The Capability of Acuminate Ice-generated Puncture Lethality and Depth in Mammalian Torso

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Abstract: During certain months of the year and depending on where we are in the world, we can walk outside and observe icicles forming on overhangs of houses. Due to their shape and unexpected tendencies to break and fall, these spikes may have been labeled as dangerous by the public. Nonetheless, the icicle is not recognized as an object carrying a high possibility of causing fatal injury. In this experiment, we explored that possibility to its necessary extent. Utilizing a prototype, the efficiency of spikes of ice when used to stab a meat body was evaluated by observing wound depths and durability of the ice during and before action. Chicken breast and pork ribs were utilized under various conditions and overall, the experiment confirmed the capability of ice, when accuminated, to be a lethal instrument. With an effective lethal situation and a depth of 7.6 cm on the chicken breasts, results showed that the spikes of ice were able to pierce meat comparable to the human abdomen with enough depth to compromise any of the vital organs in that region, including the liver. But otherwise, the chest region proved almost impenetrable to the spikes of ice, leaving the heart and other major arteries surrounding it seemingly unreachable.

Keywords: Sharp Force Injuries (SFI), icicles, acuminate ice, lethality

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Sharp force injuries (SFIs) are described as injuries inflicted by a sharp instrument, typically cutting or stabbing in nature. According to the Centers for Disease Control and Prevention's (CDC's) Injury Center's Statistics reports from 1981 to 2019, homicides remained in the top 5 leading causes of death in the nation (CDC, 2021).Of homicides in the United States, firearms account for the greatest percentage of deaths, totaling 75.3% in 2019 (CDC, 2020). The causes of death contained in the remaining 24.7% include SFIs. The lack of appearance of SFIs in modern homicide allows for the number of studies dedicated to delineating the manner of death in cases like these to be scarce (Kemal et al., 2013). So, when the internet explodes with the question of whether an SFI sustained from an icicle, someone can easily pluck off the overhang of a house, is lethal enough to make an icicle the perfect murder weapon, a high level of fear should emerge.

Among victims of SFI homicides, the chest area is the most common site for both single and multiple fatal stab wounds (Rouse, 1994). In cases involving death from multiple stab wounds, approximately 75% of them occur in the chest region (Rouse, 1994). Most of the fatal injuries in the chest region reach the heart and the major vessels surrounding it (Rouse, 1994). However, outside the safety of our ribs and sternum, lie some of our other fundamental organs: our abdominal aorta, liver, and throat. All of these are relatively close to the surface of our external skin. A study of soft-tissue injuries caused by sharp tools measured the distance from the skin surface to the surface of vital organs and found that our heart is, on average, 2.4 cm deep, our abdominal aorta, 6 cm, our liver, 3.7 cm deep (2 cm from the side near our hip), and our throat, 1.3 cm (Haddadin et al., 2011). For comparison, the average adult pinkie is approximately 5 to 6 cm long (Alexander & Viktor, 2010).

Acuminate ice, for the purposes of this paper, is defined as solid ice that has been sharpened either manually or overtime through natural processes. This experiment exists to compare the depth of acuminate ice plunged into a meat-body to the depth of a sharp instrument inserted into the human body to determine whether the device is effective enough to be considered a lethal instrument. This information will help us to better understand the diverseness in instruments associated with SFIs, including puncture wounds. It goes without saying but the information derived from this experiment is not a guide on another method to commit murder, but for greater scientific and educational consideration and understanding.

Materials and Methods

Mold Assembly. To construct the mold for our ice spike, approximately 1.2 lbs. of air-dry clay (*Crayola, Easton, PA*) was used to sculpt the prototype of the spike, given dimensions were 17.5 cm in height, 18.3 cm in slant height, and 4.5 cm in diameter of base. After the clay had completely dried (an elapsed time of about 6 hours) the base was hot glued to a 13.02 x 18.42 x 0.63 cm rectangle plaque (*PLAID Enterprises, Inc., Huangyan, China*). A 33.02 x 40.64 x 0.15 cm (l x w x thickness) PVC desk cover (*NECAUX, Guangzhou, China*) was tapered to dimensions of 16 x 22 x 0.15 cm and rolled into cylindrical shape with a diameter of 7.5 cm. The parts of the desk cover that had overlapped were taped over so as to prevent any leaking. It was then put over, surrounding the prototype and hot glued to the plaque as well, allowing for almost an inch of space between the tip of the prototype and the top and sides of our cylindrical desk cover. Following the directions found on the bottles of our silicone rubber mold making kit (*Sipolysum, Shenzhen, China*), equal measures of both were mixed in a plastic bowl, to assure the least number of bubbles in our solution, the bowl was banged on a hard countertop approximately ten times with no more than a maximum height of 4 inches between each bang. Fill the cylindrical space created by the desk cover until the prototype is

completely submerged and there is a maximum 3 cm distance between the solution and top of the desk cover. Let it sit for 24 hours and once it's finished, grip the sides of the plaque closest to the prototype and slowly try to pull the plaque, along with the prototype, out of the silicon mold. If the prototype will not surrender, rinse it under hot water so the clay can soften and empty the mold of all the clay water and scraps. Lastly, remove the plastic desk cover from the mold without compromising the mold, which itself is tough and flexible.

Ice Casting Preparation. The silicone mold is filled to the top with filtered tap water. A rubber band is submerged into the water with a third of its body still above the water. The filled mold is placed in a freezer set to -18 degrees Celsius. Within eight hours, the water has become completely solid ice. Utilizing the rubber band, pull the ice cast from the mold. Once the ice cast is free from the mold, place our now “spike of ice” back into the freezer and repeat the process of filling the mold to the top with water and placing a rubber band into it as before until there are exactly eight spikes of ice inside the freezer for the experiment.

Pre-experimental Lab Setup. After the eight spikes of ice have been casted and remain in the freezer. From the fridge, take out the 3 x 3 boneless chicken breast packs (*Sanderson Farms, Laurel, MS*) and the pork back ribs (*Smithfield Fresh Meats Corp., Smithfield, VA*) and place them on any surface in your kitchen to begin dethawing. After about six hours, check if your poultry and meat are ready, you can do this by pressing hard with your thumb into the meaty areas, if the elasticity of the meat is low, meaning the meat does not immediately resume its normal shape or does not resist your thumb too much, it should be thawed enough to begin your experimental procedure. Otherwise, let it sit longer until completely thawed. When determining the depth of the wound after each puncture, wait until you have completed the section you are performing and after slice the meat through the center of the one (or two) puncture hole(s) and measure from the base of the wound to the top. To hold each spike of ice as to prevent heat absorption from skin-to-skin contact and your hands from getting too cold, a cotton glove was worn on the hand holding the ice.

Experimental Procedure. In **Section One**, two spikes of ice were stabbed into two chicken breasts stacked on top of each other, thawed to room temperature. (1A) After the first spike of ice is stabbed into the breast, observations are recorded to reveal whether the ice broke or did not, and if it did, did it break before or after impact. Measurements are then taken to determine the length/depth of the wound or passage if any. (1B) The second spike is then stabbed into a second stack of two chicken breasts and the same methods for observations and measurements are recorded.

In **Section Two**, two spikes of ice were stabbed into a similar stack of chicken breasts with a cotton t-shirt (*Hanesbrands LLC, Winston-Salem, NC*) worn over it. After the first spike of ice is stabbed into the model, observations are recorded to reveal whether the ice broke or did not, and if it did, did it break before or after impact, also

noting whether it penetrated the shirt or not. Measurements are then taken to determine the length/depth of the wound or passage if any. The second spike is then stabbed into a second model with the same shirt and a different stack of chicken breasts and the same methods for observations and measurements are recorded.

In **Section Three**, two spikes of ice were stabbed into room-temperature pork ribs. After the first spike of ice is stabbed into the ribs, observations are recorded to reveal whether the ice broke or did not, and if it did, did it break before or after impact. Measurements are then taken to determine the length/depth of the wound or passage if any. The second spike is then stabbed into the same ribs with at least an inch length away from where the first spike had been

Results

Overall, the most effective situation for the spike of ice to be considered most lethal based on the depth of wound (7.6 cm) was in Section One where a stack of two chicken breasts were stabbed without a cotton t-shirt. used and the same methods for observations and measurements are recorded.

In **Section Four**, two spikes of ice were stabbed into room-temperature pork ribs with the same cotton t-shirt from Section Two worn over it. After the first spike of ice is stabbed into the model, observations are recorded to reveal whether the ice broke or did not, and if it did, did it break before or after impact, also noting whether it penetrated the shirt or not. Measurements are then taken to determine the length/depth of the wound or passage if any. The second spike is then stabbed into the same model with at least an inch of space away from the area the first spike was used and the same methods for observations and measurements are recorded.

On average, the depth of the wound made by the spike of ice in a boneless chicken breast was 7.3 cm, and 2.1 cm for the depth of the wound in pork-back ribs. Stabbing the boneless chicken breasts yielded a 348% deeper wound against stabbing the pork-back ribs (Table 1).

Table 1. The comparison of wound depths and durability of the ice in different situations according to each section.

Section	Part	Wound Depth (cm)	Did it Break? (yes/no) (before/after)	Puncture the shirt? (yes/no)
1	1A	8.2	no	--
	1B	6.9	yes, after	--

2	2A	6.8	no	no
	2B	7.3	no	yes
3	3A	--	yes, before	--
	3B	2.3	yes, after	--
4	4A	2.2	no	no
	4B	1.8	yes, after	no

In Section One, the ice had an average wound depth of about 7.6 cm and only one of the two spikes broke after it performed a deeper passage. In Section Two, the ice had an average wound depth of 7.1 cm without any breaks and one of the two spikes was able to pierce the cotton t-shirt wrapped around the body of meat. In Section Three, only one of the two spikes was able to pierce the rib-meat body and break right after. The other spike had broken before it could touch the meat body, likely due to an error in taking it from the mold. In Section Four, the average wound depth of the spikes of ice was 2.0 cm with only one breaking after it performed a shorter passage than the other. Both were not able to pierce the cotton t-shirt.

Discussion

Water is considered a renewable resource, meaning it will continuously exist on this planet (Clements, 2019). And if we have water and temperatures so low that moisture in the atmosphere combines and expands, we will continue to have snow and ice as well (NSIDC, 2020a). Some places in the world have more snow than others, some will never experience snow or ice due to the lack of moisture in their atmosphere. For the places in our world that do, including parts of the United States (NSIDC, 2020b), the people who live in the regions that snow may walk outside and see icicles formed on the overhangs of houses. These long cone-shaped ice structures come in year-round and can be the victim to that of a child trying to playfully make a kabob out of his/her siblings or friends. And now we know that the lethality of ice can be very real.

With a 17.5 cm tall spike of ice, we were able to jab over a third of that into a meaty body, comparable to that of the human abdominal region. Unfortunately, generating a deep enough wound to puncture any of our

vital organs in that region from the side or head-on. Fortunately, it appears our thorax region, the common-most site for fatal stab wounds (Rouse, 1994), is strong enough to protect that of our heart and other organs being surrounded by the ribs and sternum from a spike of ice. Where the spike of ice was only able to make it a maximum of 2.2 cm into the meat body surrounding the bones in the pork-back ribs. However, with a difference of 0.2 cm from the surface of the heart, someone who is stronger than me may be able to insert the spike of ice deeper into the rib so this would call for further experimentation involving different subjects capable of stabbing the meat bodies with greater force.

Throughout the experiment, difficulties like how well the spike of ice left the mold may have contributed to whether it broke before/after it punctured the meat body, or like the diversity of the amount of force used per swing of the spike may have contributed to a greater or less wound depth or whether the ice broke or pierced the t-shirt should be acknowledged but without the proper equipment, were unable to be recorded for comparison. And therefore, further study into this topic and experiment are invited and appreciated.

Under the subject of wound morphology, during Sections One and Two, two spikes of ice were observed to come out of the meat body misshapen or warped. The best explanation for this phenomenon was found to be that of ice regelation whereas under high pressures, ice will melt and refreeze simultaneously (Byjus, 2021). When the wounds of Sections One and Two were compared (the ones who performed regelation and the ones that did not) it appeared that the ones who performed regelation had rounder bases on the bottom of the wound as opposed to the pointier bases of the wounds made by the spikes of ice that did not undergo regelation. This is interesting since if the wound morphology is looked at from a person who is not aware yet of what has happened all they may see is that the body was stabbed with a blunt object, which is a rare occurrence in the fields of forensic science as we know the ice was sharp before it was used, making the device used in the manner of death uneasily identifiable.

To emphasize the most important aspects in this experiment, acuminate ice is lethal in terms of puncture depth, for which it is capable and should be highly regarded. Future studies should occur to further the knowledge of types of SFIs like this one here and to help delineate manners of death especially in cases involving obscure occurrences like that of regelation. Examples related to ice-specific SFIs would include research on how ice punctures affect body temperature at the site or discovery of tests that could chemically characterize the use of ice in related events.

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