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DEFECTS IN COTTON FABRIC WHEN SHOT FROM «FORT 12R» AND «AE 790G1» PISTOLS: AN EXPERIMENTAL STUDY USING A HUMAN BODY SIMULATOR

Abstract. The aim of the study was to determine the characteristics of cotton fabric defects formed as a result of shots from the «Fort 12R» and «AE 790G1» pistols at the complex «clothing + non-biological human body simulator». Materials and methods. To conduct a controlled ballistic experiment in a shooting range, 30 gelatin blocks were made and subsequently fired from close, 25 and 50 cm distances (10 blocks in each group). Within each group, there were two subgroups according to the pistol used to make the shots: «Fort 12R» and «AE 790G1» (5 blocks in each subgroup). The blocks were covered with a cotton cloth. The fired blocks were examined using generally accepted descriptive methods in forensic science. Results. When shooting at close range, both «Fort 12R» and «AE 790G1» produced the so-called «punching mark». In the case of the «AE 790G1», tears in the fabric around the entrance hole were formed at 12, 3, 6 and 9 o'clock; when firing the «Fort 12R», no tears in the clothing were observed, but a specific soot deposit was found below the entrance hole, corresponding to the area of the end surface of the recoil spring rod. No differences in the macroscopic pattern of clothing damage were found at 25 and 50 cm, except for a slight predominance of the defect size when using the «AE 790G1» pistol. At all shot distances, when both pistols were used, the deposition of residual shot components in the form of unburned powder particles was noted. Conclusions. When shooting from AE790G1 at close range, a significant number of additional factors of the shot were released, as evidenced by the formation

of tears in the clothing, which were not observed when shooting from Fort 12R. Fort 12R is characterized by the formation of a specific soot deposit in the area of the end surface of the return spring rod, which can serve for differential diagnosis of the weapon.

Keywords: cotton fabric, firearm, firearm injury, firearm damage to clothing, non-lethal weapon.

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ДЕФЕКТИ БАВОВНЯНОЇ ТКАНИНИ ПРИ ПОСТРІЛАХ З ПІСТОЛЕТІВ «ФОРТ 12Р» ТА «AE 790G1»: ЕКСПЕРИМЕНТАЛЬНЕ ДОСЛІДЖЕННЯ З ЗАСТОСУВАННЯМ ІМІТАТОРА ТІЛА ЛЮДИНИ

Анотація. Мета дослідження – встановити особливості дефектів бавовняної тканини утворених в результаті пострілів з пістолетів «Форт 12Р» та «AE 790G1» у комплекс «одяг+небіологічниий імітатор тіла людини. Матеріали та методи. Для проведення контрольованого балістичного експерименту в умовах тиру було виготовлено 30 желатинових блоків, які в подальшому відстрілювали з дистанцій впритул, 25 та 50 см (по 10 блоків в кожній групі). В межах кожної групи були дві підгрупи відповідно до пістолета з якого здійснювали постріли: «Форт 12Р» та «AE 790G1» (по 5 блоків в кожній підгрупі). Блоки покривали бавовняною тканиною. Відстріляні блоки досліджували з використанням загальноприйнятих описових методів в судовій криміналістиці. Результати. При пострілах впритул як при використанні «Форт 12Р» так і «AE 790G1» відбувається утворення так званої «штанцмарки». У випадку використання «AE 790G1» навколо вхідного отвору утворюються розриви тканини розташовані на 12, 3, 6 та 9 годин; при прострілах з «Форт 12Р» розриви одягу не спостерігаються, проте нижче вхідного отвору виявлено специфічне відкладання кіптяви, що відповідає

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ділянці торцевої поверхні стержня зворотної пружини. При пострілах з дистанцій 25 та 50 см будь яких відмінностей в макроскопічній картині пошкодження одягу не було виявлено, окрім як незначного переважання розмірів дефекту при застосуванні пістолету «AE 790G1». На всіх дистанціях пострілу при застосуванні обох пістолетів відмічено відкладання залишкових компонентів пострілу у вигляді незгорілих часточок пороху. Висновки. При пострілах з AE790G1 впритул відмічається виділення значної кількості додаткових чинників пострілу, доказом чого є утворення розривів на одязі, які не спостерігаються при пострілах з Форт 12Р. Для Форт 12Р при пострілах впритул характерним є утворення специфічного відкладання кіптяви в ділянці торцевої поверхні стержня зворотної пружини, що може служити для диференційної діагностики знаряддя пострілу.

Ключові слова: бавовняна тканина, вогнепальна зброя, вогнепальна травма, вогнепальне пошкодження одягу, нелетальна зброя.

Statement of the problem. The problem of the use of firearms for the purpose of committing illegal acts is relevant for different countries in the world, regardless of their socio-economic well-being, the presence of internal conflicts, armed confrontations, etc. Cases of firearms use are a burden not only for clinicians, but also for expert institutions, including forensic bureaus. Thus, according to the latter, 40 deaths were recorded in central Ghana from 2011 to 2017. 95% of the deceased were men. Among the causes of death were civil disobedience (27.5%), domestic violence involving children (20%) and robbery (17.5%) [1].

An analysis of data conducted in Podlasie (northeastern Poland) during the period from 1964 to 2015 revealed 87 fatalities involving firearms. As in the previous study, it was noted that the majority of the deceased were men, aged 21-30. However, the circumstances of death were absolutely dominated by cases of suicide. In addition, it was found that most of the deceased had consumed alcoholic beverages before their deaths [2]. In Geneva (Switzerland), an analysis of data from 2001 to 2010 revealed 133 cases of fatalities involving the use of firearms. 106 cases were suicides, which is in line with the trend established in Podlasie (Poland). In 25 cases, murder was recorded and in 2 cases it was an accident [3].

In order to establish the circumstances of death (murder, suicide or accident), physical evidence in the form of residual components of clothing, projectile remnants, weapons, injuries on the body of the deceased or clothing plays a key role. The last physical evidence in this list can be a source of significant information. However, the correct interpretation of the data requires the use of reliable data. One of the problems that arises in this case is the long-standing ignoring of the relationship between clothing and the body of the deceased and the existence of a possible influence of each other on the formation and characteristics of damage. At present, such works are few and mostly concern the study of the effect of clothing on the characteristics of damage to the tissues of the human body or its imitator [4]. Domestic works are mostly focused on the study of the deposition of residual components of the shot [5].

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There are only a few studies on the influence of underlying fabrics (or fabric imitators) on the peculiarities of clothing damage formation, and therefore there is a need for a controlled ballistic study to address this issue.

Connection of the publication with planned scientific research works. The work was carried out as part of the research work of the National Pirogov Memorial Medical University, Vinnytsia at the expense of state funding of the Ministry of Health of Ukraine: "Characteristics of damage to human body tissue simulators caused by non-lethal weapons" (state registration number 0121U107924).

The aim of the study – identify the features of cotton fabric defects formed as a result of shots from the «Fort 12R» and «AE 790G1» pistols at the complex «clothing + non-biological human body simulator».

Research objects and methods. To conduct an experimental study of damage to cotton fabric caused by shots from traumatic pistols, a complex «clothing + non-biological human body simulator» was used. The non-biological human body simulator was a gelatin block covered with cotton fabric. A 10 % solution of food gelatin type A 270 Bloom (TM «Junca Gelatines SL», Spain) was used to create the human body simulator, which was made using the method of Fackler and Malinowski [6]. For experimental shooting, 30 blocks of 30x15x15 cm each were made. Before performing the experimental shootings, they were covered with a 200 μm thick plastic film to simulate human skin and a cotton cloth was placed on top.

Shots were fired in the complexes at the shooting range of the Vinnytsia Research and Forensic Expert Center of the Ministry of Internal Affairs of Ukraine. Experimental firing was performed using traumatic pistols «Fort 12P» and «AE 790G1» equipped with 9 mm ammunition. The ammunition was factory-made with an elastic, traumatic bullet. The firing units were delivered within 30 minutes of being removed from the refrigerator. The pistols are rigidly fixed in vices.

The damage formed on the complexes «clothing + non-biological imitator of the human body» after the experimental shots were photographed in compliance with the rules of forensic photography using a digital camera («Alpha A6000 Sony» camera) with subsequent analysis of damage to cotton fabric in accordance with generally accepted principles of forensic research.

Committee on Bioethics of National Pirogov Memorial Medical University, Vinnytsya (protocol № 11 From 03.12.2020) found that the studies do not contradict the basic bioethical standards of the Declaration of Helsinki, the Council of Europe Convention on Human Rights and Biomedicine (1977), the relevant WHO regulations and laws of Ukraine.

Presentation of the main material.

Research results and their discussion. When fired at close range with AE790G1, damage in the form of a defect (minus fabric) of a rounded shape, measuring from 1.1x1.2 cm to 1.3x1.4 cm, was formed on cotton fabric (Fig. 1). The edges of the damage are uneven, roughened, the threads protrude into the lumen of the damage to different lengths, the end ends of the threads are disheveled and thinned, somewhat turned inward (in the direction of the bullet flight), partially burned. Radial tears extend from the edges of the damage at 12, 3, 6, and 9 o'clock

(imaginary clock face), ranging in size from 0.4 cm to 4.4 cm. The edges of the damage are uneven, rough, with threads protruding into the lumen of the damage to different lengths, and the end ends of the threads are disheveled and thinned. Around the damage, there is a concentric deposition of soot of dark gray and blackish gray colors 0.4 cm wide with an outer diameter of up to 1.5 cm. Behind these concentric deposits there is a ring of lightening with a slight soot deposit. The through-hole damage is located against the background of the muzzle mark, which is a contoured light gray soot deposit. This deposit is irregularly pear-shaped, tapering downward, with a total length of 1.5 to 3.2 cm and a width of 2.3 to 2.6 cm. The upper and lower edges of the imprint are clear, the sides are lighter. Also, around the damage and on the threads inside the damage, single (1 to 6 pcs.) half-burnt and unburnt gunpowder particles of irregular oblong and hemispherical shape, gray in color, were found.

Fig. 1. *Damage to cotton fabric when shot at close range with the AE790G1.*

When fired from a distance of 25 cm with the AE790G1, damage was formed on cotton fabric in the form of a defect (minus fabric) of a square shape fabric, measuring from 1.2x1.2 cm to 1.4x1.4 cm (Fig. 2). The edges of the damage are uneven, fringed, the threads protrude into the lumen of the damage to different lengths, the end ends of the threads are disheveled and thinned, slightly turned inward (in the direction of the bullet flight). There is no charring of the fibers. Radial tears at 9 and 3 o'clock (imaginary clock face) with dimensions from 1.1 cm to 1.8 cm extend from the edges of the damage. The edges of the tears are uneven, fringed, and the end ends of the threads are disheveled and thinned. Around the damage there is a light gray soot deposit at a distance of 1.2 cm from the center of the damage. Also, around the damage, there were found (from 3 to 20 pieces) of unburned gunpowder particles of irregular oblong and hemispherical shape, light brown in color.

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Fig.2. *Damage to cotton fabric when shot with the AE790G1 from a distance of 25 cm.*

When fired from the AE790G1 at a distance of 50 cm, damage was formed on cotton fabric in the form of a defect (minus fabric) of a square shape fabric, measuring from 0.9x1.0 cm to 1.1x1.2 cm (Fig. 3). The edges of the damage are uneven, fringed, the threads protrude into the lumen of the damage to different lengths, the end ends of the threads are disheveled and thinned, somewhat turned inward (in the direction of the bullet flight) There is no charring of the fibers. There is no soot deposition around the damage. Also, single (from 1 to 7 pieces) unburned gunpowder particles of irregular oblong and hemispherical shape, light brown in color, were found around the damage.

Fig.3. *Damage to cotton fabric when shot with the AE790G1 at a distance of 50 cm.*

Shots fired close to Fort 12R caused damage to the cotton material (Fig. 4), in the form of a defect (minus fabric) of a round-shaped fabric, ranging in size from 0.9x1.1 cm to 1.2x1.2. The edges of the lesion are uneven, fringed, the threads protrude into the lumen of the lesion to different lengths, the end ends of the threads are disheveled and thinned, somewhat turned inward (in the direction of the bullet flight). Around the damage there is a concentric deposition of soot of dark gray and blackish gray colors 0.3 cm wide with an outer diameter of up to 2.5 cm. Behind this concentric deposit is a ring of lightening with a slight soot deposit. The through-hole damage is located against the background of the muzzle mark, which is a contoured light gray soot deposit. This deposit is irregularly pear-shaped, tapering downward, with a total length of 3.4 to 3.7 cm and a width of 2.2 to 2.4 cm. The upper and lower edges of the imprint are clear, lighter on the sides. In the lower part of the impression, 1.5 to 1.7 cm from the center of the through damage, there is a dark gray circle with a diameter of 0.9 cm, which corresponds to the impression of the end surface of the return spring rod. Also, around the damage and on the threads inside the damage, single (2 to 4 pcs.) half-burnt and unburnt gunpowder particles of irregular oblong and hemispherical shape, gray in color, were found. In addition, multiple traces of grease were found around the damage at a distance of up to 3.7 cm from its center.

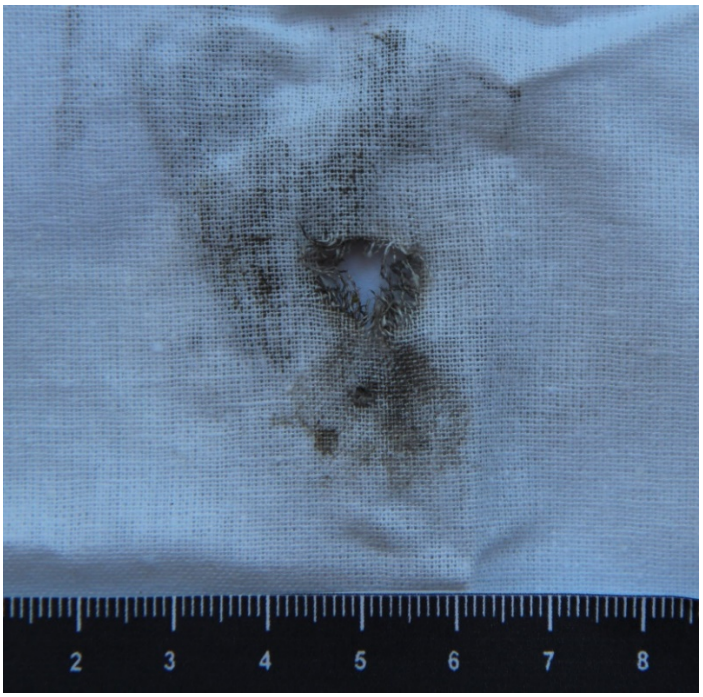

Fig. 4. *Damage to cotton fabric caused by a shot at close range from Fort 12R.*

Shots from Fort 12R from a distance of 25 cm resulted in damage in the form of a defect (minus fabric) in a square-shaped cotton fabric, ranging in size from 0.9x1.0 to 1.1x1.1 cm (Fig. 5). The edges of the damage, the end ends of the threads are disheveled and thinned, directed in the direction of the bullet flight. There is no charring of the fibers. There is no soot deposition around the damage. Also,

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numerous (25 to 30 pieces) unburned gunpowder particles of irregular oblong and hemispherical shape, gray in color, were found around the damage.

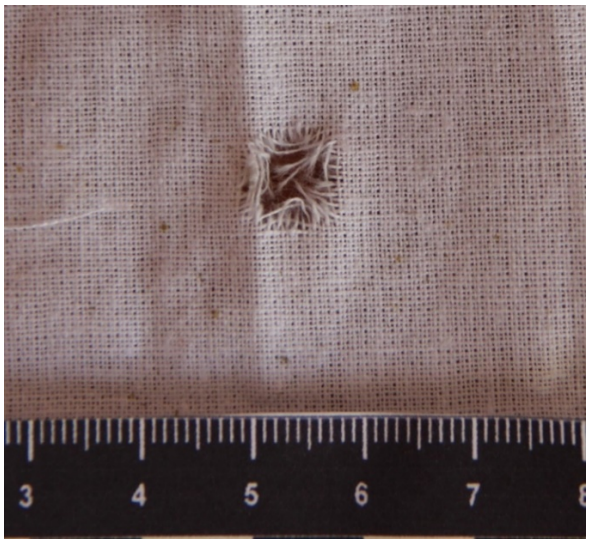

Fig. 5. *Damage to cotton fabric caused by a shot from Fort 12R at a distance of 25 cm.*

Shots from Fort 12R at a distance of 50 cm resulted in damage in the form of a defect (minus fabric) in cotton fabric of square and rectangular shapes, ranging in size from 0.9×0.9 to 0.9×1.4 cm (Fig. 5). The edges of the damage, the end ends of the threads are disheveled and thinned, directed in the direction of the bullet flight. There is no soot deposition around the damage. Also, single (from 1 to 5 pieces) unburned gunpowder particles of irregular oblong and hemispherical shape, gray in color, were found around the damage.

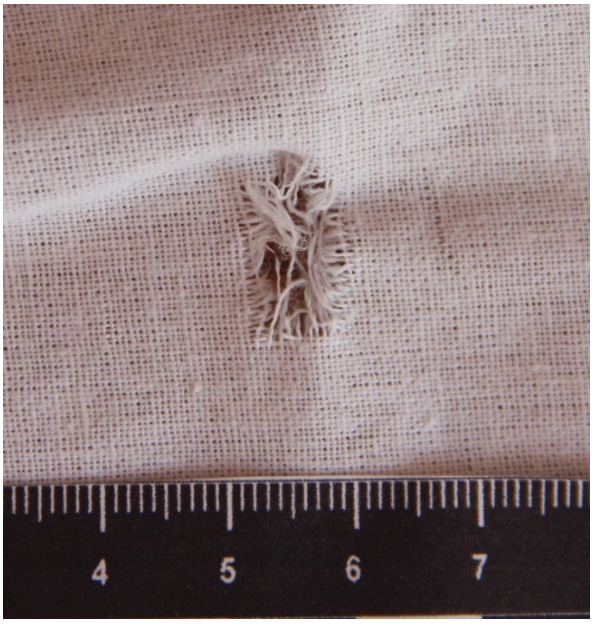

Fig. 6. *Damage to cotton fabric caused by a shot from Fort 12R at a distance of 50 cm.*

One of the very few works that studied the interaction of clothing with a human body simulator is the study by Gunas V.I. with co-authors [7], where they made shots from a Fort 12RM pistol at close range at a non-biological simulator of a human torso dressed in cotton knitwear. As in this study, when using the Fort 12R, the formation of an irregularly pear-shaped barrel (described by the authors as candle-shaped) with the formation of an imprint from the recoil spring rod was detected.

It is noteworthy that the data obtained in this study, compared to the data of Gunas V.I. et al. and the results of the study mentioned by them, where shots were made into a cotton cloth fixed in a frame, occupies an intermediate position (our data - from 0.9×1.1 cm to 1.2×1.2; the study of Gunas V.I and co-authors - 1.67×1.38 cm; the study with the fixation of cotton fabric in the frame - 1.0×1.0 cm). Such differences are probably an indication that the use of a model of an anatomically correct non-biological human body imitator should be considered as another option for setting up a ballistic experiment.

Shcherbak V.V. [8, 9] performed a series of studies using a Fort 12 combat pistol, with shots from different distances in tissue samples fixed within the framework. When shots were fired at a cotton fabric at close range, the formation of a defect measuring 1.2×1.1-1.3×1.2 cm with the formation of 4 radial tears and soot deposition was noted, similar in characteristics to the results of our study. The detected ruptures were observed at a shot distance of up to 3 cm. The dimensions of the defect at a shot distance of 50 cm ranged from 0.7 × 0.6 cm to 0.7 × 0.7 cm.

Shots from the Fort-14TP at close range into a cotton cloth fixed in a frame resulted in a defect measuring 1.5×1.3 cm to 2.0×2.0 cm with the formation of 0.5-1.1 cm long tears, which exceeds the data obtained by us (and the presence of tears) and can be explained, as in previous studies using combat pistols, by the formation of a significant number of additional factors of the shot [10].

The results of the study by Perebetiuk A.M. et al [11] are consistent with our data on the improved ability of cotton fabric to retain residual shot components. Thus, in this work, the authors emphasize that among the shots to the blocks covered with cotton fabric, denim, or leatherette, at a distance of 50 cm, soot was observed macroscopically only when shots were fired to the blocks covered with cotton.

Conclusions. When shooting at point blank range from an AE790G1 pistol into cotton fabric as a component of the complex «clothing + non-biological human body simulator», a minus-fabric defect was formed with tears in the fabric extending from the edges of the damage at 12, 3, 6 and 9 hours, with the formation of an irregular pear-shaped shape around the standard.

Similar shots from the Fort 12R pistol did not produce any tears in the clothing around the minus-fabric defect, but at the same time, a specific pattern of barrel marks was observed, which is due to the presence of a recoil spring rod at the muzzle end of the weapon, which is not present in the AE790G1.

Apart from a slight predominance of the minus-fabric defect on the side of AE790G1, no other differences between the characteristics of the damage to clothing caused by the tested pistols were found, which in turn allows only the distance of the shot at close range to be used for effective differential diagnosis.

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