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Effects of Human Decomposition on Bullet Striations

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ABSTRACT: Five different types of bullets, representing the major materials used in centerfirc handgun and rifle ammunition, were inserted into the cranial, chest and abdominal cavities, muscle and adipose tissues of a fresh cadaver. The bullets were retrieved after the body was 90% decomposed. Observation and comparison of before and after photographs let each bullet serve as its own control. Results indicate the reactivity of bullet materials and the body region are significant factors affecting the corrosion process and may obscure rifling striations.

KEYWORDS: forensic science, ballistics, anthropology, decomposition, gunshot

Bullets retained in decomposing bodies are subject to detrimental effects due to their poorly understood and incompletely studied environment. The physical changes described by Bass et al. [*1*] and Meadows et al. [*2*] increase our knowledge of decomposition, but have not yet addressed the practical impact on the quality of associated physical evidence. Published research has dealt with the reaction of materials in soil [*3*], and effects of mechanical injury on decomposition [*4*]. Following our protocol on bullet corrosion [*5*], this study investigates the physical reaction of various bullet materials exposed to different human tissues during decomposition.

Materials and Methods

Bullets selected for representative materials used in manufacture of modern centerfire handgun and rifle ammunitions were: cast lead alloy (in .38 Special), copper alloy jacketed (Smith and Wesson .45 ACP full metal jacket), aluminum alloy jacketed (Winchester-Western Silvertip® .45 ACP) nickel plated copper alloy (Winchester-Western Silvertip® 9 mm Luger) and nylon coated Federal Nyclad® .38 Special). Engraved with rifling marks and subjecting bullets to the heat stress by firing into a cotton stop box, the bullets were inscribed for identification and specific reference areas photographed. Since rifling striations are difficult to obtain on Nyclad® bullets, the patterns produced by impressed fibers from the stop box were used for comparison. Bullets were washed in tap water, then rinsed with 95% ethanol to remove fingerprints and any corrosive tap water [*6*], oven dried at 50° C and held for insertion into the cadaver.

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The nude body of a 36-year-old white male heart attack victim was kept at 4° C for 7 days until it could be placed at the decomposition facility. Bullets were inserted and spaced widely apart, to avoid contact, through small incisions into the cranial, chest and abdominal cavities. Bullets were implanted into thigh muscle and flank adipose tissues through widely spaced separate incisions. Incisions remained open to simulate gunshot wounds. The only differences between a criminal case and the experiment was the absence of gunshot residue that may have been left by firing and any immediate antemortem changes in the chemical environment. These residues; nitrates, nitrites, lead, barium, antimony and others might exert a local effect, similar to fingerprints or tap water and we elected to remove them. Heating of the metal by actual firing may also potentially affect the corrosion process, but this was considered unavoidable in order to obtain striations. Also this effect would always be present in criminal shootings.

The nude body was left to decay atop sandy soil with low ground cover for 66 days from February to May. This was a temperate period containing several frosts and frequent humid highs into the 80s on the Fahrenheit scale.

Close interval observation revealed a decomposition pattern consistent with those previously reported by Rodriguez et al. [7] and Mann et al. [8]. By the final day, the cadaver was 90% defleshed, with bullets entrapped in the cranium and viscous greasy residue beneath the body. The bullets were not directly exposed to the weather.

Upon recovery, each projectile was gently washed in mild detergent and warm water, rinsed in 95% ethanol and oven dried. Direct observation and photography of the previously documented areas allowed each bullet to serve as its own control and the effect upon rifling striations were noted. Bullets with heavy scale were ultrasonically cleaned for 5 min and rephotographed. If reference areas could not be matched photographically, newly fired bullets of the same type, fired through the same weapon, were examined with a comparison scope in hopes of obtaining a match at some other point.

Results and Discussion

The bullets showed a wide range of changes based upon their composition and local environment. Some were unchanged except for soiling by tenacious decomposition residue, others showed mild tarnishing and the remainder were markedly affected by dis-

TABLE 1—*Effects of decomposition on bullet striations.*

Gradation of corrosive changes of various bullet types as seen in different regions and tissues of a decomposing body. Scores of 1 and 2 are minimal and would not obscure striations to the point of preventing a match. Scores of 3 and 4 represent progression of artefact sufficient to obstruct matching.

Corrosion Gradient: N/C = no change, 1 = mild, 2 = moderate, 3 = severe, 4 = extreme.

	Body Region				
Bullet Types	Head	Chest	Abdomen	Muscle	Fat
Copper	4+	2+	3+	3+	4+
Aluminum	N/C	1+	N/C	1+	1+
Lead	N/C	1+	1+	3+	3+
Nylon	N/C	N/C	N/C	N/C	N/C
Nickel wash copper	3+	3+	3+	4+	4+

N/C = No change.
1+ = Mild changes, matchable.
2+ = Moderate changes, matchable.
3+ = Severe changes, not matchable.
4+ = Extreme changes, not matchable.

solution, thick oxide deposits and heavy scaling. These latter could not be matched either with their own photographs or with pristine exemplars fired from the same weapon. Ultrasonic cleaning removed scale but did not help matching. Table 1 summarizes the results. A score of 0, 1 or 2 indicates progression of artifact, but not sufficient to preclude matching. Scores of 3 and 4 indicate changes so severe, matching was not possible.

As noted in previous studies [5] the nylon coated bullets were uniformly unaffected. Concern was present because prolonged exposure to the moist decomposing environment may cause hygroscopic deterioration of the coating. It is for this reason that nylon is considered unsuitable as a biologic implant [9].

Lead-alloy bullets from the brain, chest, and abdomen exhibit mild tarnishing. Those implanted into fat and muscle showed both dissolution and oxidation to the point of obscuring a match.

The aluminum jacketed Silvertip® bullets were mildly affected. Although previously shown to be susceptible to caustic bases and aldehydes [5], the autolytic and putrefactive processes in decomposing flesh [10] did not interfere with the striations.

More severely affected were the copper-alloy jacketed and nickel-washed Silvertip® bullets. Striations were uniformly obscured except for the copper-alloy jacketed bullets from the chest, which were borderline. Given more exposure time the copper would develop sufficient black to green oxide buildup to preclude matching. The nickel-washed bullets showed severe dissolution or the thin nickel layer followed by exposure changes similar to the copper-alloy. Representative changes for the different types of bullets in different tissues are shown in Fig. 1.

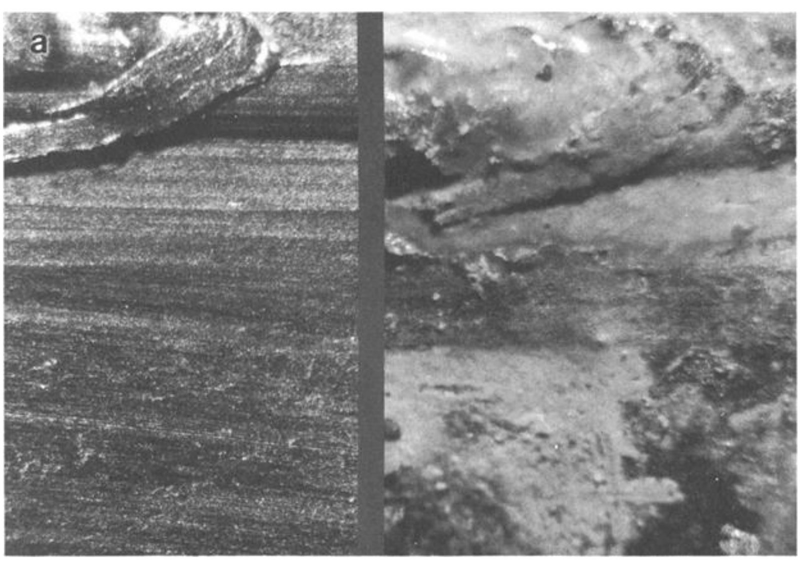

FIG. 1—*Before* (left) *and after* (right) *photographs of bullets exposed to decomposing tissues. The same reference area is depicted in each photograph, indicating the changes as a result of corrosion.* (a) *Copper jacketed bullet from the head with extreme scale and dissolution, no match.* (b) *Aluminum jacketed bullet from the head, no change except minor pitting.* (c) *Lead alloy bullet from adipose tissue, severe deposition of fluffy oxides, no match.* (d) *Nylon coated bullet from the chest, no change, note pattern of cotton fibers from the stop box.* (e) *Nickel-washed copper jacketed bullet from adipose tissues, severe dissolution of nickel layer and scale formation in the underlying copper, no match.*

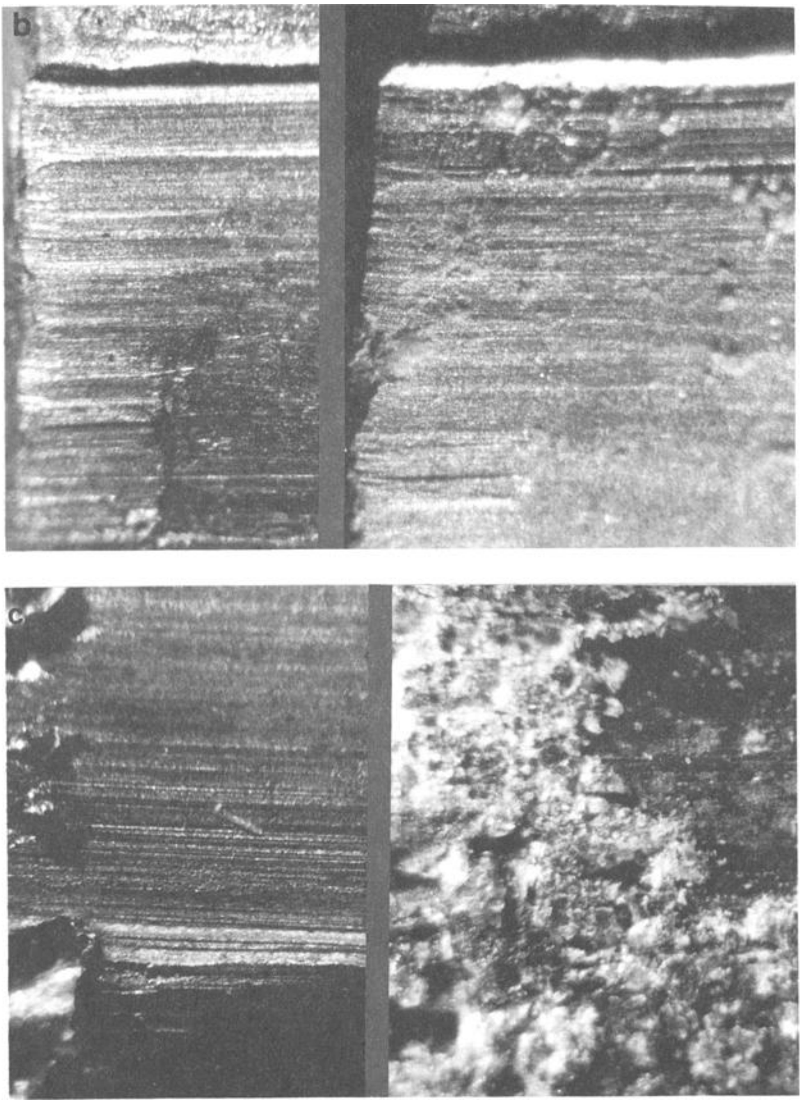

FIG. 1—*Continued.*

Conclusions

Bullets retained in decomposing bodies are subject to a complex chemical and microbial environment [*11*]. These components contribute to the corrosion process and it is difficult to determine which is predominant, or to quantify the damage. Bullet materials play a significant role in resisting the effects human decomposition has upon bullet striations. Copper and nickel are highly reactive, aluminum and nylon far less so, and lead is somewhere in between.

The body region involved indicated greatest overall effects in fat and muscle tissues. The reasons for this may include variations in pH, microbiologic activity, etc., but have

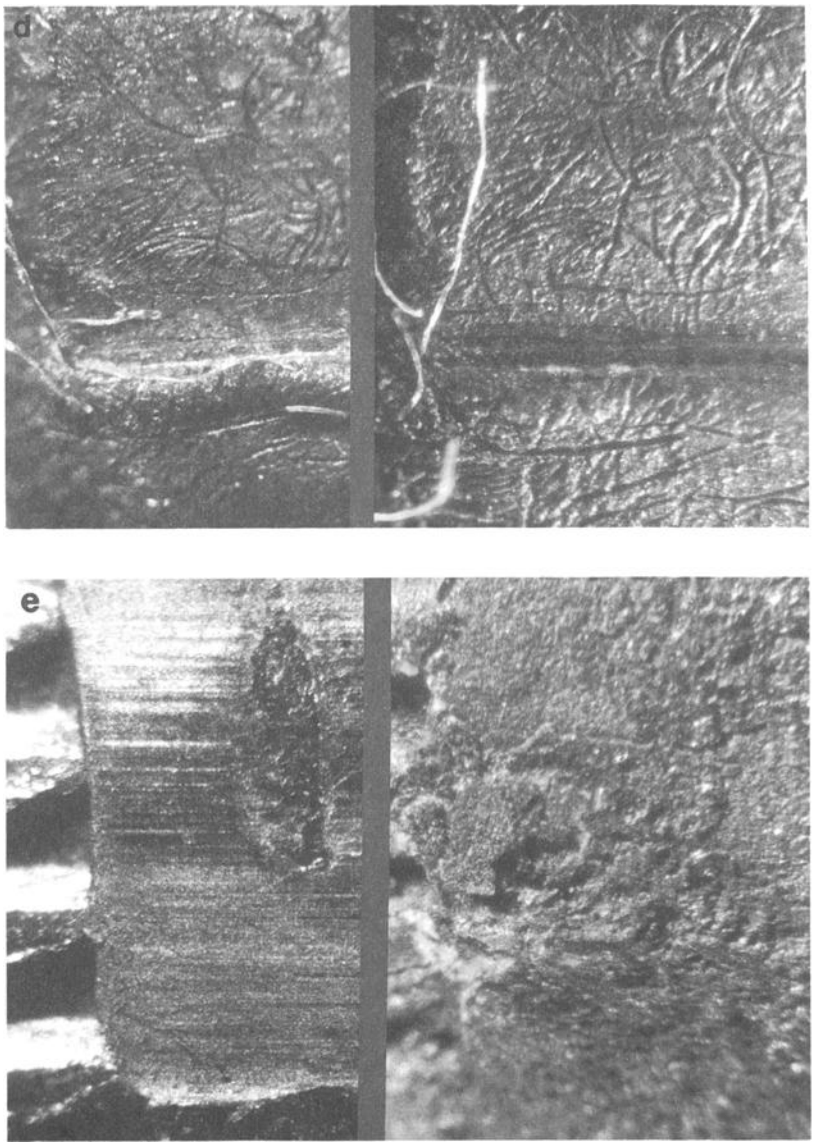

FIG. 1—*Continued.*

not been determined. However, the wide range of effects noted underscores the importance of recovering bullets from decomposed bodies. The excellent state of preservation of some bullets indicate that no bullet should be presumed too deteriorated for study.

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