PATTERN EVIDENCE

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Introduction

In the usual course of performing an autopsy examination, the pathologist will make descriptions of gunshot wounds, sharp-force and blunt-force injuries. Any of these broad causes of injury can produce a pattern on the skin (or occasionally bone) that reflects the shape of the inflicting instrument. An effort to identify the type of instrument, and possibly the specific instrument, can be of paramount importance in solving a homicide. It is the responsibility of the pathologist to recognize and document patterned injuries, and then in appropriate cases offer opinions as to the likelihood that a particular weapon or instrument was involved in their creation. Beyond appreciating that a particular injury

demonstrates a pattern, certain steps must be taken to allow for a valid injury–instrument comparison that can be supported in a court of law.

Figure 1 Airbag abrasion on the upper neck and undersurface of the chin in a motor vehicle accident victim.

Patterned Injury Definition

Broadly speaking, it is any injury (abrasion, contusion, laceration, and sometimes even a knife or gunshot wound) that suggests an inflicting instrument or unique means of its creation. Some patterned injuries are instantly recognizable as to causation based on the type of injury, location, and the circumstances of the incident and a search for the inflicting instrument may be unnecessary. For example, a large, uniform abrasion on the upper neck of a car accident victim is likely an airbag injury (Figure 1). The cause of some patterned injuries is intuitively obvious without circumstantial information and the identification of the specific instrument (and therefore assailant) would be extremely helpful. An example might be a slap contusion on the buttock of a child that leaves a clearly recognizable handprint as evidence of child abuse (Figure 2). Although the handprint is clearly recognizable, it is very unlikely that we would be able to identify the specific hand that caused the injury as most people have a hand of average size with five fingers. Patterned injuries having characteristics that reflect manufactured objects provide the best opportunity for accurate instrument identification. For example, the horizontal patterned abrasion on the neck of a hanging victim faithfully reflects the width and texture of the ligature used (Figure 3). Associating the injury with an instrument in suicides is usually not an issue as the ligature, gun, or knife is almost always there with the body. Occasionally, family members will alter a suicide scene and remove the instrument, creating some difficulty.

Figure 2 Photograph of a child's buttocks with characteristic hand slap contusion of left buttock.

Figure 3 Hanging victim with patterned abrasion injury around neck identical with the ligature (belt).

Figure 4 Homicide victim struck with pipe across the back, leaving ''tram track'' parallel contusions on skin surface. (The vertical incision was made by the pathologist.)

Mechanism of Patterned Injury Creation

Most contusions created by forceful impact with an object will leave a blanched area on the skin that was in actual contact with the object. Blood will rupture from rapidly compressed capillaries under the object into surrounding tissue, outlining the object. For example, a heavy pipe struck across the back will leave the characteristic "tram track" appearance of bruising from ruptured blood vessels to the sides and deep to the impact (Figure 4).

Abrasions are the result of the offending object scraping across the skin. If the scrape is discrete, a very accurate reproduction of the object may be left behind. Bite marks frequently allow for easy suspect identification if the bite is abraded.

Incised or lacerated wounds divide the skin and subcutaneous tissue. The major difference between the two is that lacerations generally maintain so-called tissue

Figure 5 Homicide victim with pistol-whip laceration to forehead. A corner of a roughly cube-shaped pistol grip makes a three-pointed laceration.

bridges across the wound gap composed of small blood vessels, connective tissue, and nerves. Incised wounds do not. Most incised wounds leave little additional useful information beyond their length and depth. Lacerations, on the other hand, are the result of impact forces that crush the skin until it literally splits apart and frequently provide significant information as to the impacting object. For example, a three-pointed laceration on the forehead is consistent with an impact with the corner of something that is generally cube-shaped (Figure 5). Crescent-shaped lacerations on the scalp and underlying skull are consistent with hammer blows (Figure 6).

The Concept of Class-Specific and Individual Characteristics

While most observers would appreciate the pattern of a molded boot sole on the side of a victim's head (Figure 7), there are potentially thousands of boots that were manufactured with exactly the same sole pattern. The injury may show characteristics of that class of object (size 10 molded boot sole), but it cannot be reasonably matched to a specific boot

Figure 6 (A) Homicide victim struck multiple times with a hammer. The characteristic crescent-shaped lacerations result from tangential blows. (B) One hammer blow was so forceful that it created an identical crescent-shaped fracture of the skull.

with individual characteristics unique to that boot that would be reproduced on the skin. However, if the commonly available boot sole had a rock stuck in the tread that was also reflected in the skin injury, then both class-specific and individual characteristics would be present in common with both the injury and the boot sole, making a unique match possible.

The Degree of Confidence in Offering an Opinion in an Injury–Instrument Comparison

In providing an opinion as to whether an instrument could have caused a particular injury, the pathologist may offer one of several degrees of confidence. The instrument may be "inconsistent" with the injury, effectively ruling out the instrument as having caused the injury. The instrument may be "consistent" with the injury, meaning that it could have caused the injury, but not necessarily to the exclusion of any other instrument. This opinion is usually offered when an injury reveals only class-specific characteristics in common with the instrument. Finally, the comparison may be "conclusive," when only that instrument could have caused the injury. Only unique objects or common objects with unique characteristics (like a rock stuck in the shoe tread pattern) causing an injury would lead a pathologist to such a confident opinion.

Documentation of the Patterned Injury

Written descriptions alone are inadequate for the documentation of a patterned injury if any meaningful comparison with a suspect object is anticipated. Diagrams and acetate tracings of the actual wound can offer more information than a verbal description, but the precision of the diagrams and accuracy of the tracings are dependent on the artistic skill of the pathologist. The most efficient and accurate way to document an injury is by photographs. Although articles and books have been written about the technical merits of camera selection, film choice, and lighting conditions, technique is by far of the greatest importance. Photographs are taken at the forensic autopsy for four reasons: first, to provide a visual record for the pathologist to refer to at a later time; second, to allow other professionals to review the pathologist's findings and formulate their own opinions; third, to show to jurors in trial; and finally, for teaching purposes. Most pathologists accomplish the first goal and find whatever photos they have taken useful for their own review. Unfortunately, poor technique often precludes use of the photos for the other purposes.

Specifically with respect to patterned injury documentation, the following technique issues are critical for injury–instrument comparison.

1. The skin surface with the patterned injury must be clean. Extraneous blood, dirt, or foreign material will either obscure relevant details of the injury or erroneously suggest injury details that are not actually present.
2. A ruler and case number or other identifying information must be present in the photograph of the injury (and of a suspect instrument). Optimally, the ruler would be placed on the skin surface adjacent to the injury so that the ruler is at the same height as the injury. Otherwise there is no possibility of judging the true size of the injury later in the photograph.
3. The photograph must be taken with the camera perpendicular to the skin surface. Anything else creates a tangential view and distorts the true

Figure 7 (A) Homicide victim with stomping contusion on the scalp. The straight lines and right angles in the bruise are indicative of a manufactured item causing the injury. (B) A portion of the boot sole used in the stomping attack. The boot sole has class characteristics consistent with the injury.

appearance, shape, and size of the injury in a photograph. Some people make use of the American Board of Forensic Odontology (ABFO) no. 2 scale for just this purpose. If the circles at the corners of the ruler are anything but circular in the photograph, the picture was taken tangentially to the ruler, and presumably to the skin surface, hindering any subsequent injury–instrument comparison.

4. The injury should fill most of the picture area (cropping through the lens). This eliminates having to magnify the area of interest in a more "overall" photo with the inevitable image degradation that occurs with enlargement.
5. The camera used must be capable of taking a close-up (macro) photograph. Some cameras are not capable of providing a macro function and will result in blurry close-up photos. Notorious are the inexpensive, instant picture film cameras used in emergency rooms for quick injury documentation.

The author prefers to use digital cameras for all autopsy photography. The pictures are arguably as good as film pictures (with image sizes in the 3 or 4 megapixel range) and they are immediately available for archiving, review, and digital manipulation.

Figure 8 Contact gunshot wound with .410-gauge derringer. Only the lower barrel has been fired. After reapproximating the gas pressure-induced marginal lacerations, a side-by-side comparison reveals the shape of the barrels and sight on the skin.

Making the Injury–Instrument Comparison

The easiest way to make an injury–instrument comparison is to place the suspect instrument next to the injury for visual comparison and photographic documentation. This is commonly performed if the instrument is available for examination at autopsy.

For example, the side-by-side comparison of firearms with self-inflicted, contact gunshot wounds reveals obvious similarities without performing additional effort (Figure 8). Actual contact between the suspect instrument and skin surface should be avoided in cases where DNA analysis is anticipated as cross-contamination may occur.

In most instances, however, the suspect instrument will only be available at some later date and must be compared separately. The most convenient way to do this is digitally to arrange photographs of the injury and instrument with image-editing software such that similarities can be appreciated. The author makes frequent use of Adobe Photoshop, but several other suitable image-editing programs are available. The stepwise process is performed as follows (Figures 9 and 10):

1. The two photos (instrument and injury) are adjusted so that they are in the same scale.
2. The instrument photo is inverted, thereby creating a mirror image of it. (Instruments provide a

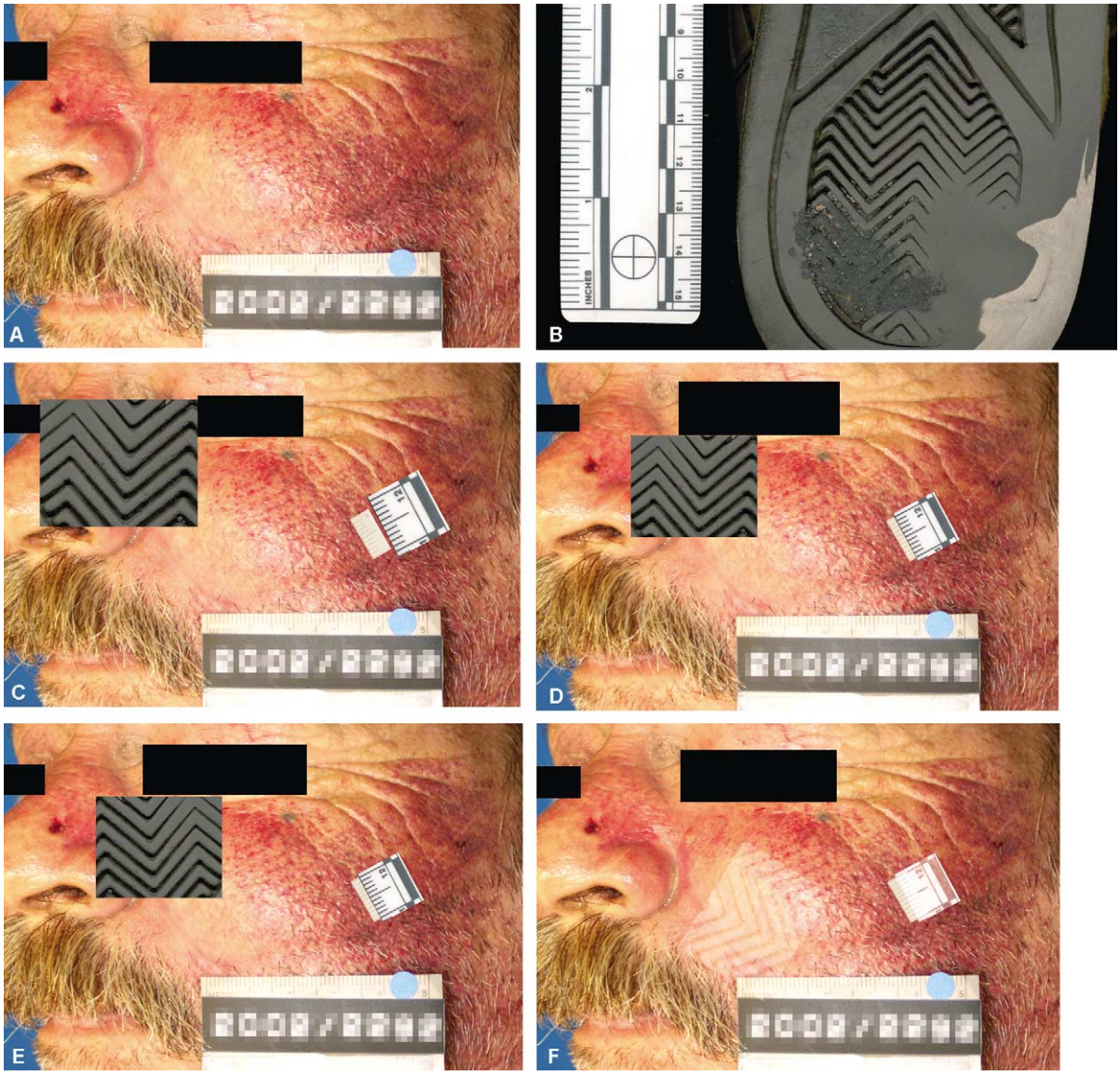

Figure 9 (A) Homicide victim with a patterned contusion on the left face having a series of equidistant parallel, zigzag lines. (B) The suspect instrument (the sole of a tennis shoe) photographed with a ruler. (C) A portion of the tennis shoe sole and ruler layered over the injury image. Note that the rulers are not in the same scale. (D) The shoe sole and ruler are reduced in size so that the two rulers are in the same scale. (E) The shoe sole is inverted left to right as an impression on the skin would be a mirror image of the object. (F) The final comparison image. The shoe sole has been rotated, color spectrum inverted, and aligned to the injury, revealing that the injury is consistent with having been created with the sole of this shoe.

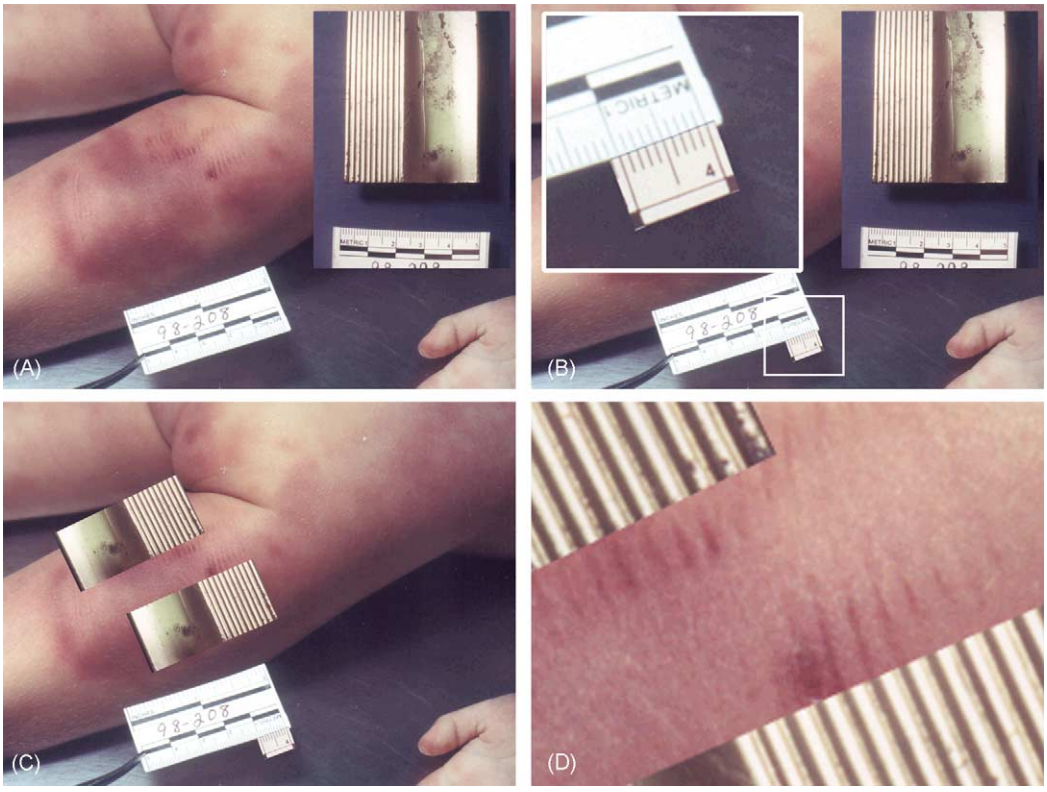

Figure 10 (A) Photograph of the bruised right thigh of a child. Several injuries are present composed of a series of uniform, parallel contusions. The end of the suspect instrument (an extruded aluminum doorway threshold) is visible in the inset. (B) The same scale is present in both the injury and instrument photos and is shown in the left upper inset. (C) A portion of the threshold is inverted, duplicated, and placed next to two of the injuries. (D) Final comparison image revealing that the injury is consistent with having been created with the threshold.

mirror image or rubberstamp impression on the skin surface.)
3. The instrument image is arranged next to or over the injury image.
4. The pathologist determines the likelihood of the instrument having caused the injury.

The most challenging analysis is made with less than perfect starting material. Take the case of a 42-year-old woman (Figure 11) who was murdered in her sleep along with three of her four children. She was shot and struck multiple times through a cotton nightgown. A prime suspect who stalked the woman's teenage daughter was arrested the next day driving a stolen car in the area of the murder but he was ultimately released for insufficient physical evidence. The crime remained unsolved for 25 years. Although the victim's firearm injuries were the fatal injuries, one bruise below the right breast showed potential for comparison with a metal bar in possession of the prime suspect when he was arrested in the stolen car. This bar had remained in an evidence warehouse ever since he was arrested for auto theft.

The autopsy photo (Figure 11A) seems to suggest that the pathologist is focused on the bruise under the right breast which the photographer documented. Unfortunately, the photo was taken too far away and at a slightly tangential angle. To make matters worse, the pathologist had the ruler in his right hand instead of on the body next to the injury! However, to the pathologist's credit, he recorded in his report that the injury was 2 cm wide, providing scale for the injury in the photograph. The bar was wrapped with a leatherette steering-wheel cover with multiple ventilation holes. A smooth plastic cord was tightly knotted around the cover at one end. The knot was crudely made with multiple tight throws, making its appearance in combination with the characteristics of the steering-wheel cover unique. After photographing the bar, stepwise digital manipulation of the bar and injury photographs was performed using Adobe Photoshop. The author found the comparison conclusive for the injury under the right breast having been caused by being struck with the bar, thereby linking the original suspect to the murders. Corroboration for the comparison was later provided during the trial by

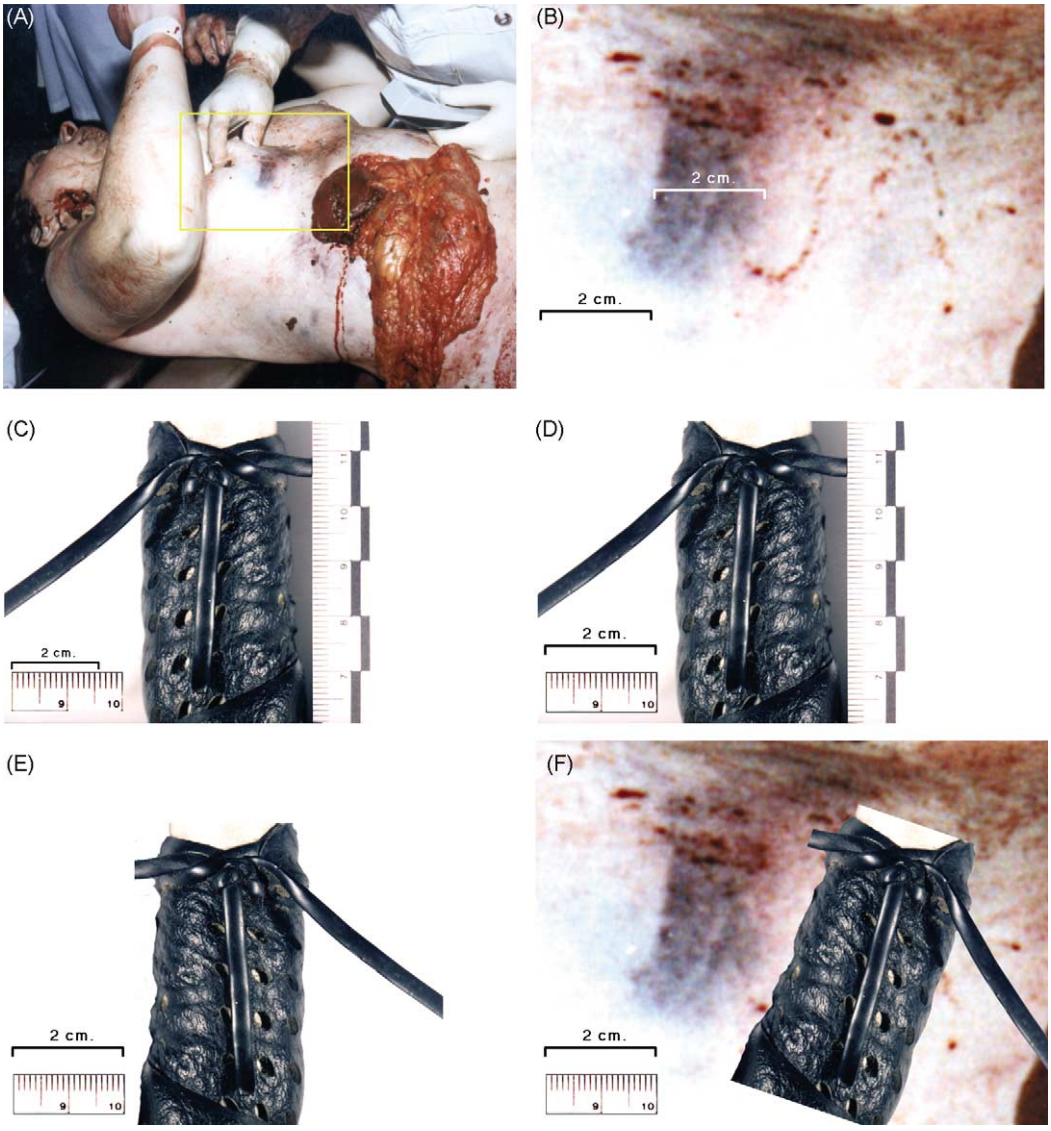

Figure 11 (A) Twenty-five-year-old autopsy photograph of a woman with shotgun wounds of the neck and abdomen, and a patterned bruise just below the right breast (boxed). (B) Enlargement of the bruise with a 2-cm scale applied to the bruise based on the bruise width description in the autopsy report. (C) Photograph of the suspect instrument (a metal bar wrapped in a leatherette steering-wheel cover) with ruler. Notice that the scale of the bar is larger than the scale of the injury. (D) The image of the bar is reduced to match the scale from the injury photograph. (E) The image of the bar is inverted horizontally to provide for the mirror image appearance of the bar. (F) The final comparison image with the bar slightly rotated to align with the bruise. The author concluded that the bar was used to create the injury.

the fact that the surviving son (now in his 30s) was able to identify his childhood toy car that was also among the evidence removed from the stolen car 25 years earlier. The suspect apparently took a souvenir from the crime scene. He was convicted.

See Also

Crime-scene Investigation and Examination: Suspicious Deaths

Further Reading

Burd DQ, Gilmore AE (1968) Individual and class characteristics of tools. *Journal of Forensic Sciences* 13(3): 390–396.

Clark EGI, Sperry KL (1992) Distinctive blunt force injuries caused by a crescent wrench. *Journal of Forensic Sciences* 37(4): 1172–1178.

Rao VJ (1986) Patterned injury and its evidentiary value. *Journal of Forensic Sciences* 31(2): 768–772.

Zugibe FT, Costello JT (1986) Identification of the murder weapon by intricate patterned injury measurements. *Journal of Forensic Sciences* 31(2): 773–777.