

# Analysis of Inpatient Falls After Total Knee Arthroplasty in Patients With Continuous Femoral Nerve Block

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Continuous femoral nerve block (cFNB) is thought to increase the risk of falls after total knee arthroplasty (TKA). Previous studies have failed to consider the timing of cFNB removal in relation to inpatient falls. We investigated all inpatient falls after TKA over a 3-year period using our institutional safety report database. Ninety-five falls were reported from a total of 3745 patients. The frequency of falls after TKA persisted at a similar rate despite removal of cFNB and likely regression of femoral nerve block. Other modifiable risk factors may play a more prominent role in falls risk after TKA. (Anesth Analg 2017;XXX:00–00)

Optimization of postoperative analgesia after total knee arthroplasty (TKA) is crucial to facilitate early mobilization and rehabilitation. Continuous femoral nerve block (cFNB) improves analgesic outcomes compared to single-shot femoral nerve block or intravenous patient-controlled opioid analgesia.<sup>1</sup> There is concern that cFNB-mediated quadriceps muscle weakness may contribute to an increased risk of falls after TKA.<sup>2</sup>

A retrospective study of 2197 patients associated cFNB, but not single-shot femoral nerve block, with an increased risk of falls after TKA.<sup>2</sup> However, a large study investigating 191,570 TKA patients could not demonstrate association between inpatient falls and peripheral nerve blockade (PNB).<sup>3</sup> This study did not specify whether single-shot or continuous catheter PNB was utilized.<sup>4</sup> A recent systematic review concluded that the paucity of literature documenting return of sensorimotor function after lower extremity PNB means the asserted causal relationship between residual quadriceps muscle weakness from PNB and inpatient falls lacks evidence.<sup>5</sup>

The aim of this retrospective study is to investigate the association between inpatient falls after TKA and the presence or recent removal of cFNB infusion in a large-volume, tertiary-care academic institution. We also aimed to evaluate the association of other plausible risk factors with inpatient falls. We hypothesized that the fall rate would be higher while the cFNB remained in situ and up to 12 hours after discontinuation.

## METHODS

After research and ethics board approval, we searched the safety report database for all inpatient falls after unilateral

TKA from November 2011 to November 2014 at Sunnybrook Health Sciences Centre, University of Toronto, a tertiary-care academic institution.

Any event in which a patient inadvertently came to rest on the ground, with or without injury, was classified as a fall. Additionally, an incident in which a fall was likely, but was averted through the action of staff or by the patient themselves, was recorded as a near miss and included as a fall. For each fall, a detailed report was completed by the appropriate nursing and medical staff and archived to the safety report database.

A comprehensive search of the electronic patient record was performed for each fall. Date and time of surgical procedure, fall, and cFNB removal were recorded, as were the circumstances and any associated complications.

Additional anesthetic, demographic, and patient comorbidity data related to potential falls risk were collected from all patients undergoing unilateral TKA during the study period, including age, sex, body mass index, American Society of Anesthesiologists score (as a surrogate for comorbidity burden), anesthesia type (intrathecal, epidural, general), presence of sciatic nerve block (SNB), use of knee immobilizer, 48-hour opioid consumption, and lowest postoperative hemoglobin (as a surrogate for postural hypotension).

Standard anesthetic technique for TKA included spinal anesthesia using 7.5–12.5 mg isobaric 0.5% bupivacaine with 10–15 µg of intrathecal fentanyl. In cases of contraindication, patient refusal, or failure of spinal anesthesia, general anesthesia is administered. Preoperative cFNB is inserted using ultrasound guidance with an in-plane or out-of-plane approach according to anesthesiologist preference; 0.5% ropivacaine (20 mL) is administered through the cFNB preoperatively, and infusion of 0.15% ropivacaine is commenced at 5 mL/h in the postanesthesia care unit. The cFNB is removed at 6 AM on postoperative day (POD) 2, unless prolonged duration is indicated on clinical grounds. SNB is performed at the discretion of the anesthesiologist, primarily for those with chronic pain or high opioid tolerance. A standard multimodal analgesia regime including acetaminophen, celecoxib, gabapentin, continuous release hydromorphone, and intravenous patient-controlled opioid analgesia is prescribed. Specific doses or use of each adjunct were dictated based on patients' medical comorbidities.

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Postoperatively, patients weight bear and ambulate with assistance on POD1 with the aid of a knee immobilizer on the operative leg and a front-wheeled walker. Discharge physiotherapy goals include achieving 0° extension, and 120° flexion, independent mobilization on flat ground and stairs, and independence with voiding. The knee immobilizer is removed after physiotherapy on POD2. All patients undergo a falls risk assessment and prevention program.

Chi-square was used to assess for a difference between those patients who fell when cFNB remained in situ or up to 12 hours after its removal, and those for whom cFNB was discontinued for >12 hours. Potential factors that could increase the risk of falls after TKA were compared between those who fell and those who did not using the 2-tailed Student *t* test or Mann-Whitney *U* test for continuous data and  $\chi^2$  or Fisher exact test for categorical data. The Bonferroni correction was used to adjust for multiple comparisons (19), and  $P < .003$  was considered statistically significant for individual inferential tests. An a priori sample size calculation was not conducted because the study period was a sample of convenience coinciding with initiation of electronic recording of paper charts at our institution and time of study conception. With 3745 patients undergoing unilateral TKA and a fall rate of 2.5%, a post hoc power analysis indicates that there was 88% power to detect a relative difference in falls of 30%. Analysis was performed with SPSS version 21 (IBM Corp, Armonk, NY).

## RESULTS

A total of 3745 patients underwent unilateral TKA during the study period; 3736 received cFNB, and 9 received epidural analgesia. The overall incidence of falls was 2.5%. This consisted of 95 fall episodes, of which 11 were near misses.

Fifty-two percent (49/95) of falls occurred >12 hours after cFNB discontinuation, and 48% (46/95) occurred while cFNB remained in situ or <12 hours after its removal. Twenty-six percent of falls (25/95) occurred during the period of cFNB infusion. Thirty-five percent (33/95) of falls occurred >24 hours after cFNB discontinuation (Figure). There was no observable difference in the proportion of falls between those patients for whom cFNB was discontinued for >12 hours and those for whom the cFNB remained in situ or was removed <12 hours previously ( $P = .58$ ).

Patients who fell were 3.5 years older than those who did not (95% confidence interval, 1.4–5.5;  $P = .001$ ), had a higher American Society of Anesthesiologists score ( $P < .001$ ), and were less likely to be utilizing a knee immobilizer ( $P < .001$ ). There were no significant differences between those patients who fell and those who did not for presence of cFNB at any time, gender, body mass index, anesthetic type, presence of SNB, 48-hour opioid consumption, or lowest postoperative hemoglobin (Table).

Regarding fall mechanism, 26 (27%) patients reported a slip or trip, 30 (32%) lost balance, 4 (4%) reported buckling of the knee (one of which was the nonoperative knee), 4 (4%) reported vasovagal or postural hypotension symptoms, 12 (13%) fell from bed, and 19 (20%) had unknown mechanisms. Regarding fall circumstances, 23 (24%) patients fell while ambulating, 41 (43%) were voiding or elimination related, 8 (8%) patients fell while reaching from bed, 4 (4%) fell while getting out of bed, and 19 (20%) were found on

the floor with unknown circumstances. No patient required surgical intervention or had a prolonged length of stay as a direct consequence of falling.

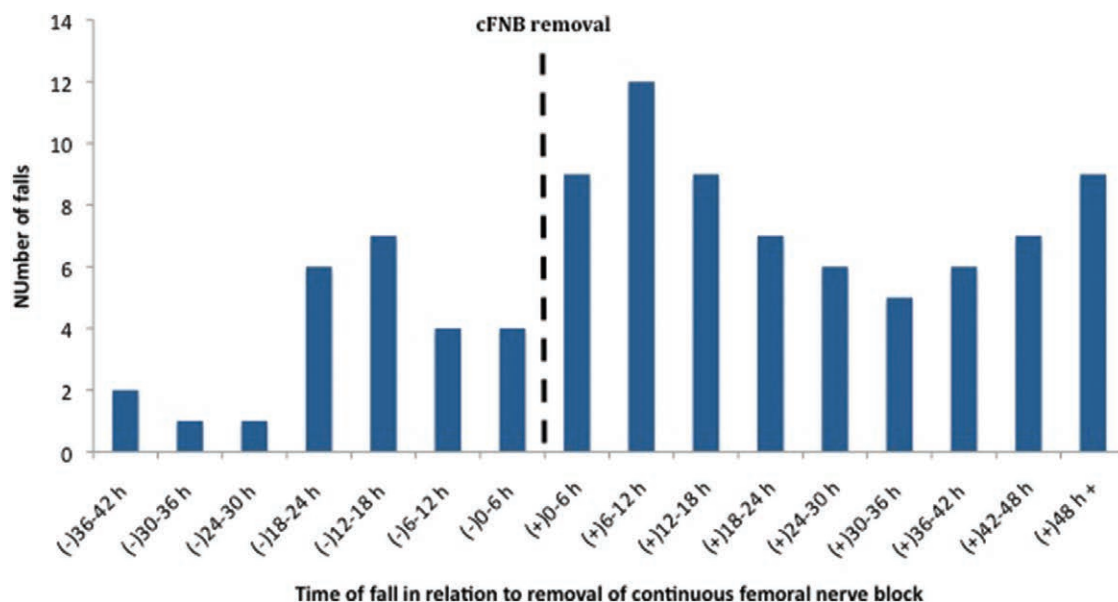
## DISCUSSION

The falls rate in our study population of 2.5% (including near misses) is comparable to previous studies, which reported an incidence ranging from 1.5% to 2.7% after TKA.<sup>6,7</sup> Frequency of postoperative falls increased after cFNB removal and persisted at a similar rate during the subsequent 48-hour inpatient period. Slightly more than half of all falls occurred during the 12 hours after cFNB removal, when the effect of local anesthetic-induced quadriceps weakness had most likely regressed. This suggests that either the duration of local anesthetic-induced quadriceps weakness after low concentration cFNB persists much greater than 12 hours after discontinuation of infusion, or that other contributory factors play a more prominent role in falls after TKA.

There are no clinical studies investigating the temporal return of motor function or proprioception after discontinuation of femoral perineural local anesthetic infusion in patients undergoing TKA. However, because post-TKA quadriceps function at 1 month is reduced by 62% compared to baseline, any clinical quantitative comparison to preoperative baseline quadriceps strength would be inherently flawed.<sup>8</sup> In 2 nonoperative volunteer studies, quadriceps strength returned to baseline at an unknown time point between 8 and 16 hours,<sup>9</sup> and 3 and 16 hours<sup>10</sup> after discontinuation of ropivacaine 0.1% infusion. Due to the retrospective nature of our study, we cannot comment quantitatively on cFNB-induced quadriceps weakness; however, a conservative assumption would be that complete regression occurs within 12 hours of discontinuing the low-concentration local anesthetic infusion.

Our findings suggest that other risk factors such as the inherent quadriceps weakness caused by the surgical procedure itself and unassisted ambulation may be more important contributors toward postoperative falls after TKA. Our data indicated that nearly half of inpatient falls (43%) were elimination related (occurring in the bathroom while going to and from the bathroom, or while using a bedside commode), and an additional 20% of falls were unwitnessed. Patients who fell were older, with a higher comorbidity burden, and it is intuitive that these patients are more likely to fall during unassisted ambulation. Advanced age, obesity, and higher comorbidity burden have previously been reported as risk factors for falls after TKA.<sup>2,3,7</sup> Study patients who fell were also less likely to be wearing a knee immobilizer. Use of knee immobilizers in our institution may contribute to a relative reduction in risk of falls during the period of cFNB infusion.

Formal fall prevention programs reduce the incidence of postoperative falls by targeting modifiable risk factors using measures such as patient education, bed alarms, alert bracelets, increased staff availability at night, toileting schedules, and patient contracts.<sup>7,11</sup> The observed mechanisms of fall episodes in our study suggest that not all falls, even in the presence of cFNB, are specifically related to quadriceps weakness. Addressing modifiable risk factors while focusing efforts on prevention of unassisted mobilization and



**Figure.** Time of fall in relation to discontinuation of cFNB infusion. cFNB indicates continuous femoral nerve block.

**Table. Comparison of Potential Risk Factors Between Patients Who Fell and Those Who Did Not Fall**

|                                       | Fall (n = 95)      | No Fall (n = 3650) | P Value | Mean Difference (95% CI) |
|---------------------------------------|--------------------|--------------------|---------|--------------------------|
| Age (y)                               | 69.9 (10.2)        | 66.4 (10.1)        | .001    | 3.5 (1.4–5.5)            |
| BMI (kg·m <sup>-2</sup> )             | 32.7 (5.6)         | 32.1 (7.1)         | .27     | 0.6 (–0.5 to 1.8)        |
| 48-h oral morphine consumption (mg)   | 197.0 [70.0–324.0] | 175 [29.8–320.2]   | .10     | ...                      |
| Lowest postoperative hemoglobin (g/L) | 97.1 (17.7)        | 98.9 (13.5)        | .32     | –1.8 (–5.4 to 1.8)       |
| cFNB at any time                      |                    |                    |         |                          |
| Yes                                   | 95                 | 3641               | .63     | ...                      |
| No                                    | 0                  | 9                  |         | ...                      |
| Anesthetic type                       |                    |                    |         |                          |
| GA                                    | 8                  | 217                | .32     | ...                      |
| Neuraxial                             | 87                 | 3433               |         | ...                      |
| Knee immobilizer                      |                    |                    |         |                          |
| Yes                                   | 27                 | 3648               | <.001   | ...                      |
| No                                    | 68                 | 2                  |         | ...                      |
| SNB                                   |                    |                    |         |                          |
| Yes                                   | 20                 | 1075               | .08     | ...                      |
| No                                    | 75                 | 2575               |         | ...                      |
| Gender                                |                    |                    |         |                          |
| Male                                  | 34                 | 1318               | .95     | ...                      |
| Female                                | 61                 | 2332               |         | ...                      |
| ASA                                   |                    |                    |         |                          |
| I                                     | 1                  | 102                | <.001   | ...                      |
| II                                    | 23                 | 1635               |         | ...                      |
| III                                   | 71                 | 1887               |         | ...                      |
| IV                                    | 0                  | 26                 |         | ...                      |

Values are mean (SD), median [IQR], or number as appropriate.  $P < .003$  = statistical significance.

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; cFNB, continuous femoral nerve block; CI, confidence interval; GA, general anesthesia; IQR, interquartile range; SNB, sciatic nerve block.

bathroom transfers could potentially reduce inpatient falls after TKA.

Although we did not observe a difference between presence of cFNB in patients who fell and those who did not, we cannot accurately comment on fall risk associated with cFNB due to the lack of an adequately sized control group because only 9 patients did not receive a cFNB. For this reason, we did not perform regression analysis.

Our study has several strengths. We included all falls and near misses, including those with a mechanism not directly linked to quadriceps weakness. We also investigated other

potential factors contributing to inpatient falls, including opioid consumption and comorbidity burden.

Limitations of our study include those inherent to any retrospective design. The use of an electronic patient safety database to record all fall episodes at the time of the event minimizes the risk of underreporting bias. We did not evaluate local anesthetic-mediated sensory function, motor function, or proprioception prospectively; therefore, we cannot exclude the possibility of prolonged motor block or impaired proprioception in a small number of patients.

In conclusion, frequency of postoperative falls after TKA increased after removal of cFNB, and persisted at a similar rate despite likely regression of femoral nerve block. Other modifiable risk factors may play a more prominent role in fall risk after TKA. Health care providers should continue to be vigilant and implement fall prevention strategies after cFNB removal. ■■

#### DISCLOSURES

**Name:** Lloyd R. Turbitt, MBBCh, BAO, FRCA.

**Contribution:** This author helped design and conduct the study, analyze the data, and write the manuscript.

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