Acute and Sub-acute Effects of Electrosurgery and Harmonic Devices on Sciatic Nerve Function and Structure

INTRODUCTION: Ultrasonic energy surgical cutting devices are used to simultaneously cut and coagulate soft tissue and vessels. However, the extent of nerve damage that may result from their application in close proximity to a nerve is not clear. Hence, the purposes of this study were to determine the effects of ultrasonic (US) energy surgical cutting devices on sciatic nerve function when applied to adjacent muscle tissue and their comparison to effects from a monopolar electrosurgery device (MES) application during acute (3 hr) as well as sub-acute phases (7 days later).

METHODS: All procedures have been approved by the Animal Investigation Committee at Wayne State University. Sixty-four adult male Sprague-Dawley rats were anesthetized with ketamine and xylazine. For acute phase, rats were divided into Harmonic SNGHK2 Blade (n=8), Harmonic SNGCB Blade (n=7), MES (n=8), and sham (n=10) application groups. For the sub-acute phase, rats were divided into Harmonic SNGHK2 Blade (n=7), Harmonic SNGCB Blade (n=8), MES (n=8), and sham (n=10) application groups. For the acute phase, the left sciatic nerve was exposed to place a stimulating electrode distal to the device application. An L2-L6 laminectomy was performed to record neural activity from L5 spinal nerve (Fig. 1). A 1, 3, and 5 volt electrical application was same as in acute phase but was performed under sterile conditions and surgical site sutured for neurophysiological recordings 7 days later. All recorded data was analyzed off-line later. Nerve conduction function changes in CAP and CV were tested by Repeated Measures ANOVA, and difference between SNGHK2, SNGCB, and Sham groups (Fig. 2). MES devices were activated for 5 seconds during their respective power setting at 5. For MES group, a conventional Bovie at 60W was used. All the devices were activated for 5 seconds during their respective applications. For sub-acute study, sciatic nerve exposure and device application was same as in acute phase but was performed under sterile conditions and surgical site sutured for neurophysiological recordings 7 days later. All recorded data was analyzed off-line later. Nerve conduction function was evaluated by changes of magnitude of CAPs (measured by area under the curve (AUC)) and changes of conduction velocity (CV) of CAPs. After neurophysiologic tests, exposed sciatic nerve segments were harvested and processed by hematoxylin and eosin (H&E) staining for semi-quantitative analysis of leukocyte infiltration in to the sciatic nerve blood vessels as a sign of inflammation. Using SPSS software (SPSS Inc., Chicago, IL), changes in CAP and CV were tested by Repeated Measures ANOVA, and % incidence of inflammatory cells in different groups were tested by non-parametric tests with p<0.05 being considered significant.

RESULTS: In the acute study, MES showed a significant AUC percentage decrease over 3 hrs recording compared to baseline and to other groups (Repeated Measures, p<0.05). There was no significant difference between different time points over the 3 hrs recording in sham group, SNGHK2 and SNGCB groups. For comparisons between groups, there was no statistical difference between SNGHK2, SNGCB, and Sham groups (Fig. 2). MES group also showed the highest percentage drop in CV compared to baseline and other groups (Repeated Measures, p<0.05). Histological studies showed that the MES exposed sciatic nerve sections demonstrated the highest % incidence of inflammatory cells compared to sham and Harmonic devices.

In the sub-acute (7 day) study, the AUC values in MES group showed significantly lower values as compared to the control and sham groups. The AUC values in SNGHK2 as well as SNGCB did not show any significant difference as compared to the control or sham groups (Fig. 3A). There was no statistical difference between CVs in any of the groups. Histologically, MES exposed sciatic nerve sections showed the highest % incidence of inflammatory cells compared to sham and Harmonic devices (Fig. 3B). No other significant differences were observed.

DISCUSSION: Data from this study demonstrated prominent AUC changes following MES application both during acute and sub-acute phases, suggestive of nerve dysfunction from MES application. On the other hand, application of Harmonic devices did not result in any prominent nerve dysfunction during sub-acute phase with signs of minor AUC changes during the acute phase. Also, MES application resulted in significant inflammatory infiltration both acutely and sub-acutely.

SIGNIFICANCE: This study provides evidence that ultrasonic blade devices can safely be used in close proximity to nerves in certain surgical procedures.

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