group receiving the 3-in-1 block while the pain scores in the recovery room were less than a third of the scores of the group not receiving a block. The group receiving the block also showed a 54% decrease in the loading dose. Our second aim in administering the loading dose in this way was to decrease the incidence of nausea and vomiting, the most common side effects of tramadol. The incidence of nausea in our study was 20% in group I, 40% in group II while the incidence of vomiting was 13% in group I and 53% in group II. We detected a significant decrease in the incidence of nausea and vomiting in parallel to the decreased loading dose in the group receiving the 3-in-1 block. In our study, we obtained a higher quality of analgesia and a lower incidence of side effects with the 3-in-1 block while tramadol consumption decreased by 36%. The group receiving the 3-in-1 block attained an adequate level of analgesia (VAS $\leq$ 3) in the recovery room (at rest and during movement) while the group without the block could only reach this level at the 4th postoperative hour. However, the VAS value was evaluated only at 1/2 and 4 hours postoperatively and we did not monitor the patients in this period. Therefore an adequate level of analgesia in group II should have been attained earlier. We believe that the superior analgesia obtained in group I is also partly due to the prevention of reflex spasm in the quadriceps femoris muscle by the preope-

rative 3-in-1 block. Reflex muscle spasm in the quadriceps femoris muscle is known to be one of the major reasons for postoperative pain after hip replacement. Metcalf et al. (Metcalf et al.2001) has stated that although iv-PCA by itself can provide adequate analgesia at rest, it is not adequate during movement and is not effective in preventing reflex spasm in the quadriceps femoris muscle or in treating already-developed spasm.

In conclusion, preoperative 3-in-1 block with 40 ml of 0.25% bupivacaine for postoperative analgesia in total hip arthroplasty decreases the intraoperative and postoperative consumption of analgesics and is an efficient technique that is easy to use, has a low incidence of complications and can increase the quality of analgesia by decreasing the incidence of side effects.

## References

- Ashburn MA, Ready LB. Postoperative pain. In: Loeser JD, Butler SH, Chapman CR, Turk DC ,eds. *Bonica's Management of Pain*. Philadelphia: Lippincott Williams & Wilkins, 2001;765-779.
- Auroy Y, Benhamou D, Bagues L, Ecoffecy C, Falissard B, Mercier FJ, Bouaziz H, Samii K. Pain and regional anesthesia; major complications of regional anesthesia in France. *Anesthesiology* 2002;97:1274-1280.
- Bertini L, Tagariello V, Molino FM, Posteraro CM, Mancini E, Rossignoli L. Patient-controlled postoperative analgesia in orthopedic surgery: epidural PCA versus intravenous PCA. *Minerva Anestesiologica* 1995;61:319-328.
- Biboulet P, Morau D, Aubas P, Bringuier-Branchereau S, Capdevila X. Postoperative analgesia after total hip-arthroplasty: Comparison of Intravenous Patient-Controlled Analgesia with Morphine and single Injection of Femoral Nerve or Psoas Compartment Block. A Prospective, Randomized, Double-Blind Study. *Reg Anesth Pain Med* 2004;29:102-109.
- Birbaum K, Prescher A, Hepler S, Heller KD. The sensory innervation of the hip joint-an anatomical study. *Surg Radiol Anat* 1997;19:371-375.
- Chayen D, Nathan H, Chayen M. The psoas compartment block. *Anesthesiology* 1976;45:95-99.
- Dyson M, Dussek JE, Ferguson MWJ. Nervous system. In: Williams PL, Bannister LH, Berry MM, Collins P, eds. *Grays' Anatomy*. New York: Churchill Livingstone,1995;1277-1292.
- Fournier R, Van Gessel E, Gaggero G, Boccovi S, Forster A, Gamulin Z. Postoperative analgesia with "3-in-1" femoral nerve block after prosthetic hip surgery. *Can J Anaesth* 1998;45:34-38.
- Hanna MH, Peat SJ, D'Costa F. Lumbar plexus block: An anatomical study. *Anaesthesia* 1993;48:675-678.
- Kampe S, Kiencke P, Delis A, Auweiler M, Konig DP, Kasper SM. The continuous epidural infusion of ropivacaine 0.1% with 0.5microgxml(-1) sufentanil provides effective postoperative analgesia after total hip replacement: a pilot study. *Can J Anesth* 2003;

50: 580-585.

- Metcalf MH, Larson RV. Painful disorders of the thigh and knee. In: Loeser JD, Butler SH, Chapman CR, Turk DC, eds. *Bonica's Management of Pain*. Philadelphia: Lippincott Williams & Wilkins, 2001;1593-1613.
- Parkinson SK, Mueller JB, Little WL, Bailey SL. Extent of blockade with various approaches to the lumbar plexus. *Anesth Analg* 1989; 68: 243-251.
- Singelyn FJ, Deyaert M, Joris D, Pendeville E, Gouverneur JM. Effects of patient-controlled analgesia with morphine, continuous epidural analgesia and continuous three-in-one block on postoperative pain and knee rehabilitation after unilateral total knee arthroplasty. *Anesth Analg* 1998;87:88-92.
- Singelyn FJ, Gouverneur JM. Postoperative analgesia after total hip arthroplasty. IV PCA with morphine, patient controlled epidural analgesia, or continuous "3-in-1" block: a prospective evaluation by our acute pain service in more than 1300 patients. *J Clin Anesth* 1999;11:550-554.
- Singelyn FJ, Vanderelst PE, Gouverneur J-M. Extended femoral nerve sheath block after total hip arthroplasty: Continuous versus patient-controlled techniques. *Anesth Analg* 2001;92:455-459.
- Spetzler B, Anderson L. Patient-controlled analgesia in the total joint arthroplasty patient. *Clin Orthop* 1987;215:122-125.
- Stevens R, Van Gessel E, Flory N, Fournier R, Gamulin Z. Lumbar plexus block reduces pain and blood loss associated with total hip arthroplasty. *Anesthesiology* 2000;93:115-121.
- Weller R, Resenblum M, Connard P, Gross JB. Comparison of epidural and patient-controlled intravenous morphine following joint replacement surgery. *Can J Anaesth* 1991;38:582-586.
- Winnie AP, Ramamurthy S, Durrani Z, Radonjic R. Plexus blocks for lower extremity surgery. New answers to old problems. *Anesth Review* 1974;1:11-16.