

# Total Hip Arthroplasty as an Overnight-Stay Procedure Using an Ambulatory Continuous Psoas Compartment Nerve Block: A Prospective Feasibility Study

Brian M. Ilfeld, M.D., M.S., Peter F. Gearen, M.D., F. Kayser Enneking, M.D., Linda F. Berry, R.N., Eugene H. Spadoni, P.T., Steven Z. George, Ph.D., P.T., and Krista Vandenborne, Ph.D., P.T.

**Objective:** Total hip arthroplasty (THA) results in severe postoperative pain requiring hospitalization to provide potent analgesia. Consequently, the average duration of hospitalization after THA in the United States is 4 to 5 days. This prospective study investigated the feasibility of converting THA into an overnight-stay procedure using a continuous psoas compartment nerve block provided at home with a portable infusion pump.

**Case Report:** Preoperatively, patients undergoing THA had a psoas compartment perineural catheter placed. Postoperatively, perineural ropivacaine 0.2% was delivered through postoperative day (POD) 4. Patients were discharged home when they met specific, prospectively defined criteria, as early as POD 3 for the first phase and POD 1 for the second phase. Of the patients in the first phase (n = 7) who remained hospitalized for at least 3 postoperative nights, 5 met discharge criteria on POD 1 and the remainder on POD 2. Of the patients in phase 2 (n = 5), all but 1 met discharge criteria on POD 1 and 3 were discharged directly home on POD 1. Postoperative pain was well controlled, opioid requirements and sleep disturbances were minimal, and patient satisfaction high.

**Conclusions:** These results suggest that for a subset of patients without major comorbidities, it is feasible to convert THA into an overnight-stay procedure using an ambulatory continuous psoas compartment nerve block as part of a multimodal analgesic regimen provided at home. Additional research is required to replicate these results in a controlled trial, define the appropriate subset of patients, and assess the incidence of complications associated with this practice before its mainstream use. *Reg Anesth Pain Med* 2006;31:113-118.

**Key Words:** Ambulatory surgery, Continuous nerve block, Continuous peripheral nerve block, Patient-controlled regional analgesia, Perineural local anesthetic infusion.

---

From the Departments of Anesthesiology (B.M.I., F.K.E.), Orthopaedics and Rehabilitation (P.F.G., F.K.E., L.F.B.), and Physical Therapy (E.H.S., S.Z.G., K.V.), University of Florida, Gainesville, FL.

Accepted for publication October 4, 2005.

Supported by the University of Florida Department of Anesthesiology, B Braun Medical Inc, Stryker Instruments, and the National Institutes of Health, National Institute of General Medical Sciences (grant no. K23-GM077026). Also supported in part by General Clinical Research Center (grant no. M01-RR00082). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of these entities. B. Braun Medical Inc. and Stryker Instruments had no input into any aspect of study conceptualization, initiation, and design; data collection, analysis, and interpretation; or manuscript preparation.

Manufacturers donated the portable infusion pumps (Stryker Instruments, Kalamazoo, MI) and perineural catheters (B Braun Medical Inc, Bethlehem, PA) used for this investigation.

Presented in part at the Annual Meeting of the American Society of Anesthesiologists, Atlanta, Georgia, October 25, 2005.

Reprint requests: Brian M. Ilfeld, M.D., M.S., Department of Anesthesiology, PO Box 100254, 1600 SW Archer Road, Gainesville, FL 32610-0254. E-mail: bilfeld@ufl.edu

© 2006 by the American Society of Regional Anesthesia and Pain Medicine.

1098-7339/06/3102-0004\$32.00/0

doi:10.1016/j.rapm.2005.10.009

Total hip arthroplasty (THA) results in severe postoperative pain, usually requiring intravenous (IV) opioids, epidural infusion, or a continuous peripheral nerve block to provide adequate analgesia allowing ambulation and rehabilitation.<sup>1-3</sup> In the United States, criteria for home discharge after THA usually include the requirements that (1) pain is controlled with only oral analgesics and (2) patients can ambulate at least 30 m so they may function at home.<sup>4</sup> Consequently, the average duration of hospitalization after THA in the United States is 4 to 5 days.<sup>5,6</sup> Unlike IV opioids and epidural infusion, a continuous peripheral nerve block, also called "perineural local anesthetic infusion," does not require hospitalization when a portable infusion pump is used.<sup>7</sup> A continuous peripheral nerve block has been shown to provide analgesia in hospitalized patients after THA,<sup>1-3</sup> but the possibility of shortening hospital duration while continuing to provide potent analgesia with ambulatory perineural infusion has not been investigated.

Therefore, this study was designed to evaluate the feasibility of converting THA into an overnight-stay procedure using a continuous psoas compartment nerve block at home through postoperative day (POD) 4. Study endpoints included postoperative pain scores, oral and IV opioid requirements, sleep disturbances, and patient satisfaction.

### Case Series

The study protocol was approved by the University of Florida Institutional Review Board, and subjects provided written informed consent before participation. The investigation was divided into 2 phases: the hospitalized phase required patients to remain in the hospital until POD 3, whereas the ambulatory phase allowed for home discharge as early as POD 1.

### Hospitalized Phase

The purpose of the hospitalized phase was to evaluate and improve the proposed protocol while having patients remain in the controlled environment of the hospital for at least 3 nights. This phase was prospectively designed to conclude after 5 patients had met all discharge criteria (Table 1) from the afternoon of POD 1 to the morning of POD 3 and successfully completed their infusion at home. We enrolled patients 18 to 80 years of age scheduled for primary, unilateral, traditional (via a 15-25 cm lateral incision) THA secondary to osteoarthritis who desired a psoas compartment perineural catheter for postoperative analgesia. Subjects were required to (1) live within 2 hours of the hospital and (2) have a "caretaker" who would remain with them during the local anesthetic infusion and could return them to the hospital if necessary. Exclusion criteria included any contraindication to psoas com-

partment nerve block, any comorbidity that resulted in moderate or severe functional limitation,<sup>8</sup> a history of opioid dependence or current chronic analgesic therapy, allergy to study medications, hepatic or renal insufficiency, peripheral neuropathy, and morbid obesity (body mass index >40 kg/m<sup>2</sup>).

**Preoperative Management.** All psoas compartment catheters were placed by one of the authors (BMI). The patient was placed in the lateral decubitus position with the operative hip up. After sterile preparation and draping, a local anesthetic skin wheal was raised at the needle entry point using previously described landmarks.<sup>3</sup> With the bevel-directed caudad, a 102- or 152-mm, 18-G, insulated needle (Contiplex; B Braun Medical Inc, Bethlehem, PA) was inserted with the long axis perpendicular to all planes of the skin. This needle was connected to a nerve stimulator (Stimuplex-DIG, B Braun Medical) initially set at 1.2 mA, 0.1 millisecond, and 2 Hz. Once the needle tip was through the skin, gentle aspiration was applied to allow for identification of a penetrated vessel. The needle was redirected, as needed, until quadriceps contractions were elicited with a current of 0.20 to 0.40 mA.<sup>3</sup>

Following this, 15 mL of D<sub>5</sub>W was injected in divided doses. The multiorifice perineural catheter was then advanced 3 to 5 cm past the needle tip. If the catheter met more than minimal resistance passing the needle tip, it was removed from the needle and replaced with a similar catheter with a single orifice at its tip (B Braun Medical Inc). The tip of this second catheter was left at the tip of the needle.<sup>9</sup> The needle itself was then withdrawn over the catheter, and the catheter tunneled subcutaneously 4 cm toward the nonoperative side using a 16-G angiocatheter. The injection port was attached to the catheter and the catheter secured with sterile liquid adhesive, an occlusive dressing, tape, and an anchoring device on the ipsilateral shoulder.<sup>7</sup>

Fifteen milliliters of mepivacaine, 2%, with epinephrine, 5 µg/mL, was injected via the catheter with gentle aspiration every 2 to 3 mL. Catheter placement was considered successful if, within 20 minutes, the patient experienced a decreased sensation to cold temperature over the ipsilateral distal thigh and weakness with knee extension. Patients without a successful nerve block had their catheters replaced or were withdrawn from the study.

**Intraoperative Management.** Patients received a standardized general anesthetic with sevoflurane in N<sub>2</sub>O and O<sub>2</sub>, titrated for a bispectral index of 40 to 60. Fentanyl (25-µg increments) was administered if necessary. A perineural ropivacaine 0.2% infusion was initiated with a basal rate of 8 mL/h, patient-controlled bolus dose of 4 mL, and lockout

**Table 1. Prospectively Defined Discharge Criteria for Hospitalized and Ambulatory Phases**

Criteria	Details
Analgesia Opioids	Numeric rating pain score consistently ≤4 Hospitalized phase: required <5 mg of IV morphine in previous 24 h (excluding recovery room) Ambulatory phase: required no IV morphine in previous 12 h
Mobility	Able to ambulate >30 m without assistance or dizziness
Oral intake	Tolerating liquids and solids without nausea
Vital signs	Stable after discharge from recovery room
Urinary voiding	Void without assistance after urinary catheter removal
Medical issues	No medical issues necessitating admission

of 30 minutes. Just before emergence, IV morphine was titrated for a respiratory rate of 12. On emergence, patients were taken to the recovery room and then to the General Clinical Research Center.

**Postoperative Management.** Patients were transfused 2 units of packed red blood cells if their hematocrit fell below 30 at any time, as is the standard of care for this surgeon (PFG). Multimodal analgesia and deep vein thrombosis (DVT) prophylaxis were established with scheduled oral acetaminophen (975 mg every 6 hours) and enteric-coated aspirin (650 mg daily) beginning the evening of POD 0 and continuing for 1 week. Rescue opioid and route of administration were determined by pain severity using a Numeric Rating Scale (NRS)<sup>10</sup> of 0 to 10 (10 equal to the worst possible pain imaginable) as follows: oral oxycodone 5 mg (NRS <4), oral oxycodone 10 mg (NRS = 4-7), or IV morphine 2 to 4 mg (NRS >7). After 30 minutes, patients were reassessed and received oxycodone 5 mg (NRS <4) or IV morphine 2-4 mg (NRS >4). Discharge criteria were evaluated after twice daily physical therapy sessions beginning the morning of POD 1 (Table 1).

At 6:00 PM on POD 2, a portable, disposable, electronic infusion pump (Pain Pump II; Stryker Corporation, Kalamazoo, MI) containing 400 mL of ropivacaine 0.2% was attached to the perineural catheter (basal 5 mL/h, bolus 4 mL, lockout 60 minutes). The patient and caretaker were given verbal and written instructions on the use of the pump and catheter and physician telephone and pager numbers. When patients met all predefined discharge criteria, as early as the morning of POD 3, they were discharged home.

**Home Management.** Rehabilitation after discharge did not differ from our institution's current standard of care; patients were visited at home by a registered nurse the day after discharge and by a physical therapist each day through POD 5 and then twice each week for 2 weeks. Patients were telephoned beginning the night of surgery through POD 5. Information collected included pain scores (average and worst NRS), oral opioid use, sleep quality, and satisfaction with analgesia. Patients were questioned about symptoms of local anesthetic toxicity, gross sensory and motor function, local anesthetic delivery (from the pump), and catheter site appearance. In the afternoon on POD 4, patients' caretakers removed the catheters using the pair of nonsterile gloves, with a physician in telephone contact throughout.<sup>7</sup>

### Ambulatory Phase

The purpose of the ambulatory phase was to evaluate if it is possible to provide THA as a single-night

admission. Additional exclusion criteria for this phase included age greater than 70 years,<sup>11</sup> any known cardiac disease, risk factors for DVT,<sup>12</sup> prostate pathology, and history of postoperative ileus. Four changes were made to the protocol after the completion of the hospitalized phase: (1) if the catheter could be advanced past the needle tip with minimal resistance, it was inserted 2 to 3 cm past the tip instead of 3 to 5 cm; (2) after demonstration of correct catheter placement with the mepivacaine bolus, 10 mL of ropivacaine, 0.5%, with epinephrine, 5 µg/mL, was injected via the catheter with aspiration every 2 mL; (3) intraoperatively, all patients received IV hetastarch 15 mL/kg; and (4) the portable infusion pump replaced the hospital-based pump 1 hour before discharge instead of on POD 2. Therefore, the ambulatory phase had the same basic protocol, with one important difference: instead of requiring a minimum hospital stay of 3 days, patients were allowed to return home as early as the morning after surgery when they met all discharge criteria (Table 1).

### Results (Hospitalized Phase)

Three men and 4 women were enrolled in this phase with a mean ( $\pm$  standard deviation [SD]) age of 59 ( $\pm$ 7) years, height of 173 ( $\pm$ 9) cm, weight of 85 ( $\pm$ 15) kg, surgical duration of 135 ( $\pm$ 24) minutes, and estimated blood loss of 721 ( $\pm$ 297) mL. All patients had a psoas compartment catheter placed per protocol. However, in 2 patients whose catheters had been inserted 5 cm past the needle tip, no sensory or motor changes could be elicited 20 minutes after local anesthetic injection. In these 2 patients, the catheter was withdrawn 3 cm, reattached, and a repeat mepivacaine/epinephrine bolus administered. Subsequently, both of these patients developed the required sensory and motor blocks and were retained in the study.

Five patients (71%) met all discharge criteria on POD 1, and 2 (29%) met criteria on POD 2. Of the patients who did not meet discharge criteria until POD 2, 1 required 14 mg of IV morphine and the other could not ambulate the minimum 30 m on POD 1. In 4 patients (57%), dizziness with orthostatic hypotension limited ambulation the morning of POD 1. Postoperative pain was well controlled (Table 2), oral opioid requirements and sleep disturbances were minimal (Table 2), and mean ( $\pm$ SD) patient satisfaction with postoperative analgesia was  $9.6 \pm 0.9$  on both POD 1 and 5 (scale: 0-10, 10 = completely satisfied). All subjects underwent successful perineural infusion at home until their catheters were purposefully removed the afternoon of POD 4.

**Table 2.** Postoperative Pain Scores, Opioid Requirements, Sleep Disturbances, and Ambulation Distance for Hospitalized and Ambulatory Phases

	Postoperative Day					
	0	1	2	3	4	5
Average NRS at rest*	2 (0-7)	2 (0-4)	1 (0-3)	0 (0-2)	3 (0-4)	2 (0-5)
	<i>3 (0-6)</i>	<i>3 (0-4)</i>	<i>1 (0-2)</i>	<i>0 (0-1)</i>	<i>3 (0-2)</i>	<i>2 (0-6)</i>
Worst NRS at rest*	8 (1-10)	5 (2-10)	5 (2-10)	5 (1-9)	5 (1-10)	5 (1-9)
	<i>7 (0-10)</i>	<i>5 (0-6)</i>	<i>3 (0-9)</i>	<i>2 (0-5)</i>	<i>2 (0-2)</i>	<i>4 (0-9)</i>
Average NRS during afternoon ambulation*		3 (0-8)	1.5 (1-5)	2 (0-4)	NC	NC
		<i>3 (0-6)</i>	<i>2 (0-3)</i>	<i>2 (0-3)</i>	<i>0 (0-3)</i>	<i>2 (2-3)</i>
Worst NRS during afternoon ambulation*		5 (4-10)	5 (3-8)	5 (1-7)	NC	NC
		<i>4 (0-7)</i>	<i>4 (0-9)</i>	<i>3 (0-5)</i>	<i>1 (0-5)</i>	<i>2 (2-4)</i>
Morning ambulatory distance (m)		20 (6-121)	133 (26-612)	192 (80-650)	280 (120-440)	
		<i>138 (0-168)</i>				
Afternoon ambulatory distance (m)		154 (44-254)	143 (55-790)			
		<i>210 (71-236)</i>				
Oral opioid consumption (mg)†	10 (0-10)	50 (30-90)	35 (0-70)	30 (0-60)	10 (0-40)	45 (10-60)
	<i>0 (0-5)</i>	<i>10 (0-10)</i>	<i>10 (0-35)</i>	<i>10 (0-40)</i>	<i>0 (0-10)</i>	<i>20 (0-40)</i>
Intravenous morphine consumption (mg)	20 (10-34)	2 (0-14)	0 (0-8)	0 (0-2)	0 (0-0)	0 (0-0)
	<i>12 (0-22)</i>	<i>0 (0-0)</i>	<i>0 (0-0)</i>	<i>0 (0-0)</i>	<i>0 (0-0)</i>	<i>0 (0-0)</i>
Patients reporting difficulty sleeping (no.)‡	2	0	1	1	2	
	<i>1</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	
Awakenings each night (per patient)‡	0 (0-4)	0 (0-0)	0 (0-10)	0 (0-0)	1 (0-10)	
	<i>0 (0-5)</i>	<i>0 (0-0)</i>	<i>0 (0-1)</i>	<i>0 (0-0)</i>	<i>0 (0-2)</i>	

Psoas compartment perineural ropivacaine, 0.2%, infusion provided postoperative days 0 to 4. Data for the ambulatory phase are presented in italics.

NOTE. Values presented as median (range).

Abbreviation: NC, data not collected.

\*NRS, Numeric rating pain scale (0-10, 0 = no pain and 10 = worst imaginable pain).

†Oral opioid: oxycodone.

‡As a result of surgical pain.

## Results (Ambulatory Phase)

Three men and 2 women were enrolled with a mean ( $\pm$ SD) age of 57 ( $\pm$ 12) years, height of 174 ( $\pm$ 16) cm, weight of 75 ( $\pm$ 20) kg, surgical duration of 120 ( $\pm$ 19) minutes, and estimated blood loss of 620 ( $\pm$ 365) mL. All had a psoas compartment catheter placed successfully. Four (80%) met all of the discharge criteria on POD 1, with 3 of these discharged home that day. The remaining patient's caretaker requested he not return home because she had 3 children to care for, and he therefore remained in the General Clinic Research Center until POD 3 and did not require any interventions from health care providers. One patient (20%) could not ambulate the minimum required 30 m until the morning of POD 2 and was discharged home at that time. In only 1 patient (20%) did dizziness upon standing limit ambulation the morning of POD 1. Postoperative pain was well controlled (Table 2), oral opioid requirements and sleep disturbances were minimal (Table 2), and mean ( $\pm$ SD) patient satisfaction was  $9.3 \pm 1.0$  on POD 2 and  $9.9 \pm 0.3$  on POD 5. All subjects underwent successful perineural infusion at home until their catheters were purposefully removed or local anesthetic reservoir was exhausted.

## Discussion

This study investigated the feasibility of converting a subset of THA into an overnight-stay procedure using an ambulatory continuous psoas compartment nerve block as part of a multimodal analgesic regimen provided at home. Although these cases show that THA can be performed on an overnight-stay basis, it does not provide data on the relative degree of analgesia provided by the perineural infusion nor does it define the appropriate subset of patients and incidence of complications associated with this practice. Caution is warranted because, after THA, the median times to myocardial infarction and pulmonary embolism are 1 and 4 days, respectively.<sup>11</sup>

In addition, the most recent American College of Chest Physicians Consensus Conference recommended low-molecular-weight heparin or adjusted-dose warfarin for DVT prophylaxis, neither of which were used for the patients of this study (enteric-coated aspirin is preferred by the surgeon involved with this study).<sup>13</sup> In patients with a continuous psoas compartment nerve block who received low-molecular-weight heparin for anticoagulation, cases of clinically significant hematoma formation have occurred.<sup>14,15</sup> These reports have led some health care

providers to manage patients with a psoas compartment catheter in a similar way as those having neuraxial block when thromboprophylaxis is ordered,<sup>14</sup> although this practice has been questioned by others.<sup>16</sup> The American Society of Regional Anesthesia consensus statement on neuraxial anesthesia and anticoagulation notes that, “conservatively, the [recommendations] . . . may be applied to plexus and peripheral techniques. However, this may be more restrictive than necessary,” and “additional information is needed to make definitive recommendations.”<sup>17</sup>

Should a catheter dislocation or infusion pump malfunction occur following discharge, patients are at high risk of experiencing severe surgical pain uncontrolled with oral opioids requiring hospital readmission. It is for this reason that we required patients to live within 2 hours of the hospital. Related to this issue, patients with heart disease were excluded from participation in the ambulatory phase out of concern that acute, severe pain could trigger an adverse cardiac event. Because not all patients desire, or are capable of accepting, the extra responsibility that comes with early postoperative discharge, appropriate patient selection is crucial for safe ambulatory perineural local anesthetic infusion.

A primary limitation of this study is the absence of a control group. Considering the well-documented acute pain experienced by patients after THA, there is little doubt that the perineural infusion provided analgesia allowing discharge on POD 1.<sup>18</sup> However, the degree of benefits of this practice remains unknown. For example, previous studies involving patients receiving solely opioids for analgesia report a mean ambulatory distance on POD 1 to 5 of 13 m<sup>19</sup> and a mean of 6 postoperative days (range 3-11) to reach 30 m.<sup>20</sup> In contrast, with the addition of a continuous psoas compartment nerve block to a multimodal analgesic regimen, patients of the current investigation ambulated 5 times as far with 75% reaching the discharge threshold of 30 m the day after surgery. However, to document and quantify the efficacy of this analgesic technique requires a randomized, double-masked, placebo-controlled study.

In conclusion, the results of this feasibility study suggest that for a subset of patients without major comorbidities, THA may be performed on an overnight-stay basis using ambulatory perineural infusion. Additional data are required to replicate these results in a controlled trial, define the appropriate subset of patients, and assess the incidence of complications associated with this practice before its mainstream use.

## Acknowledgments

The authors gratefully acknowledge the invaluable assistance of the staff of both the Shands Hospital Regional Anesthesia Induction Area (“Block Room”) and General Clinical Research Center, including Doug Theriaque, MS, for figure compilation included in the original submitted manuscript.

## References

1. Singelyn FJ, Vanderelst PE, Gouverneur JM. Extended femoral nerve sheath block after total hip arthroplasty: Continuous versus patient-controlled techniques. *Anesth Analg* 2001;92:455-459.
2. 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 1,300 patients. *J Clin Anesth* 1999;11:550-554.
3. Capdevila X, Macaire P, Dadure C, Choquet O, Biboulet P, Ryckwaert Y, d’Athys F. Continuous psoas compartment block for postoperative analgesia after total hip arthroplasty: New landmarks, technical guidelines, and clinical evaluation. *Anesth Analg* 2002;94:1606-1613.
4. Enloe LJ, Shields RK, Smith K, Leo K, Miller B. Total hip and knee replacement treatment programs: A report using consensus. *J Orthop Sports Phys Ther* 1996;23:3-11.
5. Munin MC, Kwok CK, Glynn N, Crossett L, Rubash HE. Predicting discharge outcome after elective hip and knee arthroplasty. *Am J Phys Med Rehabil* 1995;74:294-301.
6. Weinstein J. *The Dartmouth Atlas of Musculoskeletal Health Care*. Chicago, IL: AHA Press; 2000.
7. Ilfeld BM, Enneking FK. Continuous peripheral nerve blocks at home: A review. *Anesth Analg* 2005;100:1822-1833.
8. Greenfield S, Apolone G, McNeil BJ, Cleary PD. The importance of co-existent disease in the occurrence of postoperative complications and one-year recovery in patients undergoing total hip replacement. Comorbidity and outcomes after hip replacement. *Med Care* 1993;31:141-154.
9. Ilfeld BM, Morey TE, Enneking FK. Continuous infraclavicular brachial plexus block for postoperative pain control at home: A randomized, double-blinded, placebo-controlled study. *Anesthesiology* 2002;96:1297-1304.
10. Cepeda MS, Africano JM, Polo R, Alcalá R, Carr DB. What decline in pain intensity is meaningful to patients with acute pain? *Pain* 2003;105:151-157.
11. Mantilla CB, Horlocker TT, Schroeder DR, Berry DJ, Brown DL. Frequency of myocardial infarction, pulmonary embolism, deep venous thrombosis, and death following primary hip or knee arthroplasty. *Anesthesiology* 2002;96:1140-1146.
12. Mantilla CB, Horlocker TT, Schroeder DR, Berry DJ, Brown DL. Risk factors for clinically relevant pulmonary embolism and deep venous thrombosis in pa-

- tients undergoing primary hip or knee arthroplasty. *Anesthesiology* 2003;99:552-560.
13. Geerts WH, Heit JA, Clagett GP, Pineo GF, Colwell CW, Anderson FA Jr, Wheeler HB. Prevention of venous thromboembolism. *Chest* 2001;119:132S-175S.
  14. Weller RS, Gerancher JC, Crews JC, Wade KL. Extensive retroperitoneal hematoma without neurologic deficit in two patients who underwent lumbar plexus block and were later anticoagulated. *Anesthesiology* 2003;98:581-585.
  15. Klein SM, D'Ercole F, Greengrass RA, Warner DS. Enoxaparin associated with psoas hematoma and lumbar plexopathy after lumbar plexus block. *Anesthesiology* 1997;87:1576-1579.
  16. Chelly JE, Greger JR, Casati A, Gebhard R, Ben David B. What has happened to evidence-based medicine? *Anesthesiology* 2003;99:1028-1029.
  17. Horlocker TT, Wedel DJ, Benzon H, Brown DL, Enneking FK, Heit JA, Mulroy MF, Rosenquist RW, Rowlingson J, Tryba M, Yuan CS. Regional anesthesia in the anticoagulated patient: Defining the risks. *Reg Anesth Pain Med* 2003;28:172-197.
  18. Zavadak KH, Gibson KR, Whitley DM, Britz P, Kwok CK. Variability in the attainment of functional milestones during the acute care admission after total joint replacement. *J Rheumatol* 1995;22:482-487.
  19. Munin MC, Rudy TE, Glynn NW, Crossett LS, Rubash HE. Early inpatient rehabilitation after elective hip and knee arthroplasty. *JAMA* 1998;279:847-852.
  20. Wenz JF, Gurkan I, Jibodh SR. Mini-incision total hip arthroplasty: A comparative assessment of perioperative outcomes. *Orthopedics* 2002;25:1031-1043.