Sensory Neuropathy Associated With Aggressive Cauterization Using a Bipolar Radiofrequency Device in Primary TKA

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Abstract

Because significant postoperative blood loss can result in many complications, hemostasis remains a critical part of successful joint replacement outcomes. Advanced techniques, such as electrocautery use after optimally timed tourniquet release, focus on desired patient blood loss outcomes.

The purposes of this study were to report the incidence of nerve injury, identify associated risk factors following the use of bipolar electrocautery for hemostasis in the posterior knee during primary total knee arthroplasty, and compare that rate with the rate seen using a standard electrocautery device. Clinical and operative data were retrospectively reviewed for an association with postoperative nerve injury in 241 consecutive patients when using bipolar electrocautery between July 2007 and October 2008. A comparison group of 192 demographically similar consecutive patients between November 2008 and October 2009 was also evaluated to establish a surgeon-specific benchmark when using standard electrocautery. Seven (2.9%) of 241 patients in the bipolar electrocautery group reported documented neuropathies compared with 1 (0.52%) of 192 patients using standard electrocautery. In addition, female sex and rheumatoid arthritis were associated with postoperative nerve injury following bipolar electrocautery.

Although the bipolar radiofrequency device is effective in achieving hemostasis, the authors recommend judicious use of this procedure in women or patients with rheumatoid arthritis and cautious, nonaggressive use of posterior compartment bipolar radiofrequency ablation in the remaining patient populations.

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Hemostasis remains a critical part of successful joint replacement outcomes. Significant postoperative blood loss can result in a multitude of complications, such as the possibility of large hematoma formation that results in the need for further procedures, including evacuation and increased blood transfusion frequency.\(^1\)\(^2\)\(^3\) In addition, intraoperative blood loss may lead to decreased surgery visualization and an increased risk of transfusion and postoperative complications.\(^3\)

Advanced techniques have been introduced that focus on desired patient blood loss outcomes, including electrocautery use after optimally timed intraoperative tourniquet release, bone and soft tissue treatment with autologous platelet gels, continuous peripheral nerve blocks, tranexamic acid, and procoagulation fibrin sprays.\(^4\)\(^5\)\(^6\) Recently, saline-coupled bipolar radiofrequency devices have been used for patients undergoing total joint arthroplasty. In contrast with monopolar electrocautery, bipolar devices contain both active and return electrodes at the surgical site, allowing the current flow to limit itself to the tissue between those 2 electrodes.\(^7\)\(^8\) The immediate benefits of this configuration are the prevention of excessive temperatures, reduction in thermal necrosis, reduced bleeding, and a more developed area of coagulation.\(^3\) The popularity of such techniques has increased as more benefits are discovered.

Rosenberg\(^9\) has shown bipolar device use to be effective in the minimization of transfusion rates and intra- and postoperative blood-related complications. However, although benefits have been reported, no current reports describe complications associated with this technique. The purposes of this study were to report the incidences of nerve injury and identify associated risk factors following bipolar electrocautery when used in total knee arthroplasty (TKA) and to compare this rate with the rate seen using a standard electrocautery device.

**Materials and Methods**

A total of 241 TKAs were performed between June 2007 and October 2008 by a single surgeon (S.L.). All TKAs used a saline-coupled bipolar radiofrequency electrocautery device (Salient Surgical Technologies, Dover, New Hampshire) placed on the posterior compartment of the knee. A retrospective review of the patients’ medical records was performed after institutional review board approval was obtained. Patient data collected included demographics (ie, sex, age, and body mass index), operative information (ie, type of anesthesia, peripheral block used, tourniquet time and pressure, and blood loss), clinical follow-up, and medical comorbidities (specifically peripheral vascular disease and diabetes mellitus). Peripheral neuropathy was confirmed by electromyography if patients had symptoms. A demographically similar comparison group of 192 consecutive TKAs performed between November 2008 and October 2009 was reviewed to obtain the rate of nerve injury for the surgeon using a standard electrocautery device.

Demographic, surgical, and comorbidity data were evaluated using Fisher’s exact test and Mann-Whitney \(U\) test, as appropriate. The level of significance was set at a \(p\) value less than .05. Statistical analyses were performed using SPSS version 16 software (SPSS, Inc, Chicago, Illinois).

**Surgical Technique**

After induction of general anesthesia, the patient remained in the supine position with a tourniquet applied to the proximal thigh. The tourniquet was inflated to 250 to 300 mm Hg based on thigh girth, with smaller thigh circumference routinely inflated to 250 mm Hg. Midline incisions with medial parapatellar or subvastus approaches were used in all cases. The TKA was performed in the standard fashion consistent with surgical technique manuals, and a cruciate-substituting cemented knee was used in all cases. The implant trials for the TKA were inserted and consisted of a femur, tibial baseplate, and plastic insert. Once appropriate soft tissue balance was obtained, they were removed.

The bipolar electrocautery device was then used. For all cases, the device was set at 170 W, with a medium flow. The device was used in a circular repetitive motion, treating the entire posterior compartment while the knee was in extension. Next, the knee was flexed and a bone hook was used to distract the femur up from the tibia, and the device was used to treat up and under the posterior femoral condyles while under good visualization. The medial and lateral areas arising from the posterior areas of the knee around the medial collateral ligament, as well as the lateral collateral ligament and iliobibial band, were treated; cauterization then shifted to the gutters and anterior tissues. Although an attempt was made to treat the posterior capsule in a more aggressive manner to blanch the posterior tissues and go over all areas 3 times, at no time was the device kept in 1 spot or left to treat 1 small area for an extended period without movement to another area.

Times of treatment or device use were not officially measured routinely but were noted by assistants, technicians, and representatives in the room to be approximately 3 to 4 minutes to treat the knee, including the posterior compartment. The surgeon was the sole user of the device in all cases and consistently treated each knee in the manner described above. After treatment with the bipolar electrocautery device, the knee was irrigated with the pulse lavage and the TKA was cemented in place in standard fashion. Closure was standard, and a bulky Jones dressing was applied.

**Results**

Data analysis indicated that 7 (2.9%) of 241 knees had a postoperative nerve injury. Three patients presented with postoperative decreased sensation, such as numbness and tingling, and 4 patients presented with postoperative motor symptoms, such as
as foot drop. This is significantly higher than the prevalence rate of nerve injury (1.3%) following TKA (P<.05) reported in the literature. In addition, examination of the 192 demographically similar cases performed by the same surgeon using standard electrocautery indicated a nerve injury rate of 0.52% (P<.05).

Once prevalence was established, the authors compared patients’ demographics, comorbidities, preoperative varus or valgus deformity or flexion contracture, anesthesia type, and tourniquet time between those who did not develop a postoperative nerve injury and those who did. As shown in the Table, rheumatoid arthritis was associated with nerve injury (P = .029). Interestingly, although body mass index alone did not reach significance (P = .061), because all patients who had a postoperative nerve injury were women except 1, a subanalysis showed that being a women and having a low body mass index was associated with nerve injury (P = .027).

**Discussion**

Recent interest has arisen in hemostasis as debates over appropriate postoperative anticoagulation continue. Use of more aggressive postoperative anticoagulants has resulted in an increased rate of hematomas and wound compromise. With known sequela of hematoma generating complications such as infection, increased rates of transfusion, arthrofibrosis, and wound-healing complications, orthopedists need to find techniques that limit these postoperative concerns. Recent technologies are abundant and include epidural analgesia, peripheral nerve blocks, tranexamic acid, topical fibrin sprays, platelet-rich plasma, neuraxial anesthesia, and saline-coupled bipolar radio frequency electrocautery devices.

Every technique has risks and benefits. Topical fibrin sprays have been shown to decrease blood loss in TKA by up to 55%; however, major disadvantages include their cost and allogenic nature.

Similarly, epidural analgesia had some historical success, but with more aggressive anticoagulation, the risk of epidural hematoma has increased.

Saline-coupled bipolar radiofrequency electrocautery devices have been introduced to total joint arthroplasty. Although benefits have been reported, no reports on complications exist. The current study reported a 2.9% rate of tibial nerve sensory loss when using this technique, which was statistically significant compared with a published benchmark rate of 1.3% and with the current surgeon’s rate of 0.52% when standard electrocautery was used. The bipolar electrocautery device was inserted under the posterior femur into the recess anterior to the capsular tissue, thus putting the nerve at risk.

In addition, the current authors established a correlation between the described technique, tibial sensory nerve injury, and the female population. A second correlation was identified with relation to patients with rheumatoid arthritis. Rheumatoid arthritis is a reported risk factor for nerve injury in TKA and therefore would be consistent with other published data on postoperative nerve complications. In addition, the current authors hypothesize that tissue quality and thickness relates to its ability to protect the nerve and absorb heat transmission.

Peroneal nerve palsies are among the most reported TKA-associated single-nerve neuropathies, with rates ranging from 0% to 9.5%. Patients with peroneal neuropathy usually present with foot drop.
and sensory changes, including pain, over the lateral calf and dorsum of the foot.\textsuperscript{15} Frequently occurring at the knee, the most common cause of peroneal nerve injuries stem from flexion contractures as the nerve is stretched due to a valgus knee or acute trauma. Compression from surgical leg positioning during TKA, as well as arthroscopy, was also noted.\textsuperscript{1}

Although tibial nerve injuries present with substantially less incidence, their occurrence usually happens in concert with peroneal nerve injury and is most commonly a result of a proximal sciatic nerve injury. Tibial nerve injuries present with impaired plantar foot sensation along with weakened or absent plantar flexion and tibialis posterior function.\textsuperscript{14}

In the current study, 4 patients presented with foot drop and 3 presented with decreased sensation. At 12-month follow-up, 2 patients with foot drop achieved complete recovery. One patient with foot drop who did not recover was documented to have significant spinal stenosis, herniated nucleus pulposus, and other changes, possibly decreasing the threshold for nerve injury. In addition, all 3 patients with decreased sensation achieved complete recovery by 12-month follow-up. Future studies are warranted to further examine the gravity of the nerve lesions.

Although the bipolar radiofrequency device is effective in achieving hemostasis, the authors conclude that the zone of thermal necrosis presents a potential danger to a sensory branch of the tibial nerve and recommend judicious use in any patient with the aforementioned characteristics. They further recommend cautious, nonaggressive use of posterior compartment bipolar radiofrequency ablation in the remaining patient populations.

REFERENCES