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WJO covers topics concerning arthroscopy, evidence-based medicine, epidemiology, nursing, sports medicine, therapy of bone and spinal diseases, bone trauma, osteoarthropathy, bone tumors and osteoporosis, minimally invasive therapy, diagnostic imaging. Priority publication will be given to articles concerning diagnosis and treatment of orthopedic diseases. The following aspects are covered: Clinical diagnosis, laboratory diagnosis, differential diagnosis, imaging tests, pathological diagnosis, molecular biological diagnosis, immunological diagnosis, genetic diagnosis, functional diagnostics, and physical diagnosis; and comprehensive therapy, drug therapy, surgical therapy, interventional treatment, minimally invasive therapy, and robot-assisted therapy.

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Retrospective Study

Reducing costly falls after total knee arthroplasty

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Abstract

AIM

To investigate whether adductor canal nerve block (ACB) reduces patient falls when compared to femoral nerve block (FNB) after total knee arthroplasty (TKA).

METHODS

We conducted an institutional review of all-cause falls after TKA from January 2013 to August 2016 using a quality improvement database. Our inclusion criteria were patients with diagnosis of primary knee osteoarthritis who underwent primary unilateral TKA with either a FNB or an ACB and sustained a fall during their hospitalization. We excluded patients who had revision TKA and extensor mechanism reconstruction. We also excluded patients with a history of post-traumatic arthritis, prior history of lower extremity fracture, history of neurological disease, or cerebrovascular disease.

RESULTS

A total of 834 patients had TKA with femoral nerve block and knee immobilizer (FNB + KI). Of those patients, 11 (1.3%) experienced a fall during their hospital stay. In contrast, 791 patients had TKA with ACB. Of those patients, only one (0.13%) patient fall was recorded within this group. We used the Fisher's exact test to compare the differences between the two groups. The difference between the two groups achieves statistical significance ($P = 0.006$). We also found that 11 out of the 12 patients that fell had a right TKA procedure while one patient had a left TKA procedure. Nine out of twelve patients that fell were female, while only three patients were male.

CONCLUSION

Given the reduction in the number of falls with ACB, it

is recommended that ACB be considered the preferred analgesia for patients undergoing a TKA procedure.

Key words: Reducing falls; Adductor canal nerve block; Total knee arthroplasty; Femoral nerve block; Costly falls

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Core tip: When compared to femoral nerve block, adductor canal nerve block (ACB) contributed to fewer patient falls after total knee arthroplasty (TKA) at our institution from a rate of 1.3% to 0.13%. We also discovered a significant increase in fall rate after right TKA as compared to a left TKA. We recommend ACB as the preferred regional analgesia for the TKA procedure.

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INTRODUCTION

Total knee arthroplasty (TKA) is one of the most replicable and effective orthopedic procedures available. It is used to treat end-stage knee osteoarthritis, post-traumatic arthritis and rheumatoid arthritis of the knee. TKA is an elective procedure performed to relieve pain and restore function to an arthritic knee. The goal of a knee replacement procedure is to relieve pain, improve quality of life, and maintain or improve knee function^[1]. It is approximated that 700000 total knee replacement procedures are performed annually in the United States, and it is projected to increase to 3.48 million procedures per year by 2030^[2]. With the increasing demand for TKA, recent TKA reimbursement changes and limited hospital beds, most hospitals are transitioning to outpatient TKA procedures. Major limitations to outpatient TKA include management of comorbidities, post-operative fall prevention and postoperative pain control^[3].

Inadequate pain control postoperatively can limit rehabilitation and slow down recovery^[4]. Femoral nerve block (FNB) used to be the preferred regional analgesic modality for TKA due to adequate pain control and ease of application. It is administered around the femoral nerve at the level of the inguinal crease. At this level, the femoral nerve contains both motor and sensory distribution. Therefore, one of the complications of FNB is motor blockade, which is due to the anesthesia infiltrating the femoral motor nerve. This causes quadriceps weakness, which could lead to instability in the affected extremity, subsequently increasing the risk of falls. Several studies have shown that quadriceps weakness slows the rehabilitation process and limits ambulatory distance post-operatively^[5]. To reduce post-operative falls at our institution, we started placing patients' operative

extremity in DeRoyal 24-in knee immobilizers (KI) to help improve knee stability. Previously, we performed a retrospective study comparing the fall rate between TKA patients who used KI post-operatively and patients that did not use KI. The study showed that the use of KI reduces the number of patient falls from 3.7% to 1.6%^[4]. A fall rate of 1.6% was considered unacceptable given the high cost and morbidity associated with patient falls. During the study and after polling the floor staff, we discovered that the majority of patients were noncompliant with the use of the KI and a couple of patients fell while wearing the KI. Given the unsatisfactory compliance with the use of the KI and relatively high fall rate, the adult reconstruction team discontinued the use of KI and started considering better alternatives to help reduce fall rate. One of the alternatives proposed was switching the regional anesthesia from FNB to adductor canal block (ACB).

There have been multiple recent studies indicating that ACB, a relatively new sensory block technique that predominantly blocks sensory nerves by anesthetizing only the saphenous nerve in the adductor canal, might be a safer option when compared to FNB, as it preserves quadriceps function while still effectively alleviating post-operative pain^[5,6]. Most studies, including a randomized control trial and a meta-analysis, have shown that patients who receive ACB have faster pain relief, greater quadriceps strength, earlier ambulation, greater average distance of ambulation during physical therapy, faster timed up and go test, and decreased hospital length of stay^[5]. There have been several studies comparing the fall rate between the two regional block techniques (FNB vs ACB), and all findings thus far have been equivocal^[7]. A great deal of knee replacement centers has adopted ACB as the analgesia of choice, even though the data comparing fall rates between the two nerve blocks are inconclusive. Our institution transitioned to using ACB as the preferred anesthesia over FNB for TKA in 2015 to reduce patient falls, however the effects of this change in practice has yet to be evaluated. Therefore, the purpose of this study was to perform an institutional review comparing the fall rate between ACB and FNB + KI after TKA to evaluate its effectiveness at our institution and compare our own fall rates to those reported in the literature.

MATERIALS AND METHODS

We identified patients that fell during their hospitalization period after TKA using our institutional quality improvement reporting database, Be-Safe. The Be-Safe database is used by the floor staff at our Hospital to report in-house unexpected patient outcomes, including falls. All data obtained from the Be-Safe database is used for quality improvement and is exempt from Institutional Review Board approval. The fall data from January 2013 to September 2016 was evaluated. The data included documentation of the date of the fall, procedure performed, the patient's medical record number and a

Table 1 The annual number of reported falls after total knee arthroplasty

Year	Total number of TKA	No. of falls
2013	402	9
2014	432	2
2015	434	0
2016	357	1

TKA: Total knee arthroplasty.

Table 2 The total number of reported falls for each regional nerve block

Nerve block	No. of TKAs per block	No. of reported falls per block	P-value
ACB	791	1	0.006
FNB + KI	834	11	

TKA: Total knee arthroplasty; ACB: Adductor canal nerve block; FNB: Femoral nerve block; KI: Knee immobilizer.

brief description of the circumstances surrounding the incident. We then accessed the electronic medical records for each patient to confirm the procedure that was performed on the patient, the type of regional anesthesia received prior to the fall and the patient's past medical history. We also reviewed operative notes, fall event notes, injuries sustained secondary to the fall, treatments received and any deviation from a normal post-operative course as a result of the fall, including requirement for additional imaging studies. Inclusion criteria included patients with the diagnosis of primary knee osteoarthritis who underwent primary unilateral TKA with either a FNB or ACB regional block and sustained a fall during their hospitalization. Exclusion criteria were patients with history of post-traumatic arthritis, prior history of lower extremity fracture, history of neurological disease, cerebrovascular disease, psychiatric diagnosis, non-ambulatory patients, and patients with a history of chronic opioid use. We also excluded patients who had revision TKA, unicompartmental knee replacements, history of total hip arthroplasty and extensor mechanism reconstruction.

We reviewed anesthesia records on all the patients who fell to confirm the type of regional anesthesia they received. The standard protocol for FNB done for all the TKA patients at our institution consisted of a single shot of 20 mL of 0.5% Ropivacaine injection around the femoral nerve under ultrasound guidance with a continuous infusion of 0.2% Ropivacaine at a rate of 6 mL/h through a femoral catheter that was removed on post-operative day two. The protocol for the ACB consisted of a single shot of 30 mL of 0.5% Ropivacaine under ultrasound guidance around the saphenous nerve in the adductor canal. For both types of regional blocks, a resident performed or assisted with the procedure while a supervising attending was always present.

Statistical analysis

A statistical review of the study was performed by a

biomedical statistician. We used the Fisher's exact test to evaluate differences between the two groups. A P -value < 0.05 was considered statistically significant.

RESULTS

Seven patients were excluded from the study. One patient was excluded from the ACB fall group due to prior history of falls and history of a neurological disease. Five patients were excluded from the FNB group because they had revision TKA. One patient was excluded from the FNB fall group because the patient had an extensor mechanism reconstruction procedure along with a revision TKA. There was a total of 834 patients that had TKA with FNB + KI between January 2013 and December 2014 (Table 1). Of those patients, 11 (1.3%) experienced a fall during their hospital stay (Table 2). One patient had an ankle fracture necessitating operative fixation. One patient sustained facial laceration, which required sutures. Three patients' injuries necessitated X-rays of their extremity after the fall, but no fractures were identified. Within the FNB group, four patients fell on post-operative day one and seven patients fell on post-operative day two. The age range of the patients that fell after FNB was between 49-92 years old with an average age of 65.5. Eight of the eleven patients in this group were females. The average body mass index (BMI) of the patients that fell after FNB was 33.3. In contrast, of the total 791 patients that had TKA with ACB between January 2015 and August of 2016, only one patient (0.13%) fall was recorded (Table 1). The patient who fell after ACB was a 59-year-old female with a BMI of 41.77, who fell on post-operative day two. The difference between the two groups reached statistical significance ($P < 0.006$) (Table 2). It was noted that out of the total twelve patients that fell, 11 (92%) had right TKA compared to one patient fall after a left TKA. Also, nine out of twelve patients that fell were female, while only three patients were male. These last two findings warrant further investigation.

DISCUSSION

Most large joint replacement institutions have switched to ACB as the preferred regional anesthesia for TKA. The reasoning in most cases revolves around reducing the fall rate after TKA. There is a considerable amount of literature to support the use of ACB over FNB due to faster pain relief, greater quadriceps strength, earlier ambulation, greater average distance of ambulation during physical therapy, faster timed up and go test, and decreased hospital stay^[5]. However, there is no evidence to support reduction in fall rate when ACB is compared with FNB to date^[7]. Our study showed a reduction in fall rate after institution-wide transition to ACB as the preferred analgesic method over FNB. Caution must be taken when interpreting and applying our study because this study is a retrospective, non-matched design without control groups for possible confounding variables or

differing patient group risk factors. Underreporting by staff members is an inherent limitation to using a quality assurance report like the one used in this present study. We also had a very low number of falls.

While gathering data for this study, we reviewed fall data exclusively from the dedicated orthopedic surgery post-operative acute inpatient ward. In very rare circumstances, patients were transferred to other floors if the orthopedic ward was at capacity or if the patient's comorbidities or intra-operative complications required admission to the intensive care unit or the intermediate care unit. It is possible that some of the TKA patients fell while on other floors.

A major confounding variable is the general institutional emphasis on reducing all cause falls during the same time period. Over the past five years, there has been a hospital wide initiative to reduce the number of falls at our institution. Our institution has invested in fall prevention awareness programs, which included frequent education of floor staff, replacing old hospital beds with new beds equipped with bed alarms and motion sensors that detect patients' movement out of bed and automatically notify floor staff. All patients with increased fall risk are now identified early in the pre-admission phase based on several factors including age, past medical history and medications being taken. These patients are provided bright yellow wristbands, yellow gowns, yellow slip resistant socks and are monitored more frequently. All patients having an arthroplasty procedure are now required to attend an arthroplasty course in which they are well educated on fall prevention. We believe that the new fall prevention initiative could possibly have contributed to the reduction in fall rate, but the effect of ACB is likely additive. Our analysis would be strengthened with more fall patients, which will allow us to have more data points to analyze and perform a multivariate analysis for potentially confounding variables (spinal vs general anesthesia, use of PCA vs oral analgesics, BMI and age).

An interesting result we found during this study was increased fall rate after right TKA compared with left TKA. A literature search showed no prior studies comparing the fall rate between right TKA vs left TKA. The increase in fall rate could be due to several factors, including extremity dominance, higher rate of right TKA procedures than left TKA at our institution, or it could be a stochastic anomaly. Nevertheless, the association of laterality with fall risk merits further investigation given our findings.

In conclusion, the present study found a significant relationship between ACB and fall reduction as compared with FNB + KI. This study is limited by the small numbers of falls and confounding variables that were not controlled for.

ARTICLE HIGHLIGHTS

Research background

There have been multiple recent studies indicating that adductor canal block

(ACB) might be a safer option for patients undergoing total knee arthroplasty (TKA) procedure when compared to femoral nerve block (FNB) because of its potential ability to reduce patient falls, as it preserves quadriceps function while still effectively alleviating postoperative pain. Most studies, including a randomized control trial and a couple meta-analysis studies, have shown that patients who ACB have faster pain relief, greater quadriceps strength, and decreased hospital length of stay. There have been several studies comparing the fall rate between the two regional block techniques (FNB vs ACB), and all findings thus far have been equivocal. A lot of institutions have switched to ACB as their preferred regional analgesia simply based on preservation of quadriceps strength and early mobilization. Our institution made the switch to ACB as the primary regional analgesia after the occurrence of several patient falls following a TKA procedure using FNB. This study is significant and was done to evaluate the effectiveness of ACB at preventing falls at our institution and compare our fall rates to those reported in the literature.

Research motivation

The motivation behind this research is to evaluate and compare the fall rate after TKA procedure between ACB and FNB at our institution. This research is significant because it allows us to evaluate how effective ACB is at reducing patient falls after TKA when compared to FNB. Results from this study can be applied at various institutions to help decrease patient falls. Results from this study could also be a source of data points for future meta-analysis.

Research objectives

The main objective of this study was to evaluate and compare the fall rate after TKA procedure between ACB and FNB at our institution. Our results indicated that there was significant reduction in patient falls after TKA procedure after switching to ACB. This is important because our institution will continue to use ACB as the preferred regional analgesia for TKA procedure.

Research methods

In this study, we analyzed the fall data at our institution using our institutional quality improvement reporting database, Be-Safe from January 2013 to September 2016. We then accessed the electronic medical records for each patient that fell to confirm the procedure that was performed on the patient, the type of regional anesthesia received prior to the fall and the patient's past medical history. We only included patients with the diagnosis of primary knee osteoarthritis who underwent primary unilateral TKA with either a FNB or ACB regional block and sustained a fall during their hospitalization. We excluded patients who had revision TKA, unicompartmental knee replacements, history of total hip arthroplasty and extensor mechanism reconstruction. We then compared the fall rates in patients after receiving ACB vs FNB after a TKA procedure. We used the Fisher's exact test to compare differences between the two groups, and there was a statistical significant difference between the groups ($P < 0.006$).

Research results

A total of 11 (1.3%) experienced a fall during their hospital stay after receiving FNB for a TKA procedure while one patient (0.13%) fell after receiving ACB for a TKA procedure. Results from this study indicated a significant drop in the fall rate at our institution after switching from FNB to the ACB. Our data indicate that patient and staff education on fall prevention and the use of ACB for patients undergoing TKA is effective at reducing falls.

Research conclusions

New findings in this study highlighted that there was an increased rate of patient falls after right TKA compared to left TKA. We also found that more female patients fell after TKA compared to male patients. We propose a new theory that due to extremity dominance, patients are more likely to fall after having a TKA procedure on their dominant lower extremity due to instability and weakness in their dominant/lead extremity. For unknown reasons, we also think that female patients are more likely to fall after TKA procedure when compared to male patients. We summarize that switching to ACB helped contribute to reducing the fall rate after TKA at our institution. We believe that the reduction in the fall rate is related to the preservation of the quadriceps strength with ACB as demonstrated by multiple prior studies^[5]. We hypothesize that a systematic review or a case control study will help confirm our theory that female patients and patients that have TKA on their dominant extremity are more likely to fall

when compared to male patients and patients that have TKA on their non-dominant extremity. There were no new methods proposed by this study. Our hypothesis that ACB reduces patient falls was confirmed in this study. Based on this study, our institution will continue to use ACB as the regional anesthesia for a TKA procedure. We will also continue to educate and take special precautions with patients that are high fall risk.

Research perspectives

This study helped highlight the importance of developing and maintaining patient safety initiatives in healthcare. It also helped in displaying the importance of patient and staff education and awareness to difficult safety issues in the hospital. The direction of future research will be to do a meta-analysis or retrospective study to further investigate if there is truly an increased risk in patient falls in females and after TKA on the dominant extremity. The best method for future research will be to perform a prospective study looking at the degree of quadriceps weakness, ambulatory distance, earlier or late ambulation, distance of ambulation during physical therapy, timed up and going test, and hospital length of stay post-operatively in male vs female patients and in dominant vs non-dominant extremity.

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