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Terminal Ballistics of the 9mm with Action Safety Bullet or Blitz-Action-Trauma (BAT) Ammunition

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ABSTRACT: Specialty ammunition creating atypical gunshot wounds of entrance can create confusion and may be misinterpreted by pathologists unfamiliar with the terminal ballistics of these projectiles. The previously unreported wound ballistics caused by the 9mm with Action Safety bullet described in a homicide highlights the atypical entrance wound(s) and wounding capacity of this novel ammunition. Manufactured by Geco division of Dynamit Nobel, the bullet consists of a nonjacketed solid copper alloy bullet body without a conventional lead core. The large deformation well and part of the smaller central channel is filled with a hard plastic core and post that creates a round nose bullet. The internal ballistics and unique design allow the plastic nose cap and post to separate from the copper alloy base while still in the barrel. The radiolucent nose cap leaves the bullet's path but can still penetrate tissue giving the appearance of a separate but smaller entrance wound. The sharp leading edge of the deformation well and relative high velocity of the bullet body creates a punched out entrance wound with minimal marginal abrasion. When the plastic nose cap or fragments of the plastic post impact the subject, test firings may allow an inference to the muzzle-target distance even in the absence of soot deposition or stippling.

KEYWORDS: pathology and biology, ballistics, terminal ballistics, gunshot wounds, ammunition

Seeking enhanced incapacitation from handgun bullets, ammunition manufacturers have developed and produced specialty handgun ammunition with novel ballistic features. When shootings occur with these unusual and sometimes exotic bullets, unique findings may be encountered at autopsy. Familiarity with these uncommon projectiles may allow the forensic pathologist to readily identify the ammunition type and assist law enforcement authorities in their investigation. Also, the unconventional design of certain ammunition may contain elements emitted from the muzzle contemporaneous with the main projectile that may aid in muzzle-target distance estimates.

Ammunition manufacturers continually attempt to create the exemplary anticriminal firearm projectile, since many perceive that conventional law enforcement handgun ammunition has certain disadvantages, such as suboptimal energy release in soft targets,

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danger to bystanders after exiting the primary target, and the hazard of rebounds or ricochets. To surmount these drawbacks of conventional ammunition, Geco division of Dynamit Nobel developed the 86 grain, 9mm Luger with Action Safety Bullet. In the United States, this ammunition has been called the Blitz-Action-Trauma (BAT) bullet [*1*].

The 9mm with Action Safety bullet incorporates a nonlead hollowpoint copper alloy body with a specially designed cavity in the nose that is drilled axially to the base. A plastic tip provides the bullet with a round nosed shape for dependable feeding into self-loading weapons and protects the primer and propellent from moisture and the cavity from mechanical damage. The Sintox primer contains no lead or barium. After ignition of the propellant, gases enter the axially drilled channel and accelerate the plastic tip faster than the bullet body. According to the manufacturer, the plastic cap leaves the muzzle before the bullet body and due to its asymmetrical shape, deviates immediately from the bullet trajectory, falling harmlessly to the ground a few meters from the muzzle. The bullet body follows its trajectory undisturbed after leaving the muzzle [*2*].

Case Report

A 39-year-old man was found lying prone in the backyard of his estranged wife's house. He had sustained multiple gunshot wounds of the chest, abdomen, and back. A 9mm Heckler & Koch (H&K) VP 70Z semi-automatic pistol was found on the kitchen floor next to the breakfast bar. Three gunshot wounds of entrance were identified on the left upper anterior chest, left mid-posterior back, and lower back in the midline (Fig. 1). The decedent wore a cotton, knit, short sleeved, pullover shirt, denim jeans, and jockey-style undershorts. A single exit was located below the left clavicle. The entrance wounds measured 0.6 cm in diameter with minimal marginal abrasion and each had a paired adjacent irregular abrasion or smaller penetrating defect in the skin and subcutaneous

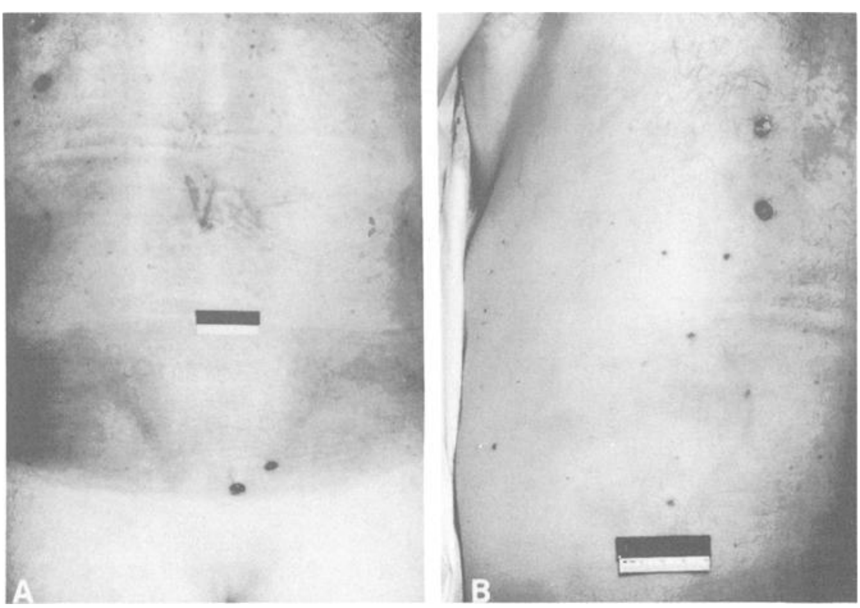

FIG. 1—*Entrance gunshot wounds and paired smaller penetrating wound and abrasion located on the decedent's left posterior thorax and lower back* (A). *Irregular punctate abrasions localized beneath the perforating gunshot wound of entrance* (B).

tissue. The distance between the main entrance wounds and the paired wound or abrasion varied from 2.5 to 4.2 cm. Surrounding the entrance wound and penetrating defect of the left mid-back were punctate to 0.1 cm, irregular abrasions larger than stippling (Fig. 2). Two projectiles were identified on the postmortem radiographs; however, no other radio-opaque objects were detected (Fig. 3). Three asymmetrical brown plastic caps were recovered from the clothing or within the subcutaneous tissue of the smaller penetrating wounds. The non-exiting projectiles were identified as BAT or 9mm with Action Safety bullets manufactured by Geco division of Dynamit Nobel (Fig. 4). The gunshot wound of the left upper chest perforated the upper left lung, left pulmonary artery, trachea, and upper right lung. The perforating wound of the left mid-posterior back perforated the posterior left 9th rib, stomach, diaphragm, and left 2nd-3rd intercostal space before exiting the left upper anterior chest medial to the entrance wound of the left chest. The gunshot wound of the lower back penetrated the fifth lumbar vertebral body. The left and right pleural cavities contained 1460 mL and 250 mL of blood, respectively. The maximum diameters of the two recovered bullets were 12 and 15 millimeters.

Although no soot or stippling surrounded the entrance wounds, a question was posited if the separation distance or spread between the bullet body and plastic cap could predict the muzzle-target distance analogous to muzzle-target estimates based on the spread of shotgun or shotshell ammunition [*3–8*]. A second question concerned the source of the punctate abrasions adjacent to the entrance wound of the left mid-back.

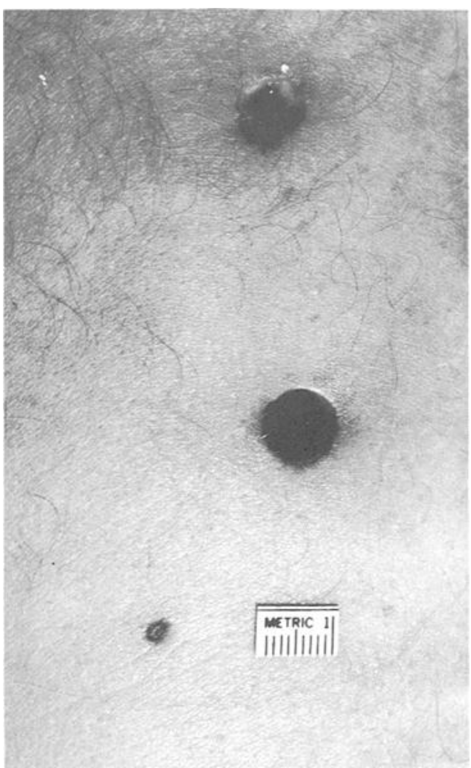

FIG. 2—*The main bullet body creates a circular entrance wound with minimal marginal abrasion. The plastic nose cap penetrated skin and subcutaneous tissue causing the smaller penetrating wound. The punctate abrasion was caused by the fragmented plastic centerpost.*

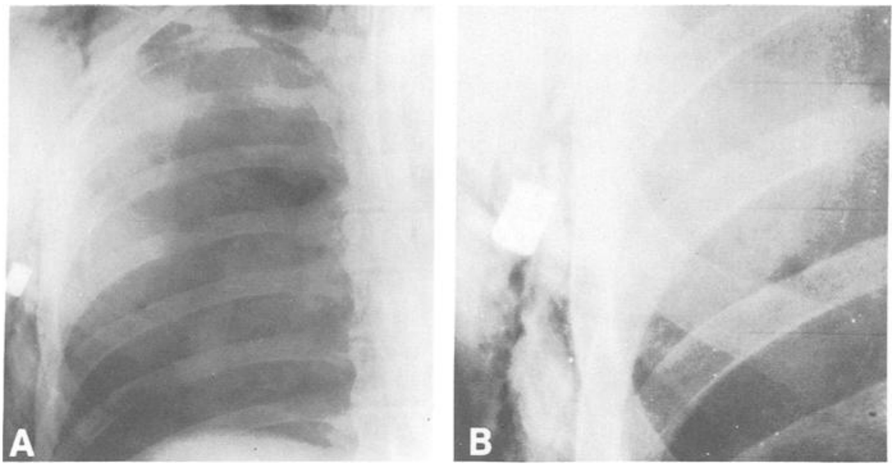

FIG. 3—*Postmortem chest radiograph discloses the deformed bullet body* (A *and* B).

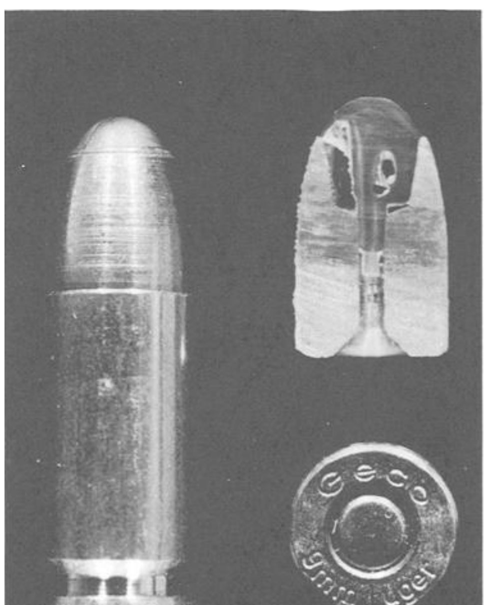

FIG. 4—*Clockwise from left: the 9mm with action safety bullet, cross section of bullet exposing the axially drilled central channel with implanted plastic nose cap and post, and cartridge headstamp.*

Materials and Methods

Following a pilot study involving 65 test firings at five distances, a second analysis consisted of 250 rounds using the assailant's weapon (H&K VP 70Z). At one meter intervals, 25 rounds were fired from distances of one through ten meters from the target. The separation distances between the bullet body and plastic cap were measured in centimeters (Fig. 5).

Five rounds were fired from each of five distances from one through five meters into pig skin obtained from a local meat processing plant. This allowed assessment of the penetrating ability of the plastic caps and evaluate the source of the punctate abrasions on the decedent's skin.

To measure the radiolucency of the plastic nose caps, three bullets were radiographed in a Hewlett-Packard Faxitron radiographic console model 43805N on Kodak X-OMAT TL film (Eastman Kodak Co., Rochester, NY). The bullets were all placed on the unexposed film and subjected to 2.5 milli-amperes for 60 seconds at 20, 40, and 60 peak killivolts (kVp), respectively.

Results

Regression analysis models for predicting muzzle-target distance from the separation distance between the bullet and plastic cap using the test firings were considered including linear, quadratic, cubic, and transformation of spread. The relationship was not linear with a quadratic term significantly ($P < .001$) improving the fit of the model and adding a cubic term did not significantly enhance the fit of the model. Examination of the residuals showed that the variance of the spread measurements at each distance was increasing with the mean spread of each muzzle-target distance. This suggested weighted

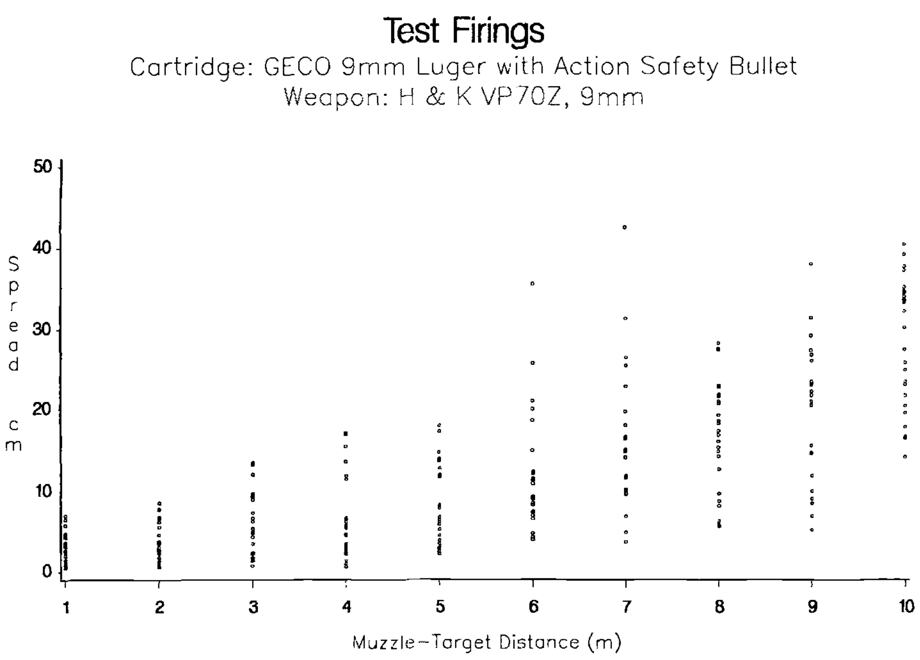

FIG. 5—*Separation distance between bullet body and plastic nose cap versus muzzle-target distance.*

regression would provide a better estimation scheme with highest explanatory model. This model was based on the test firings at 1 to 10 meters from the target and cannot be used to extrapolate to distances outside this range.

The mean spread, standard deviation, and variance at each distance for the 250 test firings are shown in Table 1. A clear feature of the findings is that variance and mean value of the spread increase with distance. The data exhibited an increasing curvilinear shape and preliminary analysis from the pilot study showed that adding a squared distance term provided the necessary curvilinearity. Logarithmic and square root transformations of the dependent variable were also considered. A linear model using square root transformation gave the best fit and the resulting model,

$$\text{Spread (cm)} = (0.9856 + 0.3927 \times \text{Distance (m)})^2$$

estimates the maximum spread of the projectile components as a function of distance from muzzle to target. Figure 6 reveals that at two meters the average separation distance between the projectile components is 3.1 cm and the 95% confidence interval is within a 12 cm radius. At 10 meters the predicted average spread for an individual shot increases to 24 cm with a 95% upper confidence interval of 44 cm.

The plastic caps penetrated the pig skin in all test firings. However, the fragmented plastic posts impacted the pig skin at muzzle-target distances of two meters or less (Fig. 7). Fragments of the center post were not observed on the skin surface when the muzzle-target distance was three meters or greater.

Radiographically, the plastic nose cap could be visualized at 20 kVp but not at the higher settings (Fig. 8).

The position of the plastic nose cap relative to the bullet body at the target appeared randomly distributed. Of the 125 rounds fired at 1 to 5 meters, 56.8% of the nose caps penetrated the target above the main bullet body, while 54.4% of the plastic nose caps penetrated the target above the main bullet body at 6 to 10 meters.

Discussion

Firearm manufacturers continually try to improve ammunition efficacy. One of the more notorious projectile modifications was made to the Mark II .303 British round-nose bullet when Captain Clay of the Indian Army arsenal at Dum-Dum, India, exposed the lead core of the full metal jacketed projectile [9].

The ideal bullet for law enforcement must penetrate and expand reliably causing in-

TABLE 1—*Mean, standard deviation, and variance of separation distance (spread) by distance of test firings.*

Distance (m)	Mean (cm)	Std. Deviation SD	Variance
1	2.93	1.80	3.24
2	3.68	2.55	6.50
3	5.28	3.95	15.63
4	6.63	5.17	26.74
5	8.00	4.85	23.55
6	11.96	7.40	54.81
7	16.12	8.52	72.59
8	16.91	6.78	45.94
9	19.45	8.39	70.46
10	28.32	7.97	63.48

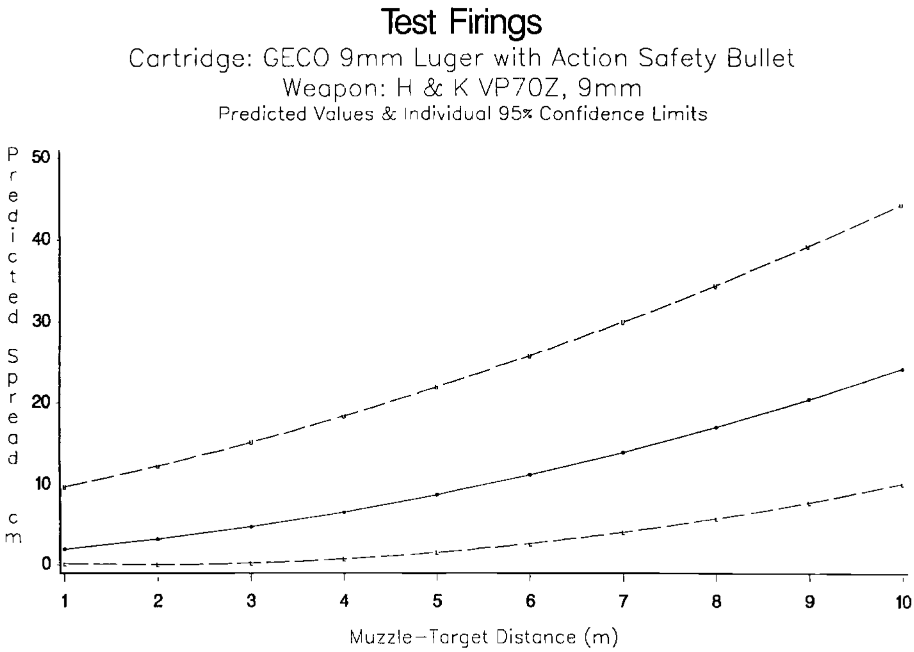

FIG. 6—*Predicted spread and 95% confidence limits calculated from test firings transformed back to the original units.*

stantaneous incapacitation. An added consideration is required for autoloading pistols—bullets must feed dependably from the magazine into the chamber and fully cycle the weapon, causing the discharged cartridge to eject and the next round to feed into the chamber.

Specialty ammunition manufacturers claim their product offers definite improvements over conventional ammunition. Numerous distinct and sometimes exotic projectiles have been produced during the last few decades, including the Glaser Safety slug, Silver-tip (Winchester), Magsafe, Power Plus Beehive, Hydra-Shok (Federal), Action Safety or BAT (Geco), MEN Quick Defense (Metallwerk Elisenhütte GmbH), MAP (Personal Protection Systems Ltd.), MPP/MMC (Hi-Vel), THV (Société Française des Munitions),

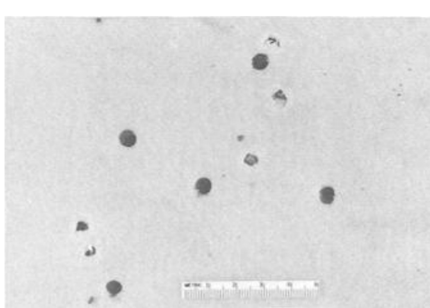

FIG. 7—*Test firings into pigskin demonstrating defects caused by main bullet body, plastic nose cap, and fragmented centerpost (muzzle-target distance: 2 meters).*

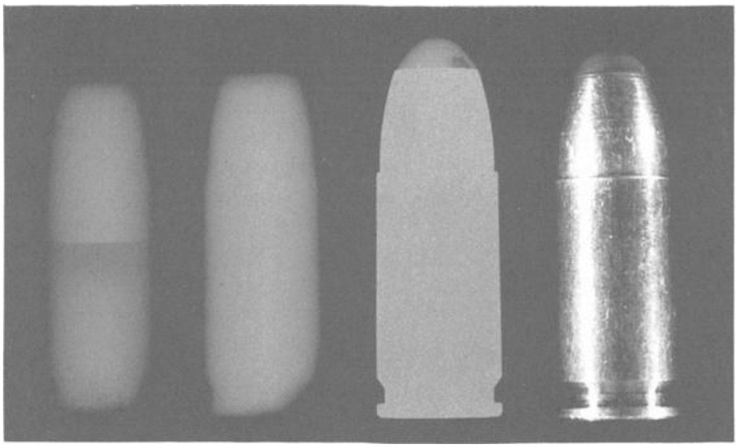

FIG. 8—*Superimposed 9mm with Action Safety bullet on radiograph of cartridges exposed at 60, 40, and 20 kVp. The plastic nose cap is radiographically visible only at the lowest kVp setting.*

Equaloy SWC (Kendall International), Black talon (Winchester), PMC Ultramag, Nyclad (Federal), multiple loads, handgun shotshells, sabot bullets, and ''exploding'' bullets [*9–19*].

The 9mm Action Safety bullet, developed and produced by Geco of Dynamit Nobel, was designed to overcome certain undesirable characteristics of conventional handgun ammunition, including low energy release in soft targets, overpenetration, and high risk of ricochets. Reportedly with the 9mm Action Safety bullet, the risk of overpenetration and ricochets is reduced. The copper alloy hollow point projectile does not fragment but expands axially, increasing the bullet's effective diameter (Fig. 9). The Action bullet has a non-lead metallic body and a plastic nose tip giving the bullet an FMJ-profile, thus

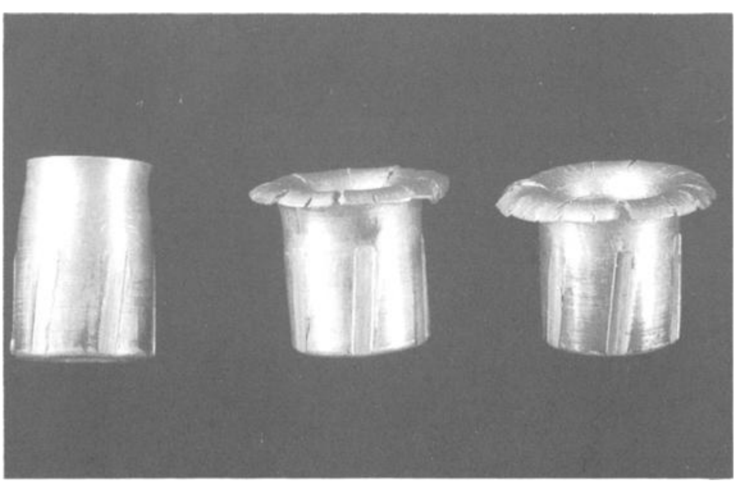

FIG. 9—*Variably deformed projectiles recovered from test firings into watertank.*

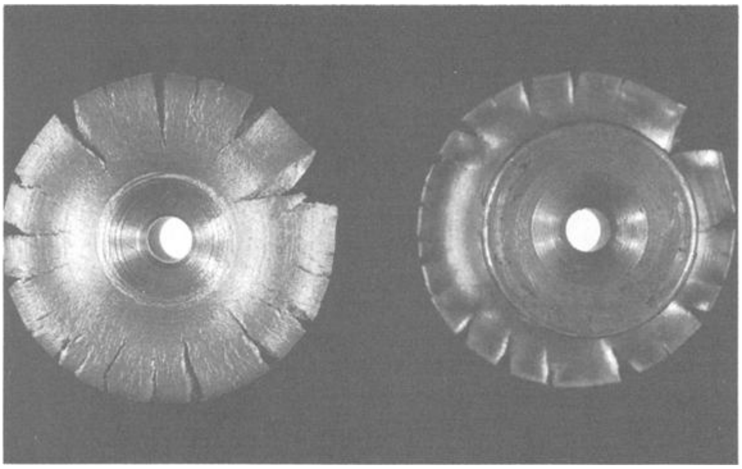

FIG. 10—*Axially drilled central channel as viewed from expanded cavity* (left) *and base* (right).

aiding feeding into self-loading weapons. The bullet body weighs 5.4 g. The plastic cap and post add up to 0.2 g. The hollow point bullet body is drilled axially to the base (Fig. 10). The plastic nose tip and post protect the primer and powder from moisture and the bullet tip from mechanical damage. The lead and barium free Sintox primer contains zinc peroxide, titanium, tetrazene, and dinol [*20,21*]. Thus, the predominant elemental gunshot residues from this ammunition are zinc, titanium, and copper (projectile residue).

When the primer ignites the powder, the expanding gases enter the axially drilled channel in the bullet body causing the plastic tip and post to accelerate faster than the bullet body (Fig. 11). The plastic tip and post exit the muzzle before the bullet and departs from the bullet's trajectory due to the specially designed asymmetrical shape (Fig. 12). The manufacturer indicates the plastic tip falls harmlessly to the ground a few meters from the muzzle. This case and study indicate that the plastic tip can penetrate skin and could cause injuries to adjacent bystanders; however, the minimal velocity necessary to penetrate skin was not determined [*22*].

Due to its lower mass, the muzzle velocity (430 to 480 m/s) of the Action bullet is significantly higher than conventional full metal jacket (FMJ) 9mm ammunition; how-

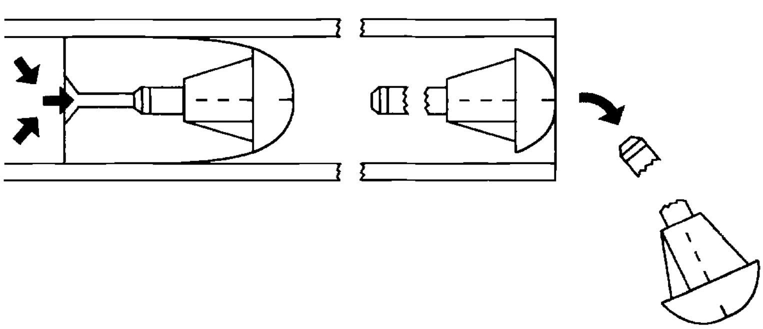

FIG. 11—*Expanding gases entering central channel* (arrows) *accelerate plastic cap and fragmented post ahead of bullet body.*

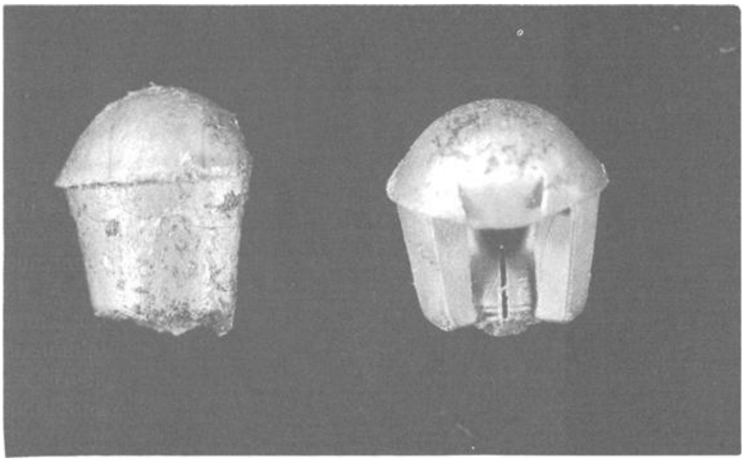

FIG. 12—*Plastic nose caps recovered during test firings. (Note asymmetrical shape and absence of plastic post.)*

ever, the greater drag coefficient of the 9mm Action Safety bullet causes a greater velocity reduction than conventional FMJ ammunition, thus the maximum range is reduced and the possibility of ricochets is minimized [*2*]. The minimal marginal abrasion surrounding the punched out, "cookie cutter-like," entrance wounds produced by the bullet body is due to the relative high muzzle velocity of the projectile [*23*].

The Action Safety bullet is made in 9mm, but .38 Special and .357 magnum loads are under development. An Action-3 bullet is similar to the original Action Safety bullet, except the bullet body weighs 5.9 g and the plastic tip weighs 0.1 g. The bullet material is brass and reportedly maintains its shape in soft targets without mushrooming [*2*].

The plastic nose tip is radiolucent at kVp settings used for most postmortem radiography and is visible only by settings used for soft tissue radiography. Thus, careful inspection and dissection are required to identify the plastic tips when they have penetrated clothing or subcutaneous tissue.

When a forensic pathologist examines a fatal gunshot wound, a categorical evaluation of the muzzle-target or shooting distance can be made indicating whether the wound is contact, close, intermediate or indeterminate. The indeterminate category may be further delineated depending on the ammunition employed or projectile deformation [*24*].

Based on these test firings of the 9mm Action Safety bullet and subsequent analysis, one cannot accurately predict the muzzle-target distance from a single observed separation distance of the bullet body and plastic tip; however, the prediction intervals from the square root transformation model can anticipate spread from distance. The interpretation of these intervals depends on consistence with testimony, rather than assigning probability to a given distance. Figure 6 shows the plot of prediction intervals against distance. A prediction interval gives a 95% confidence interval for a single spread, given a specified distance. The confidence limits are interpreted as the range in which the spread from a single shot will occur with 95% probability. The interval can be compared with testified distance for consistency and corroboration. For example, if the shot fired in a given scenario produced a spread of 21 cm, that is consistent with a distance of equal to or greater than five meters. Conversely, it is not consistent with a distance of two meters or less, since the prediction interval at those distances do not contain that separation span.

The unique design of this ammunition makes it readily identifiable when recovered at autopsy. The bullet body is a copper alloy hollowpoint with an axially drilled channel from the bullet base to the central cavity. Entrance wounds created by the bullet body have a punched out appearance with minimal marginal abrasion. Careful inspection of the body and clothing may disclose the plastic nose cap and plastic fragments from the plastic centerpost. At muzzle-target distances of two meters or less with the H&K VP 70Z, irregular punctate abrasions adjacent to the entrance would occur when the fragmented plastic centerpost impacts and abrades skin. Although shooting distance cannot be predicted by measuring the separation distance or spread between the bullet body and plastic tip, the prediction interval can be compared with asserted distances to support or refute statements or testimony.

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