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Collection of Trace Evidence from Bombing Victims at Autopsy

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ABSTRACT: The body recovered from the scene of a bombing may contain important trace evidence that links the suspect to the crime. Recognizing the lack of guidelines for evidence removal from the body, we have prepared a protocol to guide the pathologist in the collection of trace evidence from the bombing victim. Case material used in the development of the protocol included 13 bombing fatalities reported to the St. Louis Medical Examiner's Office since 1975.

KEYWORDS: pathology and biology, trace evidence, explosives, blast, explosions, explosive residue, forensic radiology

Nationwide, over the past ten years, fewer than 10% of all bombing cases have been solved [*1*]. In most instances this is partly a result of a lack of physical evidence from the exploded device that would connect a particular suspect to the incident. Examples might include matching fragments of wire recovered from a bomb with an identical wire found in the suspect's possession or comparing toolmarks on a wire or other metallic fragment to the suspect's tools. The search for such evidence at the bomb scene is meticulous, often requiring days to complete. Equally important—although this is not as well recognized—is a meticulous search for trace evidence on the bodies of victims. Experience with 13 recent bombing fatalities at the City of St. Louis Medical Examiner's Office has led to the development of a protocol to guide the forensic pathologist in recovering all available trace evidence from the body.

Bomb Construction

A basic knowledge of the common types of bombs and their parts [*2,3*] is essential for the collection of trace evidence. The explosions encountered in forensic science practice usually result from detonation of explosive material housed as a bomb. The basic components of an explosive device consist of an initiator, a detonator, and a main charge. The initiator, once activated, leads to the detonator, which explodes and detonates the main charge. As a guide to trace evidence collection, it is useful to consider common bombs as being one of three types: straight bombs, disguised bombs, or hidden bombs. A straight bomb is an explosive device easily recognizable as a bomb, such as a stick of dynamite (main charge) attached to a fuse (initiator) and a blasting cap (detonator). A pipe bomb is another example of a straight

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bomb; it is composed of a safety fuse (initiator), a nonelectric blasting cap (detonator), and a pipe filled with explosive, usually black powder (the main charge). A disguised bomb is an explosive device housed in a unsuspicious-looking container, such as a suitcase or package. A disguised bomb must have a trigger mechanism, usually a pull, an application of pressure, a release of pressure, or a time delay, that will complete the circuit to an electric blasting cap and detonate the explosion. In a recent St. Louis case, a bomb disguised as a package exploded when the pull of opening the package released a spring, which completed a battery circuit to a blasting cap and detonated a pipe bomb. A hidden bomb is any explosive device hidden in a vehicle or other large complex housing, most commonly an automobile. Straight, disguised, and hidden bombs can be expected to leave different types of trace material in bodies.

Background Scene Information

Although the pathologist need not be present at the scene of a bomb explosion in order to anticipate the amount and types of trace evidence to be found in the body, certain initial information pertaining to the investigation at the scene is required. Most importantly, the position of the body at the scene should be noted. For example, a body near the explosion center is a more valuable evidence trap than a body further removed or shielded from the blast by a large object. Postexplosion alterations of the scene should also be ascertained. A fire or structural collapse secondary to the explosion may mask the pattern of injuries resulting from the initial explosion. Knowledge of the types of material in the environment, such as the color of the interior of the car in the case of a car bombing or the furnishings in the case of a residential bombing, is necessary to alert the pathologist to materials foreign to that environment that may thus be associated with the explosive device. Finally, the initial impression of the investigators at the scene as to the type of bomb, whether straight, disguised, or hidden, is helpful to the pathologist in approaching the collection of trace evidence.

Evidence Identification and Recovery

Three different types of trace evidence should be collected from the bombing victim: radiopaque material, radiolucent material, and explosive residue.

Radiopaque Material

Radiographs, in at least antero-posterior and lateral views, are necessary to identify and locate radiopaque foreign material. Radiographic examination should be completed not only of the deceased and all tissue fragments recovered from the scene, but also of all surgical specimens and any survivors, as they may contain parts of the bomb. For any case material, but especially for survivors, it can be helpful to use direct magnification radiography, since the magnified image may facilitate evaluation of the foreign material present in the body [*4*]. Following the removal of radiopaque fragments, it is a good practice to reradiograph to assure complete removal or to determine the type and amount of material remaining in the specimen. In general, the amount of radiopaque trace evidence in the body depends upon the particular type of bomb. The explosion of a straight bomb leaves very little radiopaque evidence in the body; a disguised bomb leaves more and a hidden bomb can leave an overwhelming amount.

The key pieces of radiopaque evidence from a straight bomb are portions of the nonelectric blasting cap and the container used for the explosive. Any small, thin, twisted fragments of aluminum or copper may be portions of a blasting cap. Metal fragments with threads or other markings may identify the explosive device as a pipe bomb and are of particular interest because they may allow the pipe to be traced to a particular distributor (Fig. 1). After the

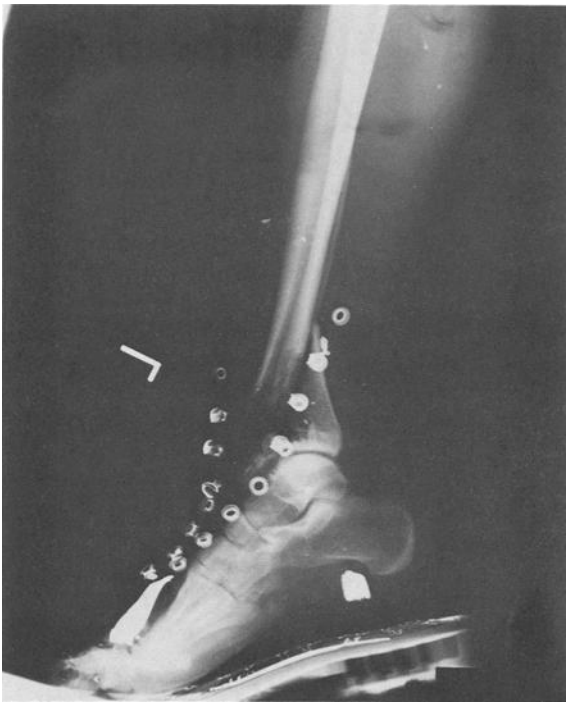

FIG. 1—*A radiopaque fragment bearing thread marks is present under the heel of the foot and contained within the shoe. This helped to identify the explosive device as a pipe bomb and indicated the particular type of pipe used to construct the bomb.*

explosion of a disguised bomb, portions of the trigger mechanism, such as batteries, screws, springs, wires, or gears, may be seen on X-ray. Wires are among the most important evidence to recover (Fig. 2). Electric blasting caps, often used in disguised bombs, have two lengths of single-stranded wire, known as leg wires, which are insulated by colored plastic and attached to the cap containing a high explosive. Recovery of a portion of a leg wire is significant not only because it indicates the use of an electric blasting cap in the construction of the bomb, but also because it will indicate a specific manufacturer, depending on the color and chemical composition of the plastic insulation of the two leg wires [*5*].

The explosion of a hidden bomb, most commonly a car bomb, generates an immense amount of radiopaque material. However, only a few fragments will be from the bomb itself, with the majority of fragments being from the car [*6*]. Unfortunately, bomb fragments cannot usually be distinguished radiographically from the other radiopaque fragments after the explosion of a hidden bomb, and thus an attempt must be made to remove all radiopaque material from the body (Fig. 3). Removal of such evidence from the body is time-consuming and may require tissue maceration. At a minimum, all springs, wires, and unusually shaped fragments should be removed.

Radiolucent Material

The second major category of trace evidence that the pathologist must search for when examining a bombing victim is radiolucent material. Again, the type of radiolucent trace evidence depends on the type of bomb. The explosion of a straight bomb may leave fragments of the explosive wrapper and parts of the safety fuse. When dynamite is used, for

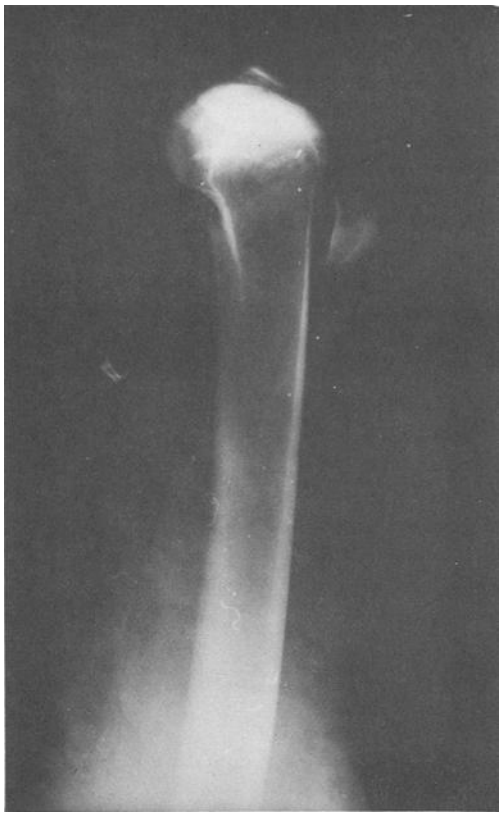

FIG. 2—*Small fragments of single-stranded wire, characteristics of the type derived from blasting cap leg wires, are embedded in the soft tissue overlying the bone in the lower portion of the X-ray.*

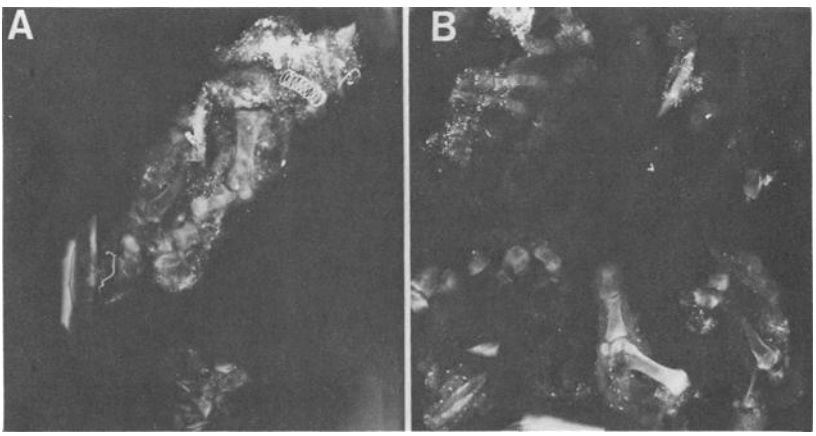

FIG. 3—*Fragments present in tissue from a car bombing* (a) *before and* (b) *after removal of radiopaque trace evidence.*

example, fragments of paraffin-coated paper that formerly covered the dynamite stick may be propelled into the body by the force of the blast. Finding any portion of the wrapper showing numbers is particularly significant, since when the fragments are pieced together, the code number indicates the manufacture of the explosive and the date and shift is was made [7]. Disguised and hidden bombs incorporate many additional radiolucent elements such as cloth, cardboard, wood, or plastic, used to conceal the basic parts of the bomb.

The complete recovery of radiolucent material requires that the clothing and external body surfaces by examined and that all wound tracts be explored for small bits of material that could have been part of the explosive device (Fig. 4).

Explosive Residue

The final category of trace evidence that may be present on the bombing victim is explosive residue. During an explosion, undetonated, detonating, and detonated explosive are propelled outward from the explosion center and can be recovered from the body at autopsy. Straight, disguised, and hidden bombs all produce explosive residues. Occasionally, when an explosive mixture does not detonate properly, undetonated explosive may be visible on the body. Undetonated dynamites commonly appear as soft, oily, yellow-brown material. Most explosives, however, do detonate completely, leaving a black or gray-white residue. Depending on the spatial relationship of the body and the bomb, the body may be the best source of explosive residue, especially if it was near the explosion center (Fig. 5).

Swabbing for explosive residue should be taken from (1) areas grossly soiled with residue, (2) areas without visible residue but having obviously received the blast effect, and (3) the hands, as the deceased may have handled the explosive. Different elements of explosives and their residue are recovered by different solvents. In general, when one is dealing with an unknown explosive, the best procedure is to swab the same area first with methanol (or, if unavailable, ethanol) to recover organic compounds and those dissolved in the skin; second

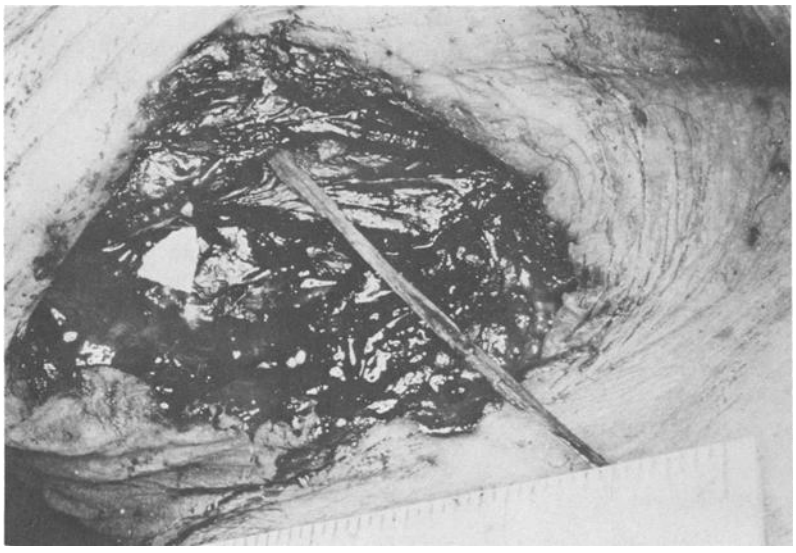

FIG. 4— *Wood and paper recovered from this neck laceration were preserved and subsequently found to have been used in the construction of a package bomb delivered to the victim by the United Parcel Service.*

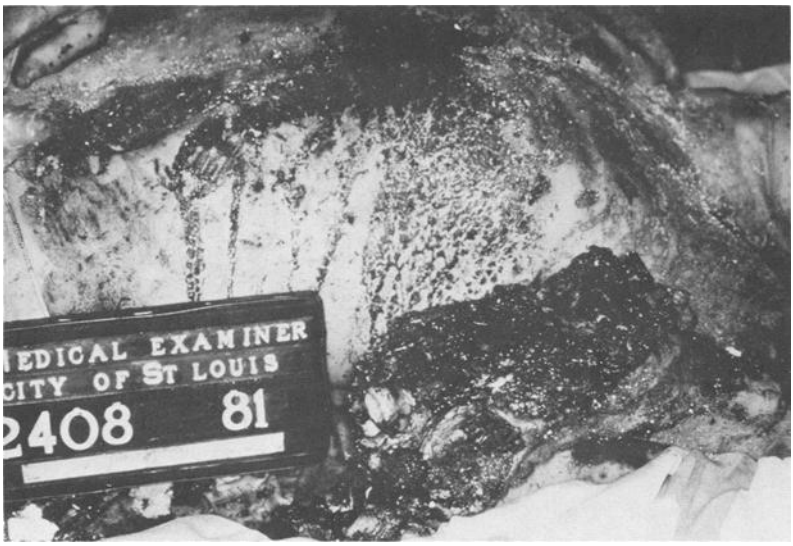

FIG. 5—*There is abundant residue blackening the surface of the laceration on the arm. This individual was a victim of a disguised bomb explosion containing black powder.*

with distilled water to recover inorganics; and third with a dry swab.[2] Control swabs moistened with the solvent and then packaged without touching a body surface must be included. Fingernail scrapings and scalp hair, especially if it is oily, should be taken for analysis because both can trap residue. Clothing should ideally be preserved in plastic bags of nylon, polyester, or polypropylene [*8*]. Vapors of certain explosives can migrate through polyethylene or polystyrene bags, which are the types of plastic bags commonly available. This problem can be circumvented by wrapping the clothing in any type of plastic sheet, then in aluminum foil, and finally in a polyethylene or polystyrene bag.

It is also important to realize that explosive residue may be present on any radiopaque or radiolucent evidence removed from the body. Thus, although it is customary to clean materials that are to be submitted as evidence, it is not advisable to clean evidence removed from the bombing victim. Such fragments should be air-dried and then packaged in clean, airtight containers such as metal paint cans or glass jars [*9*].

To aid in explosive identification, small magnetic, fluorescent, color-coded information chips known as taggants were incorporated into some brands of explosives during the mid-1970s. They identify the manufacturer of the explosive, date of production, and shift. Although taggants are no longer in use, they may be encountered in old explosives and can be recovered by sweeping a magnet covered with a small plastic bag over the body and then inverting the bag so as to retain any particles attached to the magnet [*1*].

All trace evidence recovered should be submitted to the Alcohol, Tobacco, and Firearms (ATF) Division of the U.S. Treasury Department. The best containers for trace evidence are new unused metal paint cans.

Protocol Development

Based on the examination of 13 recent bombing fatalities at the City of St. Louis Medical Examiner's Office, a comprehensive yet practical protocol, included as Table 1, has been

[2]R. Meyers, personal communication, Bureau of Alcohol, Tobacco, and Firearms, Bethesda, MD.

TABLE 1—*Protocol for collection of trace evidence from bombing victims.*

I. Materials
- A. Radiology facilities
- B. Methanol or ethanol in dropper bottles
- C. Distilled water in dropper bottle
- D. Disposable plastic gloves
- E. Wooden single-tipped cotton swabs
- F. Clean knife for fingernail scrapings
- G. Large plastic bags, plastic sheets, and aluminum foil for clothing
- H. Comb
- I. Magnet with plastic bag
- J. Metal paint cans for evidence submission

II. Background Information
- A. Position of body at scene (relative to explosion center and large objects at scene)
- B. Postexplosion alterations of scene (fire extinguishing chemicals, weather, structural collapse, secondary fire)
- C. Suspected bomb type (straight, disguised, or hidden)
- D. Materials in the environment (description of interior of car, types of furnishings in room)

III. External Examination
- A. Radiography
  1. Body of deceased
  2. Tissue fragments from scene
  3. Surgical specimens
  4. Survivors (including direct magnification radiography)
- B. Recovery of explosive residue
  1. Inspect for undetonated explosive
  2. Swab with methanol, distilled water, dry swab; include control swab
  3. Collect fingernail scrapings
  4. Sample scalp hair
  5. Perform magnet sweep
- C. Examination of clothing and body surfaces
  1. Remove radiopaque evidence
  2. Search for and remove radiolucent evidence
- D. Package clothing

IV. Internal Examination
- A. Remove radiopaque evidence
- B. Dissect wound tracks and remove radiolucent evidence
- C. Reradiograph

prepared to guide the forensic pathologist in collection of trace evidence from the bombing victim.

In order to examine the body properly, a radiology facility must be available. Other necessary materials can be purchased at the local hardware store. To obtain background information and thus anticipate the types of trace evidence that may be present, contact with the scene investigators is essential. Necessary background information includes the position of the body at the scene, postexplosion alterations such as a structural collapse or fire, and the types of materials in the environment. The investigators should be reminded to collect all fragments of tissue to be examined, since they may contain parts of the bomb. For transport from the scene to the medical examiner's office, the body should be wrapped securely in a clean sheet or body bag so that trace evidence dislodged during transport will not be lost. The hospital should be notified that all surgical specimens from survivors must be forwarded to the medical examiner and not to the hospital's surgical pathologist. Arrangements can also be made to obtain full-body radiographs of survivors and if necessary direct magnification radiographs.

At the medical examiner's office, full-body photographs and then full-body radiographs (anterio-posterior and lateral) should be taken. While the radiographs develop, it is convenient to examine the body for explosive residue. The body is first inspected for undetonated explosive, and then swabbings with methanol, distilled water, and dry cotton are taken, in addition to fingernail scrapings and scalp hair. A magnet sweep for taggant recovery may be performed. After study of the radiographs, radiopaque material on the clothing or body surfaces should be removed, bearing in mind that important radiolucent material may also be present. The clothing is then removed and packaged, the body washed and the internal examination performed. The internal examination includes removal of all radiopaque material noted on the X-ray and dissection of wound tracks in search of radiolucent trace evidence. Since removal of all trace evidence can be time-consuming, it may be necessary to retain custody of the body for several days. Before release of the body, radiographs are again taken. It is useful for the pathologist to review these final radiographs with an investigator and jointly determine that all useful evidence has been removed.

Case Presentation

The following case illustrates the importance of the forensic pathologist in the recovery of trace evidence from bombing victims.

A package, wrapped in brown paper and secured with twine, was delivered by United Parcel Service to a south St. Louis home. It was opened and thereby detonated in the family kitchen by the 15-year-old brother of the addressee, who was not at home. Their mother was also in the kitchen. Both were killed instantly as the package exploded. The 15-year-old was at the explosion center and the mother was a few feet away. At autopsy, radiographs of the fully clothed 15-year-old decedent revealed numerous metallic fragments. One of these was embedded in the shoe and showed thread marks (Fig. 1). This was recovered and helped to identify the explosive device as a pipe bomb. Abundant black sooty material was present over the right side of the body, an area which received the full force of the blast (Fig. 5). This material, some of which was also present on the walls of the kitchen, was collected and found to be consistent with residue from detonated smokeless powder and black powder and carbon from a dry cell battery. Radiographs of the second victim, the mother, also revealed a metallic fragment bearing thread marks that was recovered from the lung. No explosive residue was detected. Wound tracks produced by flying debris were explored and fragments of wood and paper, not visible on the radiographs, were recovered from the neck (Fig. 4). These fragments were believed to originate from the wrapping paper and wooden boards used to construct the bomb. Thus trace evidence recovered from the bodies suggested the components of the bomb, from which a rough construct of the disguised bomb could be formed. Within several days, a suspect was apprehended and a confession obtained, prompted in part by the investigator's knowledge of the bomb type and its components. Similar materials were found in the suspect's possession. The bomb described by the suspect, apparently sent in retaliation for a lost love, was disguised as a package consisting of a wooden frame covered with cardboard and paper. It contained a pipe filled with gunpowder attached to a 9-V dry cell battery. The circuit between these was completed by the pull of opening the box.

Summary

The explosion of a bomb produces trace evidence that can be recovered, not only from the scene but also from the body or dismembered parts of the bombing victim at autopsy. Radiopaque and radiolucent material and explosive residue should be recovered from the body and preserved by the pathologist. Such careful examination and documentation may make the difference between connecting a suspect with the crime and the inability to develop sufficient evidence to do so.

A comprehensive yet practical protocol, included as Table 1, has been prepared to guide the pathologist in collecting such trace evidence for the bombing victim at autopsy.

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