The Journal of Emergency Medicine, Vol. 41, No. 1, pp. 102–107, 2011

0736-4679/$–see front matter

ELSEVIER

doi:10.1016/j.jemermed.2010.04.027

Brief Reports

A LOCALIZING CIRCUMFERENTIAL COMPRESSION DEVICE INCREASES SURVIVAL AFTER CORAL SNAKE ENVENOMATION TO THE TORSO OF AN ANIMAL MODEL

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□ **Abstract—Background: Pressure immobilization bandages have been shown to delay onset of systemic toxicity after Eastern coral snake (*Micrurus fulvius*) envenomation to the distal extremity. Objectives: To assess the efficacy of a novel compression device in delaying onset of systemic toxicity after truncal envenomations with Eastern coral snake (*Micrurus fulvius*) venom in a porcine model. Methods: With University approval, nine juvenile pigs (11 kg to 22 kg) were sedated, anesthetized, and intubated but not paralyzed to ensure continuous spontaneous respirations in a university animal laboratory. Each animal was injected subcutaneously with 10 mg of *M. fulvius* venom in a preselected area of the trunk. After 1 min, six animals had the application of a novel, localizing circumferential compression (LoCC) device applied to the bite site (treatment group) and three animals had no treatment (control group). The device was composed of a rigid polymer clay form molded into a hollow fusiform shape with an internal dimension of 8 × 5 × 3 cm and an elastic belt wrapped around the animal securing the device in place. Vital signs were recorded at 30-min intervals. End points included a respiratory rate below 3 breaths/min, oxygen saturation < 80%, or survival to 8 h. Survival to 8 h was analyzed using Fisher's exact test, with $p < 0.05$ indicating significance. Survival analysis was performed using the Mantel-Cox test to assess time to death with outcomes represented in a Kaplan-Meier Cumulative survival plot. Results: Five of the six pigs in the treatment group survived 8 h (293–480 min). None of the control pigs survived to 8 h (Fisher's exact $p = 0.04$), with mean time of respiratory failure 322 min (272–382 min). Survival analysis showed a significant delay in time to event in the treatment group compared to the control group ($p = 0.04$). Conclusions: The LoCC device used in this study delayed the onset of systemic toxicity and significantly increased survival time after artificial truncal envenomation by Eastern coral snake venom.** © 2011 Elsevier Inc.

□ **Keywords—coral snake; envenomation; treatment; novel**

INTRODUCTION

According to the American Association of Poison Control Centers' National Poisoning and Exposure Database Annual Reports for the years 2000–2006, there were about 2000–3000 poisonous snakebites, with 50–100 from coral snakes, reported annually (1–7). Previous studies on the field treatment of snake bites exclusively discuss distal extremity envenomations and techniques aimed at impeding the lymphatic or venous transport of

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RECEIVED: 30 July 2009; FINAL SUBMISSION RECEIVED: 10 November 2009;
ACCEPTED: 4 April 2010

venom to the central circulation. These involve the application of some type of compressive or pressure immobilization bandage (8–13).

A technique able to inhibit dissemination of the venom from the area of bite might delay the onset of respiratory arrest during long transport times or while antivenom is being obtained, and can be potentially lifesaving. This may be especially important in bites from snakes with neurotoxic venom and when the antidotal therapy may be difficult to obtain; both of which are true with Eastern coral snake (*Micrurus fulvius*) envenomation; Wyeth-Ayerst stopped production of the antivenom in 2006 (14). Coral snake venom causes a curare-like effect at the neuromuscular junctions resulting in central nervous system depression, muscle paralysis including those involved in respiration, and vasomotor instability. Once systemic symptoms become clinically evident, they have been shown to progress rapidly, are difficult to reverse, and may require prolonged ventilatory support (15–17).

Essentially all published studies of treatment of snake envenomations involve bites that occur within a relatively small area of the body—the distal extremities, primarily hands, ankles, and feet, which account for $<$ 30% of the total body surface area. On more than 50% of the body surface area (proximal 1/3 of each extremity and anterior and posterior torso), a pressure immobilization bandage may not work. Although infrequent, torso or proximal extremity envenomations do occur (18–20).

In this study we evaluated the efficacy of a novel device in increasing survival and delaying the onset of systemic toxicity after artificial *M. fulvius* envenomation to the torso in a swine model.

MATERIALS AND METHODS

Study Design

The study was an unblinded, controlled trial of a novel compression device in a porcine model of artificial truncal Eastern coral snake (*Micrurus fulvius*) envenomations in pigs of various weights.

Approval was obtained for this protocol from the University Animal Care and Use Committee.

Animal Subjects

Nine juvenile female pigs ranging from 11 kg to 22 kg were used in the study. Heavier and lighter pigs were included in both treatment and control groups. The porcine model was chosen due to the similarity of response to snake venoms as compared to humans (21–24).

The pigs were obtained from a local vendor. Husbandry and care were consistent with standards contained in *The Guide for the Care and Use of Laboratory Animals* (25). Our University animal care and use program is fully accredited by the Association for the Accreditation and Assessment of Laboratory Animal Care, International.

Materials

Eastern coral snake (*M. fulvius*) venom (Medtoxin Venom Laboratories, Deland, FL) lyophilized powder was reconstituted with sterile water to a 20-mg/mL suspension.

The localizing circumferential compression (LoCC) device consisted of the form and a belt. The belt was composed of a 3-inch-wide elastic strap with D-rings at either end and a sliding buckle so tension could be incrementally adjusted. The LoCC form was designed by the primary investigator (JH, patent pending). Each LoCC form was hand-molded from polymer clay into a hollow, flat, fusiform shape with an internal dimension of 8 $\times$ 5 $\times$ 3 cm and a hook at each end. The belt was attached to the form by metal D-rings that secured the device circumferentially around the torso—adjustments in tension were made by shortening or lengthening the belt using the sliding buckle as needed depending on animal size (Figure 1). Three LoCC forms of similar size and dimensions and three straps were used for this study.

Study Protocol

As per standard protocol, each pig received intramuscular injections of xylazine, tiletamine, and zolazepam for

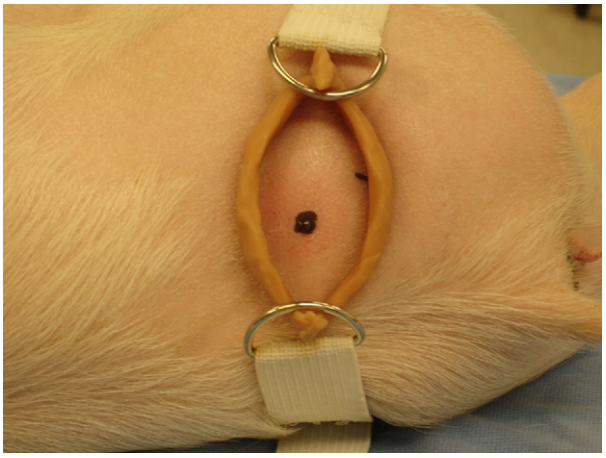

Figure 1. Localizing circumferential compression (LoCC) device in place around injection site (ink mark).