Monopolar Radiofrequency Use in Deep Gluteal Space Endoscopy: Sciatic Nerve Safety and Fluid Temperature

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Purpose: The purpose of this study was to evaluate the temperature at the sciatic nerve when using a monopolar radiofrequency (RF) probe to control bleeding in deep gluteal space endoscopy, as well as assess the fluid temperature profile. **Methods:** Ten hips in 5 fresh-frozen human cadaveric specimens from the abdomen to the toes were used for this experiment. Temperatures were measured at the sciatic nerve after 2, 5, and 10 seconds of continuous RF probe activation over an adjacent vessel, a branch of the inferior gluteal artery. Fluid temperatures were then measured at different distances from the probe (3, 5, and 10 mm) after 2, 5, and 10 seconds of continuous probe activation. All tests were performed with irrigation fluid flow at 60 mm Hg allowing outflow. **Results:** After 2, 5, or 10 seconds of activation over the crossing branch of the inferior gluteal artery, the mean temperature increased by less than 1°C on the surface and in the perineurium of the sciatic nerve. Considering the fluid temperature profile in the deep gluteal space, the distance and duration of activation influenced temperature ($P < .05$). Continuous delivery of RF energy for 10 seconds caused fluid temperature increases of 1.2°C, 2°C, and 3.1°C on average at 10 mm, 5 mm, and 3 mm of distance, respectively. **Conclusions:** This study found the tested monopolar RF device to be safe during use in vessels around the sciatic nerve after 2, 5, and 10 seconds of continuous activation. The maximum fluid temperature (28°C) after 10 seconds of activation at 3 mm of distance is lower than the minimal reported temperature necessary to cause nerve changes (40°C to 45°C). **Clinical Relevance:** Monopolar RF seems to be safe to the neural structures when used at more than 3 mm of distance and with less than 10 seconds of continuous activation in deep gluteal space endoscopy with fluid inflow and outflow.

Endoscopic procedures for deep gluteal space disorders are increasingly being performed as the understanding of posterior hip pain evolves. The most frequent indication for deep gluteal space endoscopy is decompression of the sciatic nerve.[1,2] This procedure often requires the use of radiofrequency (RF) energy for dissection or bleeding control. It is known that RF devices can affect temperature during arthroscopic surgeries.[3,4] However, there have been no data regarding sciatic nerve safety and the fluid temperature profile during the use of RF probes in endoscopic procedures in the deep gluteal space.

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RF is an electromagnetic wave with a frequency between audio and infrared, ranging from 10^4 to 3×10^2.[5] Alternating currents with frequencies higher than 10^4 Hz are known for not causing a neuromuscular response.[5] Therefore the risk of nerve damage using RF energy is triggered by heat. Animal studies have already reported the thermic effects of RF energy on nerve function and histology. Different authors have described a reversible sciatic nerve block when this nerve was exposed to temperatures from 40°C to 45°C for 12 to 58 minutes.[6-8] Another animal experiment reported the effect in the nerve after 45 seconds of heating: at 50°C, there was no nerve fiber damage; at 55°C, approximately half of the cut surface of the nerve was affected; and at 60°C, nearly the total cut surface of the nerve was injured.[9] Nevertheless, irrigation fluid has been reported to protect nerves against thermal injury from instruments of electricity-generated heat.[10] Good et al.[3] and Zoric et al.[4] reported that irrigation is the most important factor to influence temperature during RF use in shoulder arthroscopy, with higher flow conditions protecting against temperature elevation.

The superficial crossing branches of the inferior gluteal vessels (CBIGVs) are posterior to the sciatic nerve and distal to the piriformis muscle (Fig 1). To

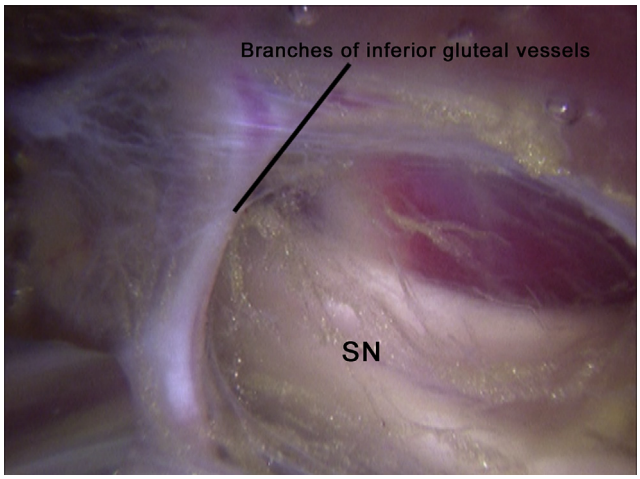

Fig 1. CBIGVs posterior to the sciatic nerve (SN).

access the piriformis muscle in endoscopic sciatic nerve decompression,[1,2] these vessels should often be coagulated or ligated when larger. Other vascular structures are occasionally also coagulated during deep gluteal space procedures.[2]

The purpose of this study was to evaluate the temperature at the sciatic nerve when using a monopolar RF probe to control bleeding during deep gluteal space endoscopy, as well as assess the fluid temperature profile. The hypothesis was that monopolar RF use in the deep gluteal space is safe from dangerous thermal increases with a shorter activation time and greater distance.

Methods

Ten hips in 5 fresh-frozen human cadaveric specimens from the abdomen to the toes, with all soft tissues maintained, were used for this experiment. The pelvis and lower limbs were preserved to maintain sciatic nerve tension and the relation between the sciatic nerve and the CBIGVs. The specimens were thawed to room temperature before the experiment.

The cadaveric specimens were positioned on a traction table with 30° of contralateral tilt. The deep gluteal space was accessed through the anterolateral portal, the posterolateral portal, and an auxiliary posterolateral portal (3 cm posterior and 3 cm superior to the greater trochanter).[2] Arthroscopic cannulas and a standard 70° arthroscope were used. Saline solution at room temperature (19°C to 21°C) was used with an inflow pressure of 60 mm Hg, which is the pressure used during the standard technique for deep gluteal space procedures[2] and was the pressure used by Zoric et al.[4] in a previous study. Outflow through the cannulas was noted in each specimen during the tests, although it was not measured.

The identification steps were as follows[2]: (1) peritrochanteric space inspection and bursectomy, (2) visualization of the quadratus femoris muscle and sciatic nerve, (3) identification of the obturator internus muscle and tendon, and (4) identification of the CBIGVs posterior to the sciatic nerve and distal to the piriformis muscle.

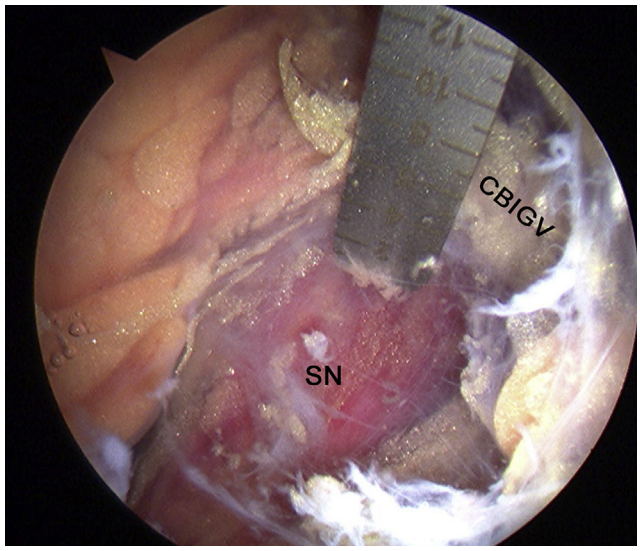

Fig 2. The distance between the CBIGVs and the sciatic nerve (SN) was determined with an arthroscopic ruler at the middle of the vessel. More than 1 view was obtained by turning the 70° arthroscope before the final measurement.

After CBIGVs identification with the arthroscope positioned in the anterolateral portal, 2 monopolar RF devices (TAC-S probes; Smith & Nephew Endoscopy, Andover, MA) were placed in the deep gluteal space. The energy probe (used to deliver RF energy) was introduced first through the posterolateral portal, under a programmed temperature of 75°C. A grounding pad was secured at the abdomen and connected to the electrothermal system of the energy probe. The second control probe (used to obtain the temperature profile) was attached to a different electrothermal system, set up only for "temperature" control without delivering RF energy. This control probe entered the deep gluteal space through the auxiliary posterolateral portal. Temperature was assessed before and at the end of each period of energy probe activation.

Temperature tests were performed in 2 different phases. Tests performed first were related to the CBIGVs and sciatic nerve. Subsequent tests were performed to assess the fluid temperature profile related to activation time and distance within the deep gluteal space.

Tests Related to CBIGVs and Sciatic Nerve

First, the distance between the CBIGVs and the sciatic nerve was determined with an arthroscopic ruler (Fig 2). The measurement was taken at the middle of the vessel. Next, the energy probe touched the CBIGVs and was continuously activated for 2, 5, and 10 seconds while the control probe was used for temperature assessment on the surface of the sciatic nerve. After that, the energy probe was activated in the same manner with the control