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Stun guns have cardiac risks, one study finds, while other suggests cocaine protects against VF
August 9, 2006 | [Michael O'Riordan](#)

Bethesda, MD - Two small animal studies published in the August 8, 2006 issue of the *Journal of the American College of Cardiology* offer some insight into the effect of stun guns, also known as neuromuscular incapacitating devices (NIDs), on the electrical function of the heart [1,2]. While the first study suggests there might be cardiac risks to those subjected to stun guns, the second study finds that cocaine might protect against the induction of ventricular fibrillation (VF).

In the first study, led by **Dr Kumaraswamy Nanthakumar** (University of Toronto, ON), investigators sought to evaluate the cardiac consequences of a stun gun applied to different parts of the body in an experimental porcine model. Nanthakumar and colleagues tested two commercially available stun-gun devices, differing in power and the amount of energy delivered in each pulse. Two discharge vectors, one thoracic and the other away from the chest and across the abdomen, as well as two durations of discharge, five seconds and 15 seconds, were tested.

In total, 150 discharges were applied to six pigs. Of these, 74 discharges resulted in stimulation of the myocardium, as documented by electrical capture. During stimulation and capture, the mean ventricular rate was 324 beats/minute. Of the 94 thoracic charges, 74 stimulated the myocardium, while none of the nonthoracic charges resulted in myocardial stimulation. The electrical stimulation depended on the length of discharge as well as the device used (the stun gun that applied voltage with a short, powerful burst followed by a longer, smaller wave was more likely to result in stimulation).

In looking at animals in a heightened sympathetic state—after the administration of epinephrine—the investigators report 13 episodes of electrical stimulation from 16 applied electrical charges. There was one reported case of VF, and one discharge caused ventricular tachycardia among the pigs given epinephrine, likely from a shortened ventricular refraction, report investigators.

"These findings suggest there exists the possibility of serious ventricular arrhythmia during NID discharges in structurally normal hearts during intense catecholamine stress," write Nanthakumar and colleagues. Such risks are heightened in individuals with preexisting electrophysiological abnormalities, they add.

Is cocaine protective when subjects are stunned?

In the second surprising study, led by **Dr Dhanunjaya Lakkireddy** (Cleveland Clinic, OH), investigators sought to study the effects of cocaine on VF threshold in pigs subjected to stun guns. Recent reports have suggested that some police custody deaths after the use of stun guns might be due to illegal drugs, including cocaine, which has a number of cardiac effects, including proarrhythmia, present in the suspect's system.



Using a device that matched the waveform of a commercially available device, Lakkireddy and colleagues applied the electrodes to various regions of the posterior and anterior trunk regions of cocaine-infused pigs. Standard discharges, lasting five seconds, did not cause ventricular fibrillation before or after cocaine infusion.

The maximum safe multiple (defined as the highest discharge multiple that could be applied without inducing VF) and the minimum VF-inducing multiple (defined as the lowest discharge multiple that induced VF) both increased as the electrode was placed further from the heart. VF threshold also increased the further the electrode was placed from the heart.

Investigators report there was a 1.5- to twofold increase in these values at each position after cocaine infusion, suggesting a decreased cardiac vulnerability for VF. They suggest that the true risk of arrhythmias among those under the influence of cocaine subjected to stun guns is with those who also have significant hemodynamic or metabolic disturbances, such as hypotension, hypoxemia, seizures, or myocardial ischemia/infarction. "The results of our study suggest that [neuromuscular incapacitating] NMI discharge at the standard five-second application is unlikely to cause life-threatening arrhythmias, at least in the normal heart," conclude the authors.

Both investigators, Nanthakumar and Lakkireddy, urge caution in extrapolation of the findings to human subjects and suggest that further studies are needed. However, Lakkireddy and colleagues note that pigs have been frequently used in fibrillation and defibrillation studies, with the results then generalized to humans.

Sources

1. Nanthakumar K, Billingsley IM, Masse S, et al. Cardiac electrophysiological consequences of neuromuscular incapacitating device discharges. *J Am Coll Cardiol* 2006; 48: 798-804. 
2. Lakkireddy D, Wallick D, Ryschon K, et al. Effects of cocaine on the threshold for stun gun induction of ventricular fibrillation. *J Am Coll Cardiol* 2006; 48: 805-811. 

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