TASER Discharges Capture Cardiac Rhythm in Swine: Effects of a Paralytic Agent

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ABSTRACT

Objectives: Data from our group and from others suggest that the TASER X26 can seriously alter cardiac function in experimental animals. We hypothesized that TASER X26 discharges can greatly reduce cardiac performance.

Methods: Using an IACUC approved protocol, 13 standard pigs (22-77 kg; 6 experimentals, 5 sham and 2 paralyzed sham controls) were anesthetized with ketamine and xylazine. Experimentals were paralyzed with succinylcholine (2 mg/kg) then exposed to two 40 sec discharges from a TASER X26 (TASER Intl., Scottsdale, AZ) across the torso. Blood pressure, vital signs, troponin I, blood gases, and electrolyte levels were obtained pre-exposure and at 5, 15, 30 and 60 min and 24, 48 and 72 hrs post-discharge. EKGs and echocardiography were performed before, **during**, and after the discharges using a GE Logiq7 ultrasound. P values < 0.05 were considered significant.

Results: EKG was unreadable during the discharges due to electrical interference, but echo images were not affected. During the discharges, cardiac rhythm was captured immediately at a rate of approximately 300 bpm in **all** animals. This capture continued for the duration of the discharge and, in 3 animals, sinus rhythm was regained within 5 sec of discontinuing the discharge. In 2 other animals, ventricular fibrillation (VF) was seen after the discharge by echo and EKG. In 1 animal, spontaneous reversion to sinus rhythm occurred after 15 sec, and in the other VF resulted in death. Another animal showed ventricular tachycardia for 5 sec before reverting to sinus rhythm. So, in these 3 cases, the abnormal rhythm seen by echo during discharge did not immediately revert to sinus rhythm when the discharge ended.
Blood chemistry values were not significantly affected in the post-discharge period. Post-discharge in surviving animals, *heart rate* was not significantly affected and hypotension was absent.

Conclusions: **The TASER X26 can clearly capture and alter cardiac rhythm, but the consequences may not be clinically detectable upon subsequent medical evaluation**.

INTRODUCTION

TASER X26 stun devices generate up to 50 kV and can be discharged for >15 minutes *continuously*. Unfortunately, there have been more than 250 TASER-associated deaths in the past several years in the US and Canada that have been temporally associated with the use of these devices. Many of these deaths have been attributed to stimulant drug overdoses and extreme agitation with hyperthermia, acidosis, and cardiac dysrhythmias.

The peer-reviewed literature on stun devices is still emerging and the results are conflicting. Some studies, utilizing a TASER-like device, showed no evidence of acute dysrhythmia and a large safety margin for the development of ventricular dysrhythmia in swine. Similarly, neither acidosis nor hyperkalemia have been observed in healthy human volunteers exposed to brief TASER X26 discharges. However, in swine, TASER exposure has been shown to cause significant acidosis and the potential for fatal dysrhythmia. Thus, it is difficult to establish guidelines regarding the need for treatment or even monitoring of the increasing number of patients who arrive in emergency rooms after exposure to TASERs.

MATERIALS and METHODS

Animals and Groups

Three to 6 month-old Yorkshire pigs (22 to 77 kg) were used. The experimental group was paralyzed with succinylcholine (2 mg/kg; SCh) before an 80 sec thoracic discharge (pTASER). The paralyzed control group (pCT) received SCh and no shock, and the sham control group received no SCh and no shock. There were 6, 2, and 5 animals in each group, respectively. Baseline (zero time) values were used as internal controls for each animal. Animals in dorsal recumbence were anesthetized with IV ketamine and xylazine, intubated, and breathing was controlled with a respirator. This project was reviewed and approved by the IACUC for the Hektoen Institute.

An unmodified, police-issue TASER X26 device powered by TASER lithium 6 V Digital Power Magazines was used (power >60%). The barbed darts were manually inserted (see Figure 1). Immediately prior to TASER discharge, SCh was given IV. The TASER X26 was then discharged in two 40 sec intervals during which time the ventilator was shut off but spontaneous breaths were permitted. Two ventilated breaths were administered during the 10 sec pause between the 40 sec discharges.

Cardiac rhythm was monitored continuously during anesthesia using a 5-lead EKG. Echocardiography was performed using a GE Logiq 7 with a 3 MHz probe. Cross-sectional echo images of the left ventricle (LV) were obtained so that LV diameter could be measured to determine ejection fraction. Pre-discharge echo images established a baseline for each animal.

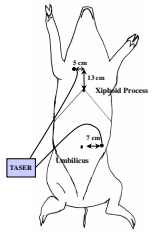

Figure 1. The darts were placed as shown. They were inserted perpendicular to the skin and to their maximum depth (3/8") such that the dart tip was located in subcutaneous tissue.

RESULTS

Figure 2
EKG Before, During, and After Discharge

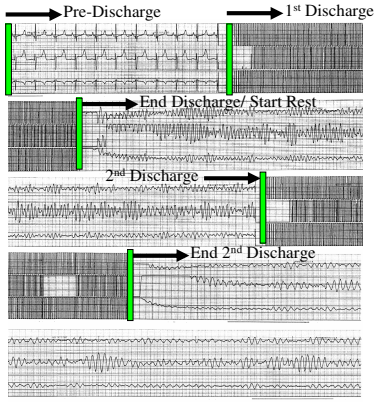

Figure 2. EKGs from one animal showing sustained ventricular tachycardia after the first discharge and VF after the second discharge.

Table 1
Average Ejection Fractions

	TASER+Sux	CT+Sux
Pre-Shock	0.44 ± 0.05	0.44 ± 0.02
Mid-Shock	0.09 ± 0.03	0.50 ± 0.03
Post-Shock	0.35 ± 0.17*	0.48 ± 0.01

Table 1. Digital video was captured and frame grabs obtained using Pinnacle Studio software. End systolic and diastolic LV diameters were quantified using UTHSCSA ImageTool v.3.00

Shown are means ± SD.

* Includes one animal with VF.

Figure 3
Troponin I Concentration

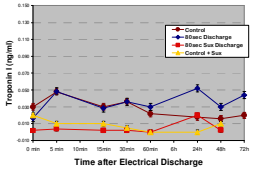

Figure 3. TnI values showed a small rise at 24h post-discharge but this was not significant (two-way ANOVA; p>0.05).

Figure 4
Central Venous pH

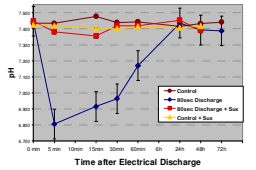

Figure 4. In the pTASER group, central venous pH showed a small decrease from baseline post-discharge but pH recovered to normal after 60 min.

Figure 5
Lactate Concentration

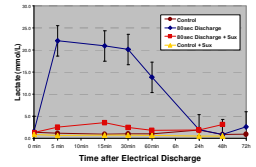

Figure 5. For the pTASER group, baseline lactate increased somewhat post-discharge but this was not significant (one-way ANOVA; p>0.05).

CONCLUSIONS

- With a transcardiac vector, TASER X26 **INVARIABLY** produced myocardial capture regardless of animal size that usually reverted spontaneously to sinus rhythm post-discharge.
- Ventricular tachycardia caused by TASER X26 discharges sometimes degenerated into fatal ventricular fibrillation.
- The extreme acid-base disturbances previously seen after lengthy TASER discharges are independent from the observed cardiac dysrhythmias and are primarily the result of intense skeletal muscle contractions.

STUDY LIMITATIONS

1. Anesthetized animal model used.
2. Limited animal numbers.
3. Resting animals, no excitatory stimuli (e.g., epinephrine) or drugs (methamphetamine, cocaine, etc.) used.
4. One trans-cardiac vector studied.