Geometric Bloodstain Interpretation

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Crimes of violence frequently produce bloodstains which, when properly studied, will aid in reconstructing the occurrences that took place to produce the patterns found at the scene. In the study of specific bloodstain patterns, care must be taken to record location, stain shape, direction, size, and surface of impact area. When this information is applied to the known physical characteristics of blood, the investigator may be able to disclose the:

1) Origin of blood,
2) Distance between impact area and origin at the time of occurrence,
3) Type and direction of impact,
4) Number of blows,
5) Position of victim during attack, and
6) Movement and direction of suspect and victim during bloodshed and after.[1]

Laws of Physics on Fluids

Due to a molecular attraction called cohesive force, a drop of blood is held together by a skin similar to a balloon. The skin is actually surface tension or an outer covering of the drop. This principle is similar to that of a razor blade floating on water if laid gently onto the surface. It is supported by the unbroken skin of the water. However, if the blade is held on its edge and placed on the water, the sharp edge will puncture the skin or surface tension, and the razor blade will sink. It is cohesive force and surface tension which cause a drop to be circular in shape during free fall and to resist rupturing even upon impact. On a perfectly smooth, clean surface, a drop will not rupture or break upon impact, regardless of the height of the free fall. However, on a rough surface or due to some other force or energy, this principle does not hold true.

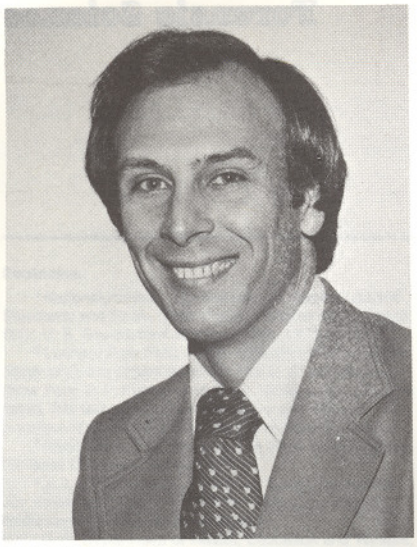
During the study of a crime scene, the investigator should keep in mind the following known characteristics of blood:

1) Blood is uniform in character and can reproduce specific patterns.
2) A drop of blood is circular in shape during free fall.
3) A drop of blood does not break up unless acted upon by some force or energy.
4) A single drop of blood has a volume of .05ml, unless acted upon by some force or energy.
5) Terminal velocity is 25.1′ per second (±0.5′) in free fall.
6) The majority of high velocity droplets have diameters of less than 1mm, which travel usually no further than 46″.[2]

Distance and Direction

To estimate accurately the distance a blood drop has fallen, it is necessary to conduct a series of blood drop vs. distance experiments on the specific surface in question and to use these as known standards for direct comparison to the unknown.

Determining the directionality of blood droplets is possible because a



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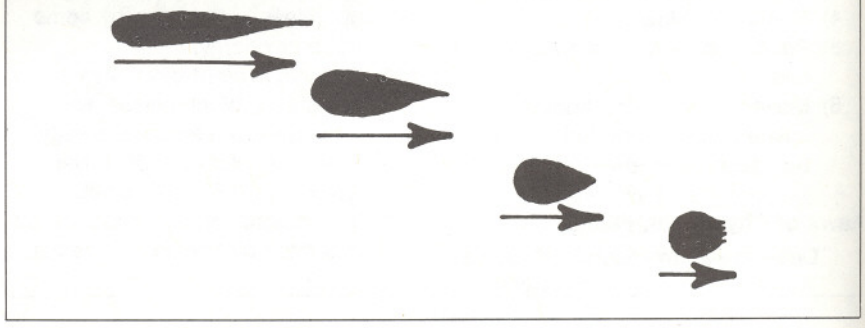
droplet striking an angled surface produces a teardrop-shaped pattern. This is caused by the physical law of inertia, i.e., the resistance of a moving body to any force operating to change its motion, direction, or speed. Therefore, as the speed is dissipated abruptly by the surface upon which it impacts, the blood droplet trails off into a pointed end of varying degrees, depending on the angle of the surface. The greater the angle, the more elongated and narrower the stain pattern produced. The pointed end shows the direction of travel of the droplet.[3] (See fig. 1.)

Blood dropping onto a flat surface that is nearly horizontal will produce an elliptical rather than a circular stain. As the angle decreases, the stain patterns become more elongated, as illustrated in figure 3.

There are certain points to remember when interpreting bloodstain patterns:

1) Surface texture, not distance fallen, determines the degree of spatter.
2) Teardrop stains (pointed ends) point in the direction of travel. Smaller and longer droplets have their pointed ends pointing back to the larger stains from which they originated.
3) The smaller the drops of blood, the greater the energy of impact.
4) The angle of impact of a bloodstain may be estimated by the geometry of the stain.[4]

Figure 1



Secondary Drops and Impact Angle

Primary blood droplets may produce smaller castoff spatters which point back to the source. The smaller droplets break away from the parent drop due to inertia or resistance to being stopped. These droplets travel close to the surface until impact, producing exclamation-like marks which point back to the parent drop. (See fig. 2.)

When dealing with firearms and bloodstain evidence, the following rules apply:

1) Back spatter usually occurs less than 3″ from muzzle to target area when blood is found inside the barrel.
2) The larger the caliber or gage, the greater the depth of blood penetration into the barrel.

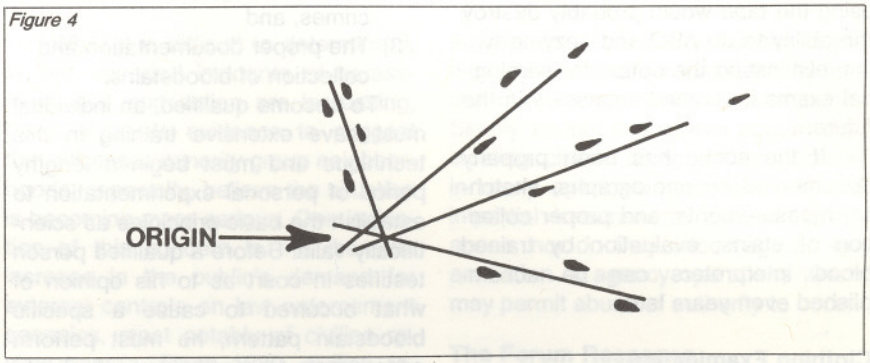
Figure 2

3) Less penetration and concentration of back spatter occurs in recoil autoloading weapons than weapons whose barrel does not recoil.
4) Higher energy loads will produce more depth of back spatter penetration than standard ammunition.
5) When double-barrel shotguns are discharged on body contact, considerable back spatter (up to 12 cm) occurs in the dormant barrel.
6) The majority of blood spatter patterns will be 1mm or less in diameter.[5]

Documentation

The purpose of documentation is to show location, direction, size, shape, impact surface, angle, number of stains and/or volume, and human blood type.[6] However, reconstructing the chain of events that occurred at a crime scene where bloodstain patterns are present is directly proportional to the skill and care taken while examining the scene. Since the ultimate test is effective prosecution in a court of law, successful presentation of physical evidence can only be accomplished if there is proper documentation, collection, and preservation of bloodstains. Therefore, the scene should first be processed for physical evidence that is easily lost or destroyed. Unlike hairs or fibers, bloodstains are easily found with proper lighting, and once dry, will stay in place in most instances. However, they can become tainted if care is not taken when processing the crime scene. For example, the powder used when dusting for latent prints can interfere with the analysis of a bloodstain and may very well make an analysis impossible. It is extremely important to the outcome of an investigation that all evidence is properly collected, packaged, marked, and preserved.

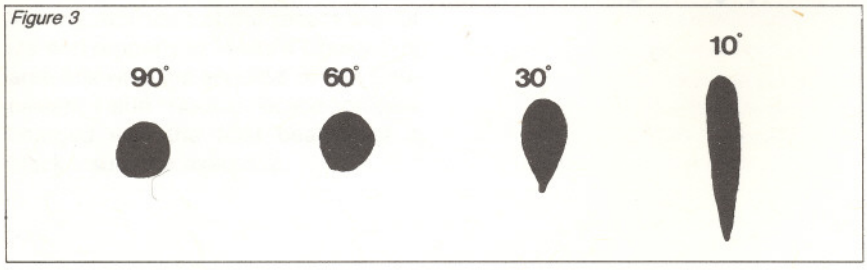
Figure 4



Photographs taken of the scene document bloodstain evidence, showing both location and relationships. Closeups must be taken with a scale of reference, such as a metric ruler, and at a 90° angle from stain to camera. The investigator should tape a string of contrasting color to the background beside the stains that form a trail to show directionality. All strings should run parallel to the surface and in the direction shown by the stains. At some point, the strings may converge if the stains form a trail made by a swinging object. A photograph should be taken to show this convergence, which should also be measured and sketched as shown in figure 4.

If the stains are on a movable object, they can be transported to the lab for more detailed study, although this is not necessary in most cases if they are properly documented. However, before the object is moved, the stains should be protected with clean paper and tape. It is essential that the item is photographed, measured, and sketched before transporting. Also, directional markings (east, west, north, and south) should be made so that the direction of the stains can be reestablished.[7]

Figure 3



"Bloodstain pattern interpretation can be a valuable investigative aid in the reconstruction of a violent crime scene."

Although there are some who assert that stains can also be preserved by fingerprint tape used for lifting latents, I prefer not to use this method. However, for those interested in the technique, the stain is covered with fingerprint tape and then placed on a contrasting colored cardboard background or on clear plastic, such as celluloid. The clear plastic can be used as a negative to contact print 1:1 photographs of the stains on high-contrast paper. One must keep in mind that using the tape would probably destroy the ability to do ABO and enzyme typing, eliminating the option for serological exams if deemed necessary in the future.

If the scene has been properly documented by photographs, sketches, measurements, and proper collection of stains, evaluation by trained blood interpreters can be accomplished even years later.

Clothing Examination

A careful examination should be made of the clothing the suspect was believed to be wearing during the commission of the crime. Again, location, size, and shape may help prove or refute any story of what took place. For example, if the victim was kicked repeatedly by the suspect, medium velocity spatter should be found on the lower front portion of the clothing covering the ankle and leg used in the assault. This will often include some upward spatter on the inside of the pant cuff. Also be sure to examine shoes and socks. Likewise, medium velocity spatter might be found on the clothing covering the wrist and arm, if an instrument or hand was used in the assault. Spatters may also be found on the inside cuff of longsleeved shirts.[8]

Summary

Bloodstain pattern interpretation can be a valuable investigative aid in the reconstruction of a violent crime scene. However, it must be stressed that this article is not an attempt to make the reader an expert in this technique. It is designed to make the reader aware of:

1) The more basic principles of bloodstain interpretation,
2) What this discipline can do to aid in the investigation of violent crimes, and
3) The proper documentation and collection of bloodstains.

To become qualified, an individual must have extensive training in this technique and must begin a lengthy period of personal experimentation to establish the basic principles as scientifically valid. Before a qualified person testifies in court as to his opinion of what occurred to cause a specific bloodstain pattern, he must perform experiments to recreate and duplicate the specific patterns. If the specific pattern cannot be duplicated using the occurrences as set forth by the expert's opinion, then his opinion is simply useless in court and cannot be accepted.

For additional information, contact Sgt. Tom Bevel, Oklahoma City Police Department, 701 Colcord Drive, Oklahoma City, Okla. 73102, or call (405) 232-5331, ext. 494. **FBI**

Footnotes

[1] Judith L. Bunker and Catherine Koeing, *Interpreting Bloodstain Patterns Lab Manual,* Orlando Police Department, Orlando, Fla., 1977, p. 7.

[2] Herbert L. MacDonell and Lorraine F. Bialousz, *Flight Characteristics and Stain Patterns of Human Blood* (Washington, D.C.: U.S. Department of Justice, Law Enforcement and Criminal Justice, 1971), p. 3.

[3] Arne Svensson, Otto Wendel, and Barry A. J. Fisher, *Techniques of Crime Scene Investigation,* 3d ed. (New York City: Elsevier,1980), pp. 170-72.

[4] Tom Bevel, "Geometric Bloodstain Interpretation," *Oklahoma Sheriff and Peace Officers Journal,* November 1979, pp. 15-19.

[5] Herbert L. MacDonell and Brian A. Brooks, "Detection and Significance of Blood in Firearms," *Legal Medicine Annual,* ed. Cyril H. Wecht (New York: Appleton-Century-Crofts, 1977), pp. 185-197.

[6] Paul L. Kirk, *Crime Investigation.* 2d ed., ed. John I. Thornton (New York: Wiley and Sons), pp. 167-181

[7] Kevin P. O'Brien and Robert C. Sullivan, *Criminalistics: Theory and Practice,* 3d ed. (Boston, Mass.: Allyn and Bacon, 1972), pp. 97-99.

[8] Cyril J. Polson, *The Essentials of Forensic Medicine,* 2d ed. (Springfield, Ill.: Charles C. Thomas, Inc., 1965), pp. 218-221.