Femoral Nerve Block vs Periarticular Bupivacaine Liposome Injection After Primary Total Knee Arthroplasty: Effect on Patient Outcomes

Brandon J. Horn, DO; Adam Cien, DO, MS; N. Peter Reeves, PhD; Pramod Pathak, PhD; and Charles J. Taunt Jr, DO

From the Department of Orthopedic Surgery at McLaren Greater Lansing Medical Center in Michigan (Drs Horn, Cien, and Taunt) and the Department of Orthopedic Research at Michigan State University in East Lansing (Drs Horn, Cien, Reeves, and Pathak).

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Address correspondence to Brandon J. Horn, DO, 2727 S Pennsylvania Ave, Lansing, MI 48910.

E-mail: brandonjhorn@gmail.com

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Context: Patients receiving femoral nerve blocks for total knee arthroplasty (TKA) have been shown to have a high incidence of postoperative falls, which has been attributed to weakening of the quadriceps muscles. Local injection of analgesic medication that allows for full motor function of the quadriceps and, therefore, better progress through inpatient physical therapy and decreased hospital stay, has been suggested as an option for postoperative pain relief.

Objective: To compare the number of inpatient physical therapy sessions and hospital days needed in patients receiving periarticular injection of extended-release bupivacaine liposome vs femoral nerve block after TKA.

Methods: Data were retrospectively reviewed from the records of patients who underwent bilateral primary TKA, in which femoral nerve block was administered at the first operation and periarticular injection of an extended-release bupivacaine liposome mixture at the second operation. An average of 2.3 years had passed between the 2 procedures. The number of inpatient physical therapy sessions and hospital days needed were compared between both procedures for each patient.

Results: Sixteen patients (14 women) were included in the study, with a mean (SD) age of 63.8 (6.7) years. Compared with femoral nerve block, periarticular injection of analgesic medication resulted in fewer inpatient physical therapy sessions (femoral nerve block: mean [SD], 3.5 [1.3] sessions; periarticular injection: mean [SD], 2.3 [1.0] sessions; P=.002) and fewer hospital days (femoral nerve block: mean [SD], 1.9 [0.6] days; periarticular injection: mean [SD], 1.5 [0.6] days; P<.032).

Conclusion: Compared with femoral nerve block, periarticular injection of analgesia was found to quicken postoperative recovery in patients hospitalized for TKA. The use of periarticular injections in patients undergoing TKA could yield substantial cost savings given the high frequency of this procedure.

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A video of the periarticular injection procedure is available on JAOA.org.

Postoperative pain management has been a major concern as it relates to patient outcome after total knee arthroplasty (TKA).[1] Appropriate analgesia in the postoperative setting allows patients to fully participate in rehabilitation protocols and progress to the home setting or a subacute rehabilitation hospital in a reasonable amount of time.[2] Femoral nerve block is a well-established technique for reducing pain and accelerating rehabilitation in patients undergoing TKA.[3] Sharma et al[3] found that patients receiving femoral nerve block had shorter hospital stays and increased ability to undergo physical

therapy compared with patients receiving oral analgesia postoperatively. However, they also had a higher incidence of postoperative complications, such as falls, which were attributed to weakening of the quadriceps muscles after nerve block.[3]

Intra-articular injection of bupivacaine and epinephrine in normal saline after wound closure has been shown to decrease the need for narcotics and increase the range of motion after elective knee replacement.[4] Periarticular injection of bupivacaine has also been found to be beneficial to patients in the postoperative setting.[5] Affas et al[6] demonstrated that the average pain level was lower in patients who received local periarticular injection of ropivacaine, ketorolac, and epinephrine, compared with those who received femoral nerve block.[6] Local periarticular injection of analgesic medication was also considered to be superior to femoral nerve block in terms of cost and ease of use.[6] Indicated for postsurgical analgesia and administered at the surgical site at the end of the procedure,[7] extended-release bupivacaine liposome has been shown to reduce pain, decrease opioid use, and improve patients' overall satisfaction after hemorrhoid operation when compared with placebo.[8] Drug diffusion occurs for up to 72 hours after administration.[7]

The key difference between femoral nerve block and periarticular injection of analgesia is that periarticular injection maintains motor function while providing pain relief. It has been shown that analgesia administered by femoral nerve block affects motor and sensory functions of the femoral nerve distribution for approximately 24 hours.[3] The purpose of the present study was to assess functional recovery from TKA and hospital length of stay at separate primary TKAs after administration of femoral nerve block or local periarticular injection of an extended-release bupivacaine liposome mixture. We hypothesized that the use of local periarticular injection of a bupivacaine liposome mixture would reduce the number of hospital days and inpatient physical therapy sessions when compared with femoral nerve block.

Methods

Approval from the institutional review board was obtained before the study began (protocol 2013-0026). We identified and retrospectively reviewed the medical records of all patients who underwent TKA by a single surgeon (C.J.T.) between March 2009 and August 2013. Patients were included in the study if they underwent an initial primary TKA with a femoral nerve block and a subsequent primary TKA with periarticular injection of an extended-release bupivacaine liposome mixture. Patients were excluded if they did not have a normal postoperative course, such as an extended medical stay as a result of medical complications, or subacute rehabilitation discharge planning, which could delay hospital discharge because of Medicare rules.

Femoral Nerve Block

With patients in the supine position, the anesthesiologist marked an injection point at the intersection of a line drawn from the anterior superior iliac spine to the pubic symphysis and a vertical line lateral to the femoral artery. An ultrasound-guided injection of 40 mL of 0.25% bupicaine was infiltrated into the nerve sheath. This target was confirmed with muscle twitches of the quadriceps.

Periarticular Injection

At the second TKA, patients received a single administration of liposomal bupivacaine mixture consisting of 266 mg of bupivacaine liposome in 40 mL of 0.9% isotonic sodium chloride solution in conjunction with 20 mL of 0.25% of bupivicaine with epinephrine. The solution was mixed on the operative field and injected before placement of the final implants. A 20-mL syringe and 1.5-inch 21-gauge needle were used. A total of 80 mL of the bupivacaine liposome mixture was infiltrated into the posterior capsule, periosteum of the femur and tibia, articular capsule medially and laterally, quadriceps tendon and vastus medialis oblique, patellar tendon, and dermal-epidermal junctions on either side of the incision (*Figure 1*, *Figure 2*, *Figure 3,* and *eVideo*).

A video of the periarticular injection procedure is available on JAOA.org.

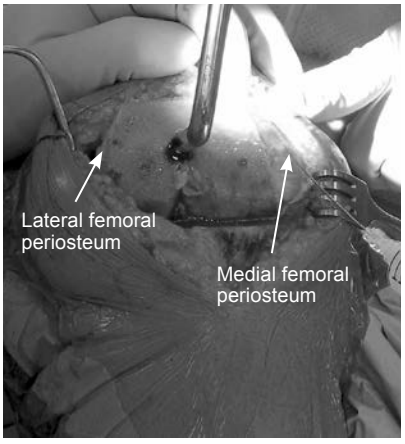

Figure 1.
Demonstration of injection of bupivacaine liposome mixture into medial and lateral femoral periosteum, posterior cruciate ligament, and posterior capsule of the knee during total knee arthroplasty.

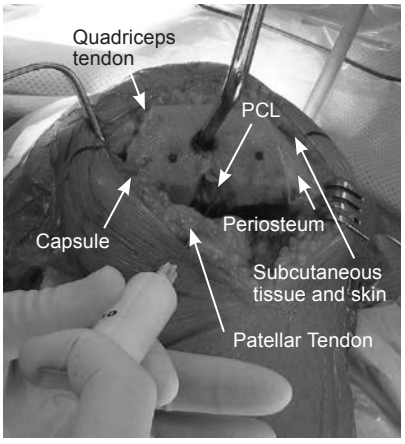

Figure 2.
Demonstration of injection of bupivacaine liposome mixture into the posterior capsule, capsule medially and laterally, quadriceps tendon and vastus medialis oblique, and patellar tendon during total knee arthroplasty.

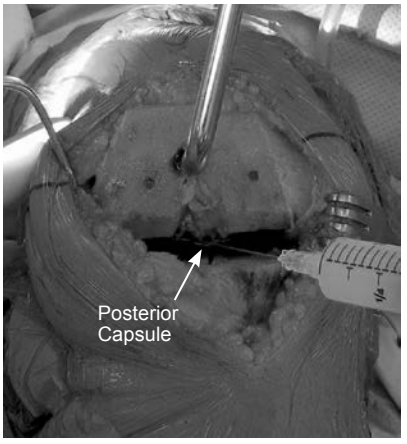

Figure 3.
Demonstration of injection of bupivacaine liposome mixture into the posterior capsule during total knee arthroplasty.

Total Knee Arthroplasty

All TKAs were performed by a single surgeon. The procedure was performed through a standard midline skin incision with a medial parapatellar arthrotomy. A standard cemented total knee system was used.

Postoperative Protocol

All patients followed an inpatient clinical pathway that included early mobilization after surgery, continuous passive motion, and weight bearing as tolerated with a walker or crutches. Patients who had femoral nerve block received a knee immobilizer with ambulation until quadriceps muscle function returned, usually between 12 and 24 hours.

Physical therapy was initiated on either postoperative day 0 or 1. If a patient underwent TKA before noon, he or she would attend a session of physical therapy on postoperative day 0. Each physical therapy session consisted of gait training with a rolling walker, therapeutic exercises, and stair climbing. Inpatient physical therapy was considered completed when patients were able to walk independently for a distance greater than 150 feet, a target based on the functional independence measures guidelines.[9]

Pain was controlled throughout the course of the hospital stay with a combination of oral, intravenous, and patient-controlled analgesia. Discharge from the hospital was based on patients' progress with inpatient physical therapy and pain control with oral pain medications represented by a visual analog scale score of less than 5 out of 10.[10]

Statistical Analysis

A sign test was used to determine whether the periarticular injection of analgesia resulted in fewer hospital days and inpatient physical therapy sessions compared with the femoral nerve block. Three possible outcomes were found: a positive difference, indicating that the

periarticular injection was superior (fewer hospital days or physical therapy sessions needed), a negative difference (indicating that the periarticular injection was not superior), or no difference (tie).

Results

Three patients were excluded because of subacute rehabilitation admission delay (2) and admission to the intensive care unit because of respiratory failure (1). A total of 16 patients (14 women) who had undergone bilateral TKAs using the 2 different methods of analgesia (femoral nerve block and extended-release bupivacaine liposome mixture) were identified.

Given that the periarticular injection protocol was incorporated into clinical practice at a later date, all patients were older when they received the periarticular injection of analgesia compared with the femoral nerve block. On average, patients underwent their second TKA 2.3 years after their first TKA. No statistically significant differences were found in time-varying patient demographics, such as weight and body mass index, between the first and second operations. More women underwent bilateral TKA than men (14 and 2, respectively).

Periarticular injection of analgesia resulted in fewer inpatient physical therapy sessions (mean [SD], 2.3 [1.0] sessions) compared with femoral nerve block (mean [SD], 3.5 [1.3] sessions). Ten patients had a positive difference, no patients had a negative difference, and 6 patients had no difference in number of inpatient physical therapy sessions. The probability of observing 10 positive differences in 10 patients was P=.002. In addition, the periarticular injection resulted in fewer hospital days (mean [SD], 1.5 [0.6] days) compared with femoral nerve block (mean [SD] 1.9, [0.6] days). Six patients had a positive difference, no patients had a negative difference, and 10 patients had no difference in number of hospital days. The probability of observing 6 positive differences in 6 patients was P=.032.

Discussion

Our data demonstrate that periarticular injection of analgesia allowed patients to complete their inpatient physical therapy in fewer sessions and to be discharged sooner compared with femoral nerve block. This finding suggests that patients who receive periarticular injection of analgesia are able to ambulate independently faster because it does not affect postoperative motor function.

Several limitations to this study exist. It was not a blinded prospective randomized study of patients undergoing TKA and receiving either femoral nerve block or periarticular injection of analgesia. Cohorts were retrospectively constructed. However, the dataset is unique in that patients served as their own controls, which minimized the variability in patient populations and minimized the risks of potential confounders normally associated with case-control designs. The methods we used allowed us to analyze the 2 analgesic interventions with few other confounding variables. The one difference between patient groups was age. Another limitation was that patients may have had improved outcomes with second TKA because they had already experienced the procedure and knew what was expected of them during the postoperative period. This issue has not been well described in the literature. Further studies could address this concern by randomizing the order in which the type of analgesic intervention was administered, or reversing the order of analgesic intervention (ie, periarticular injection of analgesia first and femoral nerve block second).

Some evidence exists to suggest that wound healing in healthy older people (>70 years) is essentially normal[11] despite generalized decreased in health status. However, systemic, regional, and local factors commonly associated with old age may impair wound healing[12] because all phases of wound healing have been shown to alter with age.[13] In addition, the aging process has been associated with a decrease in motor control. It has been shown that elderly patients who have led sedentary lifestyles, after engaging in regular walking training programs, have increased motor control.[14] Age

has been shown to be less of a factor in decreased motor control than sedentary lifestyle.[14] However, if age was a confounder in the current study, it would be expected to result in more inpatient physical therapy sessions and a longer hospital stay for the periarticular injection population, because this population was older. Our results showed the opposite effect, however. Therefore, either age did not have a notable effect on outcomes or the improvement from periarticular injection was underestimated. The generalizability of clinical findings in small studies such as this one is always a concern. This concern could be addressed by additional studies that independently replicate the findings.

One of the authors (C.J.T.) instituted liposomal bupivacaine injection into his practice in March 2013. Postoperative analgesia before that time was achieved with femoral nerve block and a postoperative knee immobilizer to protect the extremity until motor function returned. In his practice in 2013, the total cost of liposomal bupivacaine mixture and epinephrine was $929 compared with approximately $1305 for the nerve block (anesthesia fee, $540; ultrasound block guidance, $632; epinephrine, $39; and intravenous starter kit, $94). The knee immobilizer was an additional $202. These values demonstrate that periarticular injection of analgesia shows an approximately $400 savings per patient per TKA.

Although the largest portion of overall cost is incurred on the first surgical day, with charges for the operation, implant, and anesthesiologist, subsequent hospital days and physical therapy sessions add to the overall cost. The average cost per night of stay in nonprofit hospitals in the United States was $2025 in 2011.[15] Our data show an average decreased length of stay of 0.375 days. The average cost of each physical therapy session is variable depending on the services rendered.[16] At our institution, the cost was approximately $400 per session. Our data show an average decrease in the number of physical therapy sessions of 1.2 per patient. These data indicate that an average savings of $480 and $759 for decreased physical therapy sessions and decreased length of hospital stay, respectively, would be realized with each patient receiving analgesia via periarticular injection.

Conclusion

Periarticular injection of a bupivacaine liposome mixture was found to improve functional recovery of patients, decreasing the number of inpatient physical therapy sessions and the number of hospital days needed. Future studies into the benefits of periarticular injection of analgesia might be designed as prospective trials comparing the effects of femoral nerve block compared with periarticular injection of bupivacaine liposome mixture on quadriceps motor function after TKA. In our experience, the type of postoperative analgesia has been the single largest factor influencing patients' ability to complete inpatient physical therapy.

Author Contributions

All authors provided substantial contributions to conception and design, acquisition of data, or analysis and interpretation of data; all authors drafted the article or revised it critically for important intellectual content; all authors gave final approval of the version of the article to be published; and all authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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