Proving (or Disproving) Use-of-Force Narratives

BY DR. GEOFFREY DESMOULIN
GTD SCIENTIFIC INC.

When police officers lawfully respond to deadly threats, their money, reputation, and freedom still hinge on whether society believes their version of events. Dr. Geoffrey Desmoulin, Principal of GTD Scientific Inc., developed an impressive testing and shooting reconstruction methodology to scientifically evaluate use-of-force narratives. Dr. Desmoulin describes how he used biomechanical models and human factors research to assist a California jury as they considered the fate of an officer accused of excessive force and wrongful death.

Handcuffed before the Shooting?

In response to a 911 call of a violent domestic, two officers arrived in time to see the suspect running from the house. One officer pursued the suspect on foot, giving him multiple orders to stop before finally catching him in a narrow, deserted corridor.

According to the officer, while trying to detain the suspect, a struggle ensued and he used a "leg sweep" to bring the suspect to the ground. After the leg sweep, the officer noticed that his backup firearm had dislodged from his ankle holster and was now lying next to the suspect. In his attempt to move the backup firearm a safe distance away, the officer turned and retreated from the suspect. As he pivoted back towards the suspect, he unholstered his primary firearm in time to see the suspect getting up and lunging toward him with both hands now reaching for his primary firearm. Believing his life to be in danger, the officer discharged his firearm twice, in quick succession, striking the suspect with both rounds.

The officer's description of the arrest was challenged by the deceased's family and the media who suggested that the suspect had been handcuffed prior to the shooting.

Injuries and Angles

As a first step, we needed to collect relevant data that would be used to set up a simulation and evaluate the results. We began with the medical examiner's report.

The medical examiner documented one gunshot wound to the abdomen, with the entrance wound just left of and above the navel. The bullet was recovered from the left buttock suggesting a path that was backward, downward, and slightly left. It was noted that the bullet had just passed through the sacrum before coming to a stop in the soft tissue of the buttock.

Another entry wound was found on the back of the neck, with the bullet path traveling downward, frontward, and minimally rightward. According to the medical examiner, the bullet settled in the diaphragm after causing catastrophic damage to the spine, resulting in paralysis.

Notably, the suspect also presented with multiple abrasions to the elbows and forehead. These injuries would prove to be important as abrasions frequently provide independent evidence of movement patterns. With a bullet entrance wound to the abdomen and a second entrance wound to the back of the neck, it became clear that biomechanical modeling would be an important tool to *determine whether a man lunging toward an officer can get shot in the back of the neck*.

Ballistic Testing

Next, static and dynamic shooting tests were performed. The firearm used for the testing was the same make and model as that fired by the officer (Sig Sauer P229) and equivalent ammunition was used (9mm, 147 grain, Luger, hollow point).

From the static shooting test, we were able to determine the force of the bullet impact as it penetrated the suspect's body. In measuring this force, we used ballistic soap and bone simulant set at distances estimated from the autopsy report. The test results showed appropriate wound depths through the synthetic bone and the second ballistic soap block. Later, we used the bullet force data to increase the accuracy of the biomechanical modeling.

A dynamic shooting test was also performed during which a pistol was fired in rapid succession from a single hand, bent arm position. This test provided a reference by which to anticipate the placement of the second shot when fired in the manner described by the officer. In this case, the dynamic shooting tests resulted in the second round being above and to the left of the first round. This information was important as we would compare the trajectory of the wound paths found by the medical examiner with that reflected in the modeling.

Biomechanical Modeling

Biomechanical modeling was the next step in the process. Biomechanical modeling uses live humans, physical models ("dummies"), and computer simulation models to represent human movements. Most readers are likely familiar with biomechanical "crash test dummies", used to predict the body's movement when subjected to the force of an

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automobile collision.

In our case, we would use the combination of ballistic testing results, live humans, and a computer human body model to determine the expected movement and resultant injuries of the suspect. The computer model, which is designed to respond similarly to a "dummy," was scaled to match the height and weight of the deceased.

We began human movement testing with a live re-enactment of the shooting as it had been described by the officer. Measurements from the re-enactment video and results from the ballistic testing were used to construct the input to the computer model (simulation). We then compared the computer model's simulation results against the physical evidence independently documented by the medical examiner.

By analyzing the ballistic tests, the re-enactment video, and other relevant independent values (including friction between skin and asphalt), we obtained the initial conditions for the computer model. These conditions included the body positions and motion velocity involved in the altercation.

Modeling Results

From the model, we noted that the first gunshot wound would likely have hit the suspect at waist level—a result that matched both the location and trajectory detailed by the medical examiner. Thereafter, the model's initial momentum carried the "suspect" forward slightly at the waist against the force of the bullet.

In order to achieve the impact location and trajectory in the neck like that found in the autopsy, the second bullet had to be fired 282 milliseconds (ms) later. The timing of this shot interval is consistent with independent research on shot-to-shot time intervals when rapidly firing a semi-automatic pistol.

We next observed the model falling only under the acceleration of gravity. Here, the model was consistent with the movement of a paralyzed subject falling limply to the ground. Notably, upon hitting the ground, the model's forehead and elbows impacted the ground as shown in Figure 1 (right). The simulation then showed the head and elbows slide along the ground for approximately 60ms. The injury type and location documented by the medical examiner were consistent with injuries reasonably expected from someone falling and sliding in the manner portrayed through the biomechanical model.

Discussion and Conclusion

Through biomechanical modeling and the scientific method, we were able to objectively evaluate the officer's use-of-force narrative. Based on the results of the testing, the officer's description of the altercation was not only probable, but likely.

First, despite the gunshot entry wounds being on two different sides of the body (abdomen and back of neck), the model was able to show how it is probable for the two shots

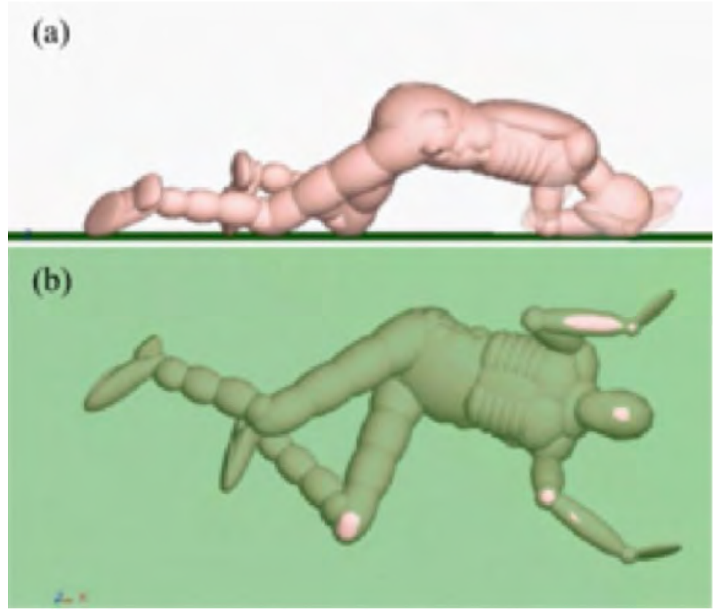

Figure 1: (a) side view and (b) bottom view of the forehead and elbow impact with the ground.

described by the officer to generate these injuries—*even as they were shot from essentially the same position*.

Second, the time between shots was consistent with independent research that suggests that officers rapidly discharging their weapon take approximately 200ms to 333ms between shots when firing a semi-automatic pistol.

Third, the forehead and elbow impacts seen in the model matched the abrasions reported by the medical examiner and conclusively refuted any suggestion that the suspect's hands were cuffed prior to the shooting.

As this case was presented in federal court, I provided my opinion that, within a reasonable degree of professional engineering certainty, the movement patterns seen in the model simulation agree with the events described by the officer involved. For the judge's part, he accepted our credentials and our methodology.

As for the jury, they unanimously found the officer "not guilty" on all counts.

Geoffrey Thor Desmoulin, PhD, RKin, EngL., is the Principal of GTD Scientific Inc. GTD offers Biomechanical Consulting Services on behalf of clients throughout North America, as well as abroad. Focused practice areas include Injury Biomechanics, Incident Reconstruction and Physical Testing with a sub-specialty in the Science of Violence™. GTD has been retained in significant complex injury litigation cases involving municipal police department use of force, violent encounters and TASER International to name just a few examples. Furthermore, landmark testing and shooting reconstruction methodology developed by Dr. Desmoulin was recently upheld as reliable and admissible by the U.S. Federal District Court for the 9th District of California.

In addition, Dr. Desmoulin was selected from an international pool of applicants to be the science and engineering host for Viacom Networks hit television show Deadliest Warrior. In this high-profile position, he assessed engineering aspects, injury potential, and overall battlefield effectiveness of weapons used by warriors throughout history. The series filmed 33 one-hour episodes and highlighted 64 warriors. Deadliest Warrior continues to air throughout the world in more than 16 countries, 32 different languages, and is available in 96 million homes in the United States alone.

