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Review

Forensic and clinical issues in the use of frangible projectile

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ABSTRACT

Frangible projectiles for firearms, which break apart on impact, are mainly used by law enforcement agencies for training purposes, but can also be used for police interventions. Apart from the usual absence of lead in the projectiles, the main advantage of using frangible projectiles is the reduced risk of ricochet after impact with a hard target. This article describes the design and function of frangible projectiles, and describes gunshot wounds caused by ultra-frangible projectiles which fragment after penetration of soft tissues. Shooting experiments performed by the authors confirmed that differences in the geometry and technology of frangible projectiles can significantly modify their wounding effects. Some frangible projectiles have minimal wounding effects because they remain compact after penetration of soft tissues, comparable to standard fully jacketed projectiles. However, a number of ultra-frangible projectiles disintegrate into very small fragments after impact with a soft tissue substitute. In shooting experiments, we found that the terminal behavior of selected ultra-frangible projectiles was similar in a block of ballistic gel and the soft tissues of the hind leg of a pig, except that the degree of disintegration was less in the gel.

1. Introduction

The range of the handgun ammunition with the non-lead projectiles made by the compression of a metal powder or a mixture of metal powders has been growing since the beginning of the 21st century. This specific type of ammunition, called as frangible ammunition, is designed to disintegrate on impact and are intended mainly for use during training by law enforcement agencies because of their relative safety (low ricochet hazard) and low toxicity.[1,2] However, new types of frangible ammunition that have been developed for combat situations and self-defense have also recently appeared on the market. Most frangible ammunition has been designed for handguns, but recently frangible ammunition for rifles has also been developed.[1–3]

Both medical and forensic experts must be made aware of the new injury patterns resulting from the use of frangible projectiles. Even when the projectiles do not leave the body, only small fragments can be found in the wounded tissues.[2–4] Frangible projectiles present a wide range of new technical challenges to the field of ballistics analysis.[2] From a criminological point of view, the most important disadvantage of frangible ammunition is the very limited ability to identify ballistic traces on the surfaces of fragmented projectiles.[1,2,4]

The aim of this article is to draw attention to the existence of frangible and ultra-frangible ammunition. The first part of this article describes the design and function of frangible projectiles. The second part reports the results of gunshot wounds caused by ultra-frangible projectiles in blocks of ballistic gel and the hind leg of a pig.

2. Design and properties of frangible ammunition

Frangible projectiles are generally designed to disintegrate after impact with a hard target. The resulting fragments are significantly smaller than the original projectile.[1–3,5]

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Fig. 1. Different types of 9 mm Luger pistol projectiles. The five projectiles on the left were made with copper powder, and the two projectiles on the right were made with iron powder.

Frangible ammunition is unique because of its terminal ballistic properties.[3,4] The projectiles show only limited penetration capability and have a reduced ricochet hazard because they fragment after impact with a hard target.[1,2,5] The ballistic properties of frangible projectiles depend on their specific manu facturing processes. Frangible projectiles are mainly manufactured by powder metallurgy (usually cold molding) of composite materials based on fine metal powders (including copper, iron, zinc, tin, bismuth, and tungsten; Fig. 1). Frangible projectiles are considered to be relatively ecologically sensitive because they have no lead content.[1,2]

For the non-professional, it is often very difficult to visually distinguish frangible projectiles from full metal jacketed projectiles with a lead core (Fig. 2), which could lead to mistakes. Some frangible projectiles can be recognized by their characteristic shape and color, and frangible projectiles usually have a flat point nose.[1–3] The nature of projectiles can only be reliably determined by special testing (such as hardness testing, fragility and strength testing, or microscopic inspection).

A classical compact frangible projectile usually fragments after impact with a rigid, hard target. The size of the created fragments is closely related to the rigidity of the target (Fig. 3). Standard frangible projectiles do not usually disintegrate after impact with a low-rigidity target (such as a thin metal sheet, wooden plate, glass window, or porous building materials). In cases of impact with a high resistance hard target (such as a thick metal sheet, armor plate, concrete or brick wall, or automobile windscreen), frangible projectiles disintegrate into a large number of small fragments which do not usually penetrate the target.[1–3] The fragmentation pattern is influenced by the impact velocity and impact angle of the projectile. The size of the fragments usually decreases as the impact velocity increases.

The most common frangible projectiles do not fragment or deform after penetration of soft tissues.[4] In this regard, their behavior in soft tissues is very similar to the behavior of standard full metal jacketed projectiles. Frangible projectiles may fragment after impact with bone, in the same way as after impact with other hard targets.[4] However, some frangible projectiles with a suitably shaped cavity in the front part disintegrate into a large number of fragments after penetration of soft tissues, even if they do not make contact with bone. These are known as ultra-frangible projectiles. The first ultra-frangible projectiles have recently been developed, tested, and used. Examples of ultra-frangible projectiles include the American commercially manufactured Extreme Shock Fang Face (FF) and Air Freedom Round (AFR) and the experimental frangible SRK-2 projectiles, manufactured in the Czech Republic (Fig. 4). The FF and AFR projectiles (Fig. 5) are intended for use by both law enforcement agencies and the general public (for training, self-defense, and hunting). The Varmint Grenade rifle ammunition, consisting of a brass jacket filled with a lightly compressed mixture

Fig. 2. Appearances of frangible projectiles (left) and classical full metal jacketed projectiles with a lead core (right). The back row on the right shows three fired projectiles, with deformation of the frontal part and grooves from the barrel rifling (all projectiles are for a 9 mm Luger pistol).