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Case Report

Forensic Section

TASER® Electronic Control Device-Induced Rhabdomyolysis and Renal Failure: A Case Report

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ABSTRACT

Many law enforcement agencies around the United States are employing the use of TASER® electronic control devices (TASER® International Inc.) to subdue combative suspects. Since its inception the TASER® has had a temporal association with reports of rhabdomyolysis. Case reports have reported TASER® induced rhabdomyolysis as mild but serious cases have also been reported. Herein we present the case of a single patient who was admitted to our health network with severe rhabdomyolysis after receiving TASER® shocks and review the pertinent literature. No direct link has been established between clinically significant rhabdomyolysis and TASER® device application but this case serves as an example of a sparsely documented but serious complication that may occur in patients who are at risk for restraint by an electronic control device.

Keywords: Law enforcement, Stun gun

CASE REPORT

Local law enforcement officers were called to an auto parts store when a 31-year-old African American male with a history of schizophrenia and hypertension complicated by medical non-compliance was frightening customers. He was reportedly "acting strange" and seemed to be "responding to internal stimuli". When law enforcement arrived to the scene the man was taken into custody and transported without difficulty to our emergency department.

On arrival to the emergency department he was moving all extremities and speaking nonsensically. He was uncooperative toward staff for further evaluation including intravenous (IV) catheter placement or vital sign measurements. His agitation worsened and he became physically combative. He was given 10 mg of haloperidol and 2mg of lorazepam intramuscularly to quell his violent state but these measures were ultimately ineffective. Multiple police officers and hospital staff members tried to restrain the patient but were unsuccessful. Because he continued to exhibit violent behaviour and was unable to be physically subdued by police he received three five-second TASER® shocks from an X26 device. After being tasered and placed in restraints the patients vital signs were obtained. He had a temperature of 36.8^{0}C (98.2^{0}F), blood pressure 154/109 mm Hg, heart rate 106 beats per minute, respiratory rate 26 breaths per minute. His oxygen saturation was 96% on room air. On physical exam he appeared to be a well-developed adult male in four point restraints. His pupils were equal and reactive bilaterally. He was tachycardic but did not exhibit murmurs, gallops or rubs. Lungs were clear to auscultation bilaterally. Abdomen was soft and non-distended without appreciable organomegaly. His skin was warm and dry. He exhibited no focal physical neurologic deficits but was oriented only to his own name. Two TASER® probes were removed from between his shoulder blades by nursing staff.

Laboratory data, was obtained five hours after arrival and was remarkable for a negative serum ethanol level, a negative urine drug screen, white blood cell count was 13600, haemoglobin 13.5 g/dl and haematocrit 39.6%, lactic acid was 3.6 mmol/L. A venous blood gas showed pH 7.36, PCO_2 43 mm Hg, PO_2 39 mm Hg and venous oxygen saturation 72%. Urinalysis revealed cloudy yellow urine with specific gravity of 1.018, protein 30 mg/dL and microscopy showed 1-3 wbc, 8-10 rbc per hpf. An initial metabolic panel and creatine kinase (CK) were obtained [Table/Fig-1] and the patient was admitted for further management. He was started on IV fluids for dehydration and rhabdomyolysis with strict monitoring of his urine output. The following morning the patient was alert and oriented and his involuntary hold was removed by the psychiatric evaluation team. Repeat labs showed a significant increase in CK [Table/Fig-1]. A renal ultrasound demonstrated unremarkable right and left kidneys. Nephrology was consulted and gave recommendations to add sodium bicarbonate for serum alkalinization as well as ongoing aggressive hydration with normal saline.

On the third day of hospitalization CK was 54,877 units/L [Table/Fig-1]. The patient expressed his desire to be discharged. Despite the objection of hospitalist, nephrologist and the physician director of medical quality the patient signed out against medical advice.

	Admission	Day 2a	Day 2b	Day 3
Sodium	138 mmol/L	137 mmol/L	-	140 mmol/L
Potassium	3.6 mmol/L	4.8 mmol/L	-	4.2 mmol/L
Bicarbonate	12 mmol/L	15 mmol/L	-	25 mmol/L
Chloride	104 mmol/L	109 mmol/L	-	105 mmol/L
Creatinine (mg/dL)	2.3 mg/dL	1.8 mg/dL	1.8 mg/dL	1.5 mg/dL
BUN (mg/dL)	20 mg/dL	21 mg/dL	21 mg/dL	16 mg/dL
Creatinine Kinase (units/L)	3678 units/L	43341 units/L	51058 units/L	54877 units/L

[Table/Fig-1]: Laboratory values indicating the sequence of progression of rhabdomyolysis

DISCUSSION

Acute rhabdomyolysis is the condition in which skeletal muscle is damaged and breakdown products are released into the bloodstream leading to myoglobin induced renal failure. Creatinine Kinase (CK), the intracellular enzyme that catalyzes the transfer of phosphate bonds between adenosine diphosphate and phosphocreatine during muscle activation, is used as a marker of muscle tissue destruction. Pathologic elevations in serum creatinine kinase occur in states where there is mechanical or metabolic tissue damage. In mechanical trauma there is a physical disruption of the muscle tissue which ruptures sarcomeres releasing CK directly into the interstitial fluid. In metabolic derangements there is an accumulation of intracellular calcium ions, enhancing cellular permeability and subsequently releasing

CK into the interstitial fluid [1]. By virtue of these basic mechanisms there are numerous causes of rhabdomyolysis including: drugs, endocrinopathies, and hyperthermia.

The TASER®, a less lethal device, is used by law enforcement to subdue individuals without resorting to lethal force. The most common electronic control device is the TASER® X26, a hand-held, battery operated, weapon that can be easily carried. It uses compressed nitrogen to propel barbed electrodes which penetrate light clothing and skin and remain attached to the hand-held unit by copper wires. When activated the devices delivers up to 50,000 volts at 19-hz for 5 seconds. It has a peak voltage of 1200V and delivers an average current of 2.1 mA [2]. While the exact mechanism of incapacitation is not fully established studies support inhibition of the alpha-motor neurons that innervate skeletal muscle fibers [3] by electrical stimulation of the presynaptic motor nerve tissue [4] causing discomfort, convulsion, and tetany.

Since its inception the TASER® has had a temporal association with reports of rhabdomyolysis. Reported cases of TASER® induced rhabdomyolysis have been mild [5] but serious cases have also been reported [6]. While no direct link has been established between clinically significant rhabdomyolysis and TASER® device application [7-9] muscle damage and subclinical elevations serum CK levels [7,10,11] are well documented. The relationship between exposure and development of rhabdomyolysis has been debated because individuals exposed to TASER® shocks had concurrent conditions predisposing them to muscle damage [5,12]. Ho et al., enrolled 66 participants who received shocks from the TASER® X26 for 4 seconds. Blood samples were collected before, immediately after, 16 hours after, and 24 hours after exposure. There were no significant changes in electrolytes but serum lactate concentration was initially elevated returning to normal by the 16 and 24 hour measurements. Furthermore, an increase in creatinine phosphokinase was noted at 16 hours and 24 hours, ranging 50 to 806 Units/L and 52 to 909 Units/L respectively [13].

Sanford et al., reported two patients with rhabdomyolysis after being tasered. In each case the patient was agitated. The first patient received six exposures and developed a peak serum CK of 3,115 U/l. The second patient, a cocaine abuser, received one exposure and developed a peak serum CK of 8,086 U/l [5].

Bozeman et al., reviewed over one thousand TASER® uses and found a single case of rhabdomyolysis with a reported serum CK of 61,116 U/L and creatinine of 5.5 mg/dL after three TASER® exposures. These particular patients confounding factors included cocaine intoxication and a lengthy foot pursuit [12]. Dawes et al., enrolled 156 healthy males and exposed them to 5-s, 10-s, and 30-s shocks and observed a positive relationship between the number of points of contact and elevation in serum CK at 24 hours but no relationship between the duration of exposure and change in CK. While modest CK elevations did occur they were not considered clinically significant [7].

Finally, Gross reported a 51-year-old male sustaining 5 shocks who had cut his wrists and throat. After surgical repair he was found to have rhabdomyolysis and renal failure requiring continuous dialysis. His CK peaked greater than 40,000 U/l and he developed multiple organ failure. After a prolonged course in the intensive care unit comfort measures were instituted and he passed away [6].

Shocks from TASER® devices have not caused thermal disruption or electroporation leading to clinically significant release of intracellular myoglobin and CK. Rather, most reports of TASER® induced rhabdomyolysis have been mild and point to a mechanism of sustained muscle contraction, ATP depletion, accumulation of lactic acid, build-up of intracellular calcium ions and compromise of myocytes due to dysregulation of the Na K-ATPase and Calcium-ATPase pumps. Clearly the pathophysiologic response to TASER® shock is heterogeneous and the risk for developing clinically significant rhabdomyolysis is likely impacted by unforeseen factors such as genetic predisposition or other unidentified risks. Multiple genetic mutations with unremarkable phenotypic manifestations exist with elevated risk for severe rhabdomyolysis. These include recessive mutations in genes such as beta enolase, phosphoglycerate mutase 2, and others [14].

CONCLUSION

This case demonstrates that common comorbidities need not be present to sustain severe rhabdomyolysis and renal failure after TASER® exposure suggesting unidentified risk factors may be present. Broad spectrum analysis of patients sustaining TASER® exposure for complications as well as comorbidities could provide law enforcement personnel additional criteria for safe deployment of this device. Furthermore, these studies will help health care providers to identify which patients are at risk for further complications.

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