

three techniques for ultrasound-guided femoral nerve catheter insertion: A randomized, blinded trial. *ANESTHESIOLOGY* 2014; 121:239–48

2. Abdallah FW, Chan VW, Gandhi R, Koshkin A, Abbas S, Brull R: The analgesic effects of proximal, distal, or no sciatic nerve block on posterior knee pain after total knee arthroplasty: A double-blind placebo-controlled randomized trial. *ANESTHESIOLOGY* 2014; 121:1302–10
3. Marhofer D, Marhofer P, Triffiterer L, Leonhardt M, Weber M, Zeitlinger M: Dislocation rates of perineural catheters: A volunteer study. *Br J Anaesth* 2013; 111:800–6
4. Gandhi K, Lindenmuth DM, Hadzic A, Xu D, Patel VS, Maliakal TJ, Gadsden JC: The effect of stimulating *versus* conventional perineural catheters on postoperative analgesia following ultrasound-guided femoral nerve localization. *J Clin Anesth* 2011; 23:626–31
5. Wiesmann T, Borntäger A, Vassiliou T, Hadzic A, Wulf H, Müller HH, Steinfeldt T: Minimal current intensity to elicit an evoked motor response cannot discern between needle-nerve contact and intraneural needle insertion. *Anesth Analg* 2014; 118:681–6

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## Cost Effectiveness of Continuous Femoral Blocks for Total Knee Replacement

To the Editor:

I read with great interest the article by Farag *et al.*<sup>1</sup> Undoubtedly, the authors tried to address a very important concern related to the use of peripheral nerve blocks as a part of comprehensive acute perioperative pain management. However, it seems that they failed to recognize the specificity of the patient population they studied. Functional recovery is the main determinant for patients undergoing total knee replacement. The goal of perioperative pain management in patients undergoing total knee replacement is not to minimize pain at rest, it is to minimize pain during physical therapy while optimizing quadriceps function and minimizing the postoperative risk of falls. Effective pain control during physical therapy has been established to facilitate functional recovery,<sup>2</sup> and excessive postoperative quadriceps weakness has been shown to be a significant cause of falls.<sup>3</sup> Unfortunately, none of these endpoints were considered in the article by Farag *et al.* The authors should recognize that the ability to recover motor function after surgery and the absence of a fall represents an important determinant of the patient length of stay in the hospital, which is estimated to cost thousands of dollars<sup>4</sup> *versus* tens of dollars as studied by Farag *et al.* In my institution, most patients start active physical therapy on the day of surgery and are discharged on postoperative day 2. Optimizing functional recovery hours after surgery is essential because if the patients cannot participate actively in physical therapy, their length of stay increases and with it the overall cost of the surgery.

I was also surprised by the authors' choice of 0.1% ropivacaine at 8 ml/h because even 4 ml/h of ropivacaine 0.1% has been well established to lead to significant motor blockade.<sup>5</sup> In my experience, 3 ml/h or less of ropivacaine 0.1% or bupivacaine 0.0625% seems to be optimal to preserve motor function postoperatively in most patients undergoing total knee replacement.

If the interest is on cost, consideration should be given to the cost of the local anesthetic solution when choosing a continuous block technique. In my institution, we switched from ropivacaine 0.1% to bupivacaine 0.0625% and saved \$30 per bag. These cost savings are substantial for my institution, as we use more than 35,000 bags annually.

In the discussion, the authors raised another important point, for example, the time required to perform a continuous block using each technique. These data were missing from the article and would be most interesting, especially as it relates to the use of ultrasound alone *versus* ultrasound combined with a stimulating needle. In my experience, the difference in the time required for each technique should be insignificant, especially in the hands of an experienced regional anesthesiologist.

In conclusion, anesthesiologists should recognize the specific surgical requirement when comparing different approaches. In patients undergoing total knee replacement, optimizing pain during physical therapy, functional recovery, and minimizing the risk of falls should represent the primary concern.

### Competing Interests

The author declares no competing interests.

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### References

1. Farag E, Atim A, Ghosh R, Bauer M, Sreenivasalu T, Kot M, Kurz A, Dalton JE, Mascha EJ, Mounir-Soliman L, Zaky S, Ali Sakr Esa W, Udeh BL, Barsoum W, Sessler DI: Comparison of three techniques for ultrasound-guided femoral nerve catheter insertion: A randomized, blinded trial. *ANESTHESIOLOGY* 2014; 121:239–48
2. Munin MC, Rudy TE, Glynn NW, Crossett LS, Rubash HE: Early inpatient rehabilitation after elective hip and knee arthroplasty. *JAMA* 1998; 279:847–52
3. Wasserstein D, Farlinger C, Brull R, Mahomed N, Gandhi R: Advanced age, obesity and continuous femoral nerve blockade are independent risk factors for inpatient falls after primary total knee arthroplasty. *J Arthroplasty* 2013; 28:1121–4
4. Ilfeld BM, Mariano ER, Williams BA, Woodard JN, Macario A: Hospitalization costs of total knee arthroplasty with a continuous femoral nerve block provided only in the hospital *versus* on an ambulatory basis: A retrospective, case-control, cost-minimization analysis. *Reg Anesth Pain Med* 2007; 32:46–54
5. Ilfeld BM, Loland VJ, Sandhu NS, Suresh PJ, Bishop MJ, Donohue MC, Ferguson EJ, Madison SJ: Continuous femoral nerve blocks: The impact of catheter tip location relative to

the femoral nerve (anterior *versus* posterior) on quadriceps weakness and cutaneous sensory block. *Anesth Analg* 2012; 115:721–7

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*In Reply:*

Our goal was to determine whether electrical stimulation, either through the needle or catheter, reduces the risk of secondary failure after femoral nerve catheter insertion using ultrasound.<sup>1</sup> The results of our well-powered trial are clear: neither type of stimulation improved analgesia after total knee arthroplasty—and both stimulation techniques took longer to perform and cost more.

Dr. Chelly highlights the importance of providing analgesia sufficient for physical therapy. We used low concentrations of ropivacaine for our femoral catheter infusions specifically because ropivacaine is motor sparing compared with bupivacaine. Bupivacaine is less expensive than ropivacaine, as Chelly notes, and it is possible that a low concentration of bupivacaine would be equally suitable; however, we did not consider the choice of anesthetic or concentration, a topic that has been addressed in numerous previous studies.<sup>2–5</sup> Our primary result—that stimulation through the needle or catheter is unnecessary—presumably applies perfectly well to ropivacaine.

Dysfunction of quadratus femoris muscle after total knee arthroplasty is mainly due to muscle edema,<sup>6</sup> rather than the regional block.<sup>7</sup> But to optimize patient safety, our Acute Pain Service team works closely with Nursing and Physical Therapy and reduces the ropivacaine infusion rate when patients develop weakness. In practice, the system works well and our patients participate actively in physical therapy. We agree that patient falls are dangerous and often disastrous. However, they are also far more likely to occur after discharge than in the hospital where patients are watched closely.<sup>8,9</sup>

Chelly asserts that we failed to report the time required to perform blocks with each approach. In fact, the results are presented in the first paragraph under the header “Secondary Outcomes.” The mean block performance time was 177 s for the stimulating catheter group, 150 s for the stimulating needle group, and 110 s for the ultrasound-only group. Mean block performance time for the ultrasound-alone group was significantly less than the time for either other groups. But as specified in our article, these differences are not clinically meaningful.

Levine *et al.* postulate that our “simple” study has an excessively complex statistical analysis. However, the study was not simple. There were two primary outcomes (pain scores and opioid consumption) and three interventions to be compared: ultrasound-alone, stimulating needles, and stimulating catheters. Our analysis was the proper one for this research question and design, and no more complex than necessary. As specified in our article: “We evaluated these outcomes using joint hypothesis testing”<sup>10</sup> because

differences in pain scores and opioid consumption are difficult to interpret in isolation. We thus considered a block approach superior only if it was shown to be noninferior on both pain and opioid consumption and superior on at least one of the two outcomes.”

Our sophisticated and appropriate analysis was a strength of this article: instead of choosing either pain score or opioid consumption as primary and relegating the other to secondary, as is sometimes done, we kept them both as primary because each is integral to pain management. We required superiority on at least one of them and evidence of being “not worse” (*i.e.*, noninferior) on the other before an intervention would be considered more effective than another—hence, our inclusion of both noninferiority and superiority testing. We thus used a powerful and appropriate approach to joint hypothesis testing.

We also powered the study appropriately and planned interim analyses so that the study could stop early, if warranted, for either efficacy or futility. We believe this should be the standard for most clinical trials, along with the graphical display of treatment effect over time that we reported for each comparison of interest.

We are nonetheless sympathetic to Levine’s broader concern that clinical research articles have become more statistically complex in recent years. Undoubtedly, inclusion of sophisticated statistical analyses makes clinical research harder to read and understand. But it is important to recognize that the statistical complexity in recent articles is not included for amusement of the authors. It is instead included to protect the anesthesia community from research conclusions that are subsequently contradicted<sup>11</sup> or simply wrong.<sup>12</sup>

Our primary outcome was secondary failure, defined by need for supplemental analgesia, as in previous studies.<sup>13,14</sup> We did not evaluate sensory or motor block. The use of ultrasound is helpful in identifying the spread of local anesthetics in the proximity of the femoral nerve, but does not identify catheter position. Therefore, secondary failure remains an important problem with continuous femoral nerve blocks and was the basis for our study. We fail to understand how our study (or any study, for that matter) could “close the door to further novel research.” All we did was ask—and answer—an important question, namely whether stimulation augments the efficacy of ultrasound guidance for insertion of femoral nerve catheters.

Levine *et al.* note that some patients have residual pain in the sciatic distribution after knee arthroplasties. However, the femoral nerve provides 80% of the sensory supply to the knee joint. Consequently, only 12% of our patients required supplementation with single-injection sciatic blocks, and the blocks were evenly distributed among the three groups.

We agree and specified that a difference of just 1 min in block performance time, while statistically significant, is not clinically important. But the stimulating catheter not only took longer, it cost more. The \$50 difference—which