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The Association Between Lower Extremity Continuous Peripheral Nerve Blocks and Patient Falls After Knee and Hip Arthroplasty

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Abstract

Background—Continuous peripheral nerve blocks (CPNB) may induce muscle weakness, and multiple recently published series emphasize patient falls after post-arthroplasty CPNB. However, none have included an adequate control group, and therefore the relationship between CPNB and falls remains speculative.

Methods—We pooled data from 3 previously published randomized, triple-masked, placebo-controlled studies of CPNB involving the femoral nerve after knee and hip arthroplasty.

Results—No patients receiving perineural saline (n=86) fell (0%, 95%CI = 0–5%), but there were 7 falls in 6 patients receiving perineural ropivacaine (n=85; 7%, 95%CI = 3–15%; Fisher's exact test p=0.013).

Conclusions—Our analysis suggests there is a causal relationship between CPNB and the risk of falling after knee and hip arthroplasty.

Introduction

More than one-million knee and hip arthroplasties are performed every year in the United States alone, and that number is expected to grow to 4-million annually within the next 20 years.¹ Continuous peripheral nerve blocks (CPNB) are often used to provide postoperative analgesia for these often painful procedures. Although inhibition of pain fibers is the primary goal of CPNB, currently available local anesthetics approved for clinical use often decrease other afferent (e.g., nonpain-related sensory and proprioception) and efferent (e.g.,

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Conflict of Interest: Dr. Ilfeld received funding for the 3 previously published studies included in this analysis from Arrow International (Reading, Pennsylvania, USA), B. Braun Medical (Bethlehem, Pennsylvania, USA), and Stryker Instruments (Kalamazoo, Michigan, USA). These companies had absolutely no input into any aspect of the present study conceptualization, design, and implementation; data collection, analysis and interpretation; or manuscript preparation of the previously published investigations or the current study.

motor) nerve fibers as well,² resulting in undesirable side effects such as muscular weakness that is particularly undesirable in CPNB that affect the femoral nerve and quadriceps femoris function required for ambulation.³ Also, in contrast to the numerous articles in anesthesiology-centered journals emphasizing the multiple benefits of CPNB, publications of patient series emphasizing falls associated with CPNB have recently appeared within the surgical literature.^{4,5} For example, Feibel et al. report a 0.7% fall rate in a series of 1190 post-knee arthroplasty patients with a femoral CPNB.⁵ Unfortunately, none of these series included an adequate control group to determine whether the CPNB added to the risk of patient falls. Therefore, it remains unknown whether the falls, common in elderly surgical patients after joint arthroplasty without regional analgesia,⁶ would have occurred regardless of the perineural local anesthetic infusion.⁷ In the current report we pool data from 3 previously published randomized, triple-masked, placebo-controlled studies of CPNB involving the femoral nerve to determine if there is a causal relationship between lower extremity CPNB and postoperative falls after knee and hip arthroplasty.

Methods

Data available from previously published multicenter, randomized, triple-masked, placebo-controlled reports involving CPNB affecting the femoral nerve after knee and hip arthroplasty were pooled.^{8–10} No IRB oversight was required since the Common Rule exempts research “involving the collection or study of existing data... if these sources are publicly available or if the information is recorded by the investigator in a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.”^{11,12} The primary outcome of the analysis was prospectively specified as the number of patient falls in each treatment group: either perineural ropivacaine 0.2% or perineural normal saline. Secondary outcomes included the association of other patient variables with the risk of falls. We first analyzed descriptive summaries of fall status for age, gender, weight, height, body mass index, surgical time, hospitalization duration, quadriceps weakness leading to local anesthetic basal infusion decrease, and ambulatory distance for each of the 3 days after surgery in the subgroup of patients that received ropivacaine. The primary end point, the comparison of proportion of falls across treatment groups, was analyzed with Fisher’s exact test applied to the pooled sample. We also checked for balance across treatment arms with respect to relevant covariates with two-sample t-tests and Fisher’s exact tests within each study and in the pooled sample. We applied the same tests to check for balance between those who fell and those who did not fall in order to identify any covariates that might also explain differential fall rates. We applied Pearson’s chi-squared test to examine differences in the fall rate across the 3 studies, and generated one sample 95% confidence intervals for the fall rate by inverting the score test and clipping the interval to 0–1.¹³ All analyses were performed using R version 2.11 (2010).†

Results

Of the 3 multicenter studies included in the analysis, 2 involved femoral and one posterior lumbar plexus (blockade of the lateral femoral cutaneous and obturator nerves in addition to the femoral nerve) CPNB. No patients of the control groups (pooled n=86) fell (0%, 95% confidence interval = 0–5%) while receiving perineural normal saline, but there were 7 falls in 6 patients receiving perineural ropivacaine (pooled n=85; 7%, 95% confidence interval = 3–15%); p=0.013 (Tables 1 and 2). In addition, among patients who received ropivacaine, the fall rate was not different across the 3 studies to a statistically significant degree (Pearson’s Chi-squared = 1.47, df=2, p=0.48). Of the secondary outcomes (Table 3), it is

†R Software Environment for Statistical Computing, R Foundation for Statistical Computing, Vienna, Austria. Available at: <http://www.r-project.org>. Accessed May 17, 2010.

noteworthy that of patients who experienced a fall (n=6), the time to discharge was less (mean [SD] = 3.0 [0.0] days) than in patients who did not experience a fall (n=165; 3.4 [1.0] days; $p<0.001$).

Discussion

While all 3 previously published multicenter, randomized, triple-masked, placebo-controlled investigations reported patient falls during ropivacaine perineural infusion and none during saline perineural saline infusion, these between-treatment differences did not reach the level of statistical significance and no conclusions were offered regarding the association of CPNB and the risk of falling.^{8–10} However, when pooled for the current analysis, the 7 falls in 6 patients receiving ropivacaine versus no patients receiving saline ($p=0.013$) does suggest that there is a causal relationship between CPNB affecting quadriceps strength and the risk of falling after knee and hip arthroplasty (none wore a knee immobilizer). While the major limitation of this analysis is selection bias, until additional data are available practitioners may want to consider steps that may minimize the risk of falls. Such steps include, but are not limited to, minimizing the dose/mass of local anesthetic;¹⁴ providing limited-volume patient-controlled bolus doses which allow for a decreased basal dose without compromising analgesia in some cases,^{15;16} although not all;¹⁷ using a knee immobilizer and walker/crutches during ambulation;¹⁸ and educating physical therapists, nurses, and surgeons of possible CPNB-induced muscle weakness and necessary fall precautions. In addition, since the risk of falling was associated with earlier discharge ($P<0.001$) and 4 of the 7 falls occurred after discharge (after previous successful in-hospital ambulation), practitioners may wish to include the risk of falling as part of patient informed consent before ambulatory CPNB after knee and hip arthroplasty.

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Table 1

Details on the individual patient falls

Fall (reference)	Joint Replaced	Catheter Location	Postop Day, Time	Ropivacaine Infusion Rate	Description
#1 ⁸	knee	femoral	4, 11:00	5 mL/h	Tripped walking through front door of home after successfully ambulating for 4 days—quadriceps weakness denied. Readmission, no injury.
#2 ⁹	hip	posterior lumbar plexus	1, 21:00	8 mL/h	Walking from hospital bed to bathroom after successfully ambulating twice earlier that day—possible quadriceps weakness. No injury.
#3 ⁹	hip	posterior lumbar plexus	3, 20:00	5 mL/h	Standing at sink at home and fell backwards—quadriceps weakness contribution unclear. Readmission, no injury.
#4 ⁹	hip	posterior lumbar plexus	3, 22:00	5 mL/h	Walking from hospital bed to bathroom after successfully ambulating for 3 days—quadriceps weakness denied. Concurrent anemia & dizziness. No injury.
#5 ¹⁰	knee	femoral	2, 16:00	6 mL/h	Standing at hospital bedside after successfully ambulating for 2 days—quadriceps weakness contribution unclear. No injury.
#6 ¹⁰	knee	femoral	3, 12:00	5 mL/h	Exiting vehicle upon returning home after ambulating successfully for 3 days—quadriceps weakness denied. No injury.
#7 ¹⁰	knee	femoral	4, 11:00	5 mL/h	Same subject as fall #6 above. Fell backwards “slowly” while walking her dog at home—quadriceps weakness denied. No injury.

Table 2

Key covariates by treatment assignment (pooled data)

	Ropivacaine (n=85)	Normal Saline (n=86)	P-Value
Age (yr)	62 (10)	63 (10)	0.60
Female (#)	50	50	0.88
Male (#)	35	36	0.88
Height (cm)	169 (11)	168 (11)	0.40
Weight (kg)	84 (19)	82 (17)	0.50
Body mass index	29 (5)	29 (5)	0.94
Surgical time (min)	134 (30)	134 (36)	0.95
Time until discharge ready* (h)	43 (22)	63 (28)	<0.001
Time until actual discharge (d)	3.3 (0.8)	3.5 (1.2)	0.08
Ambulatory distance (m)			
POD 1, morning	23 (25)	23 (31)	0.98
POD 1, afternoon	40 (33)	44 (46)	0.53
POD 2, morning	59 (41)	63 (52)	0.63
POD 2, afternoon	85 (72)	79 (64)	0.57
POD 3, morning	106 (83)	79 (58)	0.03

Values are reported as number of subjects or mean (SD)

* Discharge readiness was defined as meeting 3 criteria: adequate analgesia (0–10 pain score < 4); intravenous opioid-free for previous 12 h; and independently ambulating >30 m)

POD: postoperative day

Table 3

Key covariates by outcome (No Fall vs. Fall, pooled data)

	No Fall (n=165)	Fall (n=6)	P-Value
Age (yr)	62 (10)	67 (9)	0.28
Female (#)	96	4	0.99
Male (#)	69	2	0.99
Height (cm)	168 (11)	174 (11)	0.29
Weight (kg)	83 (18)	81 (15)	0.86
Body mass index	29 (5)	27 (5)	0.40
Surgical time (min)	135 (33)	118 (30)	0.21
Time until discharge ready* (h)	53 (27)	40 (24)	0.25
Time until actual discharge (d)	3.4 (1)	3.0 (0)	< 0.001
Ambulatory distance (m)			
POD 1, morning	22 (29)	24 (24)	0.88
POD 1, afternoon	42 (40)	39 (33)	0.89
POD 2, morning	62 (47)	46 (35)	0.38
POD 2, afternoon	83 (69)	52 (39)	0.12
POD 3, morning	93 (73)	53 (40)	0.23

Values are reported as number of subjects or mean (SD)

* Discharge readiness was defined as meeting 3 criteria: adequate analgesia (0–10 pain score < 4); intravenous opioid-free for previous 12 h; and independently ambulating >30 m)

POD: postoperative day