# G66 Comparative Evaluation of Radiolucent Projectile Components by Radiographs and Computed Tomography

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After attending this presentation, attendees will understand the necessity and limitations of forensic imaging in autopsies of suspected gunshot victims. Attendees will gain an understanding of the importance of recovery of traditionally radiolucent projectile components at autopsy and of the challenges presented in this pursuit by the use of postmortem radiography only as opposed to radiography supplemented with Computed Tomography (CT).

This presentation will impact the forensic science community by strengthening the validity and necessity of postmortem CT scanning for gunshot-related fatalities. These findings also have applications clinically, as missed radiolucent projectile components left in the body during surgery can lead to infection.

Projectile components that are traditionally radiolucent are important in determining weapon and projectile type and caliber, but these components are often not visualized on postmortem radiographs. It was hypothesized that these components would be better visualized by evaluation of CT scans compared to the forensic pathology practice standard of X-ray.

Thirty-two cartridges with projectiles that possessed a radiolucent component were both dismantled using an interia bullet puller and fired, either into a water tank or down an enclosed range, and the radiolucent components were recovered. These cartridges were comprised of a variety of centerfire handgun, shotgun, and rifle rounds. The components were embedded in disrupted zones of blocks of ballistic gelatin. Nine true negative areas of disruption were also created. The blocks were subjected to X-ray and CT scanning. The CT images were helically acquired and reconstructed in axial, coronal, and sagittal views at slice thicknesses of 1.0mm x 0.5mm, 3mm x 3mm, and 0.8mm x 0.4mm. The X-ray and CT images were evaluated by three blindfolded, board-certified radiologists (two with training in forensic radiology) for the presence/absence of projectile components. If a projectile component was present, the radiologists further described their observations.

Projectiles were broken into several categories for analysis: fired vs. unfired, X-ray vs. CT scan, and material type. The material type category was further delineated as plastics, metals, cardboard/fiber, and miscellaneous, which included rubber, styrofoam, paper, fabric, and nylon. In all instances concerning observers one and three, visualization of projectiles/projectile components was equal or better on CT scans when compared to X-ray. This was true for observer two in only the cases of unfired projectiles (0% difference), metals (0% difference), and miscellaneous projectiles (7.7% difference).

An unpaired one-tailed Student t-test ($p<0.05$) was performed to compare total numbers of projectiles/pojectile components identified correctly on X-ray versus CT scan for each observer. The null hypothesis, that there was no difference in observation of projectiles/projectile components on CT scan vs. X-ray, was rejected ($t_{crit} = 2.92$, $t = 17.022$).

Though inter-rater kappa values between the three observers were low in most instances, the percentage of projectiles identified of any material type was high. The kappa values for observers one and two were 0.075 overall, -0.019 for CT, and 0.721 for X-ray. For observers one and three, kappa values were 0.255 over all, 0.333 for CT, and 0.139 for X-ray. For observers two and three, kappa values were 0.841 overall, -0.037 for CT, and 0.104 for X-ray. Observer one identified 88.8% of projectiles correctly, with 78.6% on X-ray and 99% on CT, a 20.4% increase. Observer two identified 84.7% of projectiles correctly, with 89.8% on X-ray and 79.6% on CT, a 10.2% decrease. Observer three identified 96.9% of projectiles correctly, with 95.9% correct on X-ray and 98% correct on CT, a 2.1% increase.

Of the true negative zones created 70% were described by the radiologists. Of these, 55% were correctly identified as true negatives and the remainder as false positves. False positives were identified in 98 cases on X-ray (obvserver 1:2; 2:64; 3:32), and 87 false positives were identified on CT (observer 1:0; 2:80; 3:7).

Traditionally radiolucent projectiles/projectile components embedded in ballistic gelatin blocks were significantly better visualized with CT scans than X-ray. Though concordance between radiologists was low, the total percentages of projectiles identified by each radiologist in each modality were high. The disparities between radiologists' identification of false postives can be attributed to individual skill level and familiarity with projectiles. As gelatin blocks have densities similar to human soft tissues, CT would likely be a better modality to find these projectile components in people with fatal and non-fatal gunshot wounds.

**Forensic Pathology, Wound Ballistics, Forensic Radiology**


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