INTRODUCTION:
For many decades, electrocautery (EC) devices have been widely used in many areas of surgery. The EC devices achieve hemostasis and dissection simultaneously, which result in reducing blood loss, operative time, and potential complications as compared to conventional methods such as clamp-and-tie maneuvers and clips. One of the issues with the EC devices is a potential risk of injuring surrounding tissues related to high temperature at the tip of the instrument. In dissecting tissues around nerves, surgeons cannot use the EC devices and still rely on conventional procedures to avoid iatrogenic nerve injury.

Recently, ultrasonic (US) devices have been developed and introduced as less-invasive surgical tools. The US devices transmit high-frequency vibrations to tissues. The mechanical vibrations provoke a rupture of protein structures, and hemostasis is adequately achieved at low temperature. The dual mechanism with the US devices minimizes collateral thermal damage, which can lead to expanded clinical applications.

We designed an animal model in which surgical incisions was made in leg muscle close to the sciatic nerve using an EC or US device. The purpose of the present study was to evaluate the effects of surgical devices on motor nerve function using electromyographic (EMG) recording.

MATERIAL & METHODS:
All experimental protocols were approved by the Institutional Animal Care and Use Committee of Wayne State University. A total of 24 adult male Sprague-Dawley rats weighing 400–450g were used in this in-vivo study. The rats were divided into 3 groups: Control (n=8), EC (n=8), and US (n=8). A skin incision was made on the left lateral thigh to expose the sciatic nerve and the proximal aspect of the gastrocnemius muscle. For stimulation, a custom-made hook electrode was placed under the sciatic nerve at the sciatic notch. A pair of recording electrodes was implanted via a 22 gauge needle into the midbelly regions of the gastrocnemius muscle. A ground electrode was placed on the ipsilateral hind paw of the rat. To evoke compound muscle action potentials (CMAPs), 3 volt electric stimulations with duration of 0.3 ms were administered to the sciatic nerve at the firing rate of 1 Hz.

We used two kinds of monopolar surgical devices. Bovie (ValleyLab, Boulder, CO, USA) was used as an EC device, set at 60W. HK 105 blade (Ethicon Endo-Surgery, Inc., Cincinnati, OH, USA) was used as an US device, set at level 5. Surgical devices were applied to cut the muscles 10 mm in length and 2 mm away on each side of the sciatic nerve. CMAPs were recorded before the device application and 2, 10, 30, 60, 120 and 180 minutes after the device application. Amplitude and latency of the evoked CMAP were examined. The amplitude was measured from the baseline to the first peak. The latency was defined as the interval between the stimulus peak and the first peak of CMAP.

All data were expressed as mean ± standard error of mean. One-way ANOVA (post-hoc Scheffe) was performed to determine the differences between the three groups before the device application and the differences in the same group between the time points. Differences were considered statistically significant at p<0.05.

RESULTS:
There were no significant changes in the mean baseline amplitude of CMAP between the three groups (2.29±0.02 V in control, 2.30±0.06 V in EC, and 2.27±0.08 V in US). In EC group, the mean amplitude of CMAP significantly dropped immediately after the device application and showed no recovery at the end of recording. On the other hand, the amplitude of CMAP in US group was maintained over three hours even after the device application, similar to control group (Figs. 1&2).

With regard to the latency of the evoked CMAP, no significant changes in the baseline were found between the three groups (2.73±0.25 msec in control, 2.15±0.21 msec in EC, and 2.63±0.22 msec in US). In all of the three groups, the latency of CMAP showed no significant changes over three hours (Figs. 2&3).

DISCUSSION:
Our study showed that the EC device caused a marked drop in the amplitude of CMAP with no recovery at three hours, indicating the EC device seriously damaged the sciatic nerve near the application site. On the other hand, the US device did not change the mean amplitude of CMAP or the mean latency of CMAP over three hours. Accordingly, in terms of motor function, the US device was a safe tool for muscle dissection close to the sciatic nerve.

Our study was a series of acute experiments using neurophysiologic methods. Future studies, including behavioral assessment and histological evaluation, would be required to determine if there are any long-term effects of US devices.

SIGNIFICANCE:
We developed a methodology to evaluate motor nerve function using EMG recording. The results indicate the US blade is safer and more reliable than EC device in terms of surgical dissection around peripheral nerves.

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