Effectiveness of Different Caliber of Firearms on Penetration of the Frontal Bone and Amount of Brain Matter Destruction of Feedlot Cattle Using Computed Tomography

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Introduction

Euthanasia of an animal by gunshot or captive bolt is not aesthetically pleasing, but neither is prolonged animal suffering. Therefore, establishing protocols and guidelines for use of firearms in the depopulation of cattle is essential, because unsuccessful attempts at euthanasia are inhumane, demoralizing, and can lead to operator reticence. Usage of firearms for the depopulation of cattle is approved by both the American Veterinary Medical Association and the American Association of Bovine Practitioners as a means of euthanasia. However, there has been very little research performed to establish recommendations on what calibers of firearms and suitable munitions to employ to accomplish the objective while avoiding excessive firepower which could result in the projectile exiting the target. The objective of this study was to examine the effects different caliber of firearms have on the penetration of the projectile(s) fired into the cranium, and the amount of brain matter destruction incurred in the disembodied heads of feedlot cattle as evidenced by computed tomography (CT).

Materials and Methods

Cadaver heads from feedlot mortalities and kosher killed cattle that had died in the last 24 hours were removed from carcasses and taken to a rural shooting range. Heads were randomly assigned to one of seven treatments: 1) .22 caliber hollow point, 2) .22 caliber solid point, 3) .223 rifle, 4) 9mm pistol, 5) .45 caliber pistol, 6) 12 gauge #4 lead shot, 7) 12 gauge 1 oz slug. There were six replicates per treatment (42 total treatment applications; six replicates; seven treatments). Prior to treatment application firearms were fired across a chronograph three times to calculate the average velocity of each treatment. The kinetic energy was calculated using $KE = \frac{1}{2}\, mv^2$, where m equals the mass (mg) of the projectile(s) and v equals the velocity (m/s). All treatments were applied to cadaver heads at a fixed distance of three meters at the intersecting point of two lines drawn from the medial canthus of one eye to the opposite side base of the ear at an angle directed to the greater foramen of the occipital bone. Heads were positioned for serial coronal CT scans at 3mm intervals with the resulting image reconstructed in 1.5mm sections. CT images were observed and recorded for projectile penetration, condition of projectile, bony changes, percent brain matter destruction and brain stem lesions by a radiologist blinded to treatment designation.

Results

The kinetic energy calculations show a wide range between treatments with treatments 1 and 2 having the least kinetic energy (217 Joules) and treatment 6 and 7 containing 2,398 and 5,552 Joules, respectively. Treatments 3, 4, and 5 had 1,687, 428 and 747 Joules of kinetic energy, respectively. All replicates of all treatments penetrated the skull cavity except for a single replicate in the 12 gauge #4 shot treatment that did not enter the skull. Most of the treatments had 100% of the projectiles fragment upon entry to the skull except for the .22 solid point, 9mm, and .45 calibers. The 9mm had two replicates that did not penetrate past the skull, and the .45 caliber pistol had one treatment that passed through the entire skull. The .22 hollow point had the least penetration distance (107.5 mm) of the treatments with all other treatments having relatively identical penetration distance (150mm). The .22 solid point did not elicit any additional skull fractures whereas 100% of the 12 gauge 1oz slug treatments elicited additional fractures. The 12 gauge #4 shot and 1 oz slug treatments caused the greatest percentage brain destruction. Approximately 33% of the 9mm and 100% of the 12 gauge 1 oz slug replicates resulted in damage that was deemed significant enough to cause death.

Significance

The immediate applicability and potential impact this data can have on one of the most sensitive areas in bovine practice warrant its inclusion for presentation at the annual meeting.