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CHARACTERISTICS OF DEFECTS IN DENIM FABRIC FORMED AS A RESULT OF SHOTS FROM "FORT 12R" AND "AE 790G1" PISTOLS IN COMBINATION WITH A HUMAN BODY SIMULATOR

Abstract. The behavior of additional shot factors and residual shot components when using different types of firearms and ammunition has been a subject of discussion for a long time among experts in the field of ballistics. The study of their impact on a trace-receiving surface, which can be a human body, clothing or other objects, has become a central element of modern scientific work in this area. The behavior of additional factors of the shot and ammunition in contact with different types of clothing is rather unclear and unpredictable, which is mainly due to the different models of experiments used in the field of ballistics. The most promising and closest to real conditions is to conduct an experiment where clothing is part of a complex with a human body or a human body simulator. The purpose of the study is to establish the peculiarities of damage to denim fabric when shots from «Fort 12R» and «AE 790G1» pistols are fired at the complex «clothing + non-biological human body simulator». 30 gelatin blocks were manufactured according to a generally accepted methodology, which were subsequently covered with a skin imitator and a layer of denim. Subsequently, shots were fired from «Fort 12R» and «AE 790G1» pistols at close range, 25 and 50 cm. Generally accepted forensic methods were used to describe the damage to the clothing. The analysis of the data showed that both the «Fort 12R» and «AE 790G1» produced the largest defect at close range, but tears were observed only with the «AE 790G1»; at shots from a distance of 25 cm, virtually no differences in the macroscopic picture of denim damage were found; at shots from a distance of 50 cm, larger defect values were

found when using «AE 790G1» compared to «Fort 12R». Thus, our study showed that the macroscopic examination of denim samples after shots from the «Fort 12R» and «AE 790G1» pistols showed virtually no differences, except for shots at close range, which in turn requires the expert to use additional research methods if it is necessary to identify the pistol or the distance of the shot.

Keywords: gunshot damage to clothing, non-lethal weapons, denim, firearms, gunshot trauma.

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ХАРАКТЕРИСТИКИ ДЕФЕКТІВ ДЖИНСОВОЇ ТКАНИНИ УТВОРЕНИХ В РЕЗУЛЬТАТІ ПОСТРІЛІВ З ПІСТОЛЕТІВ «ФОРТ 12R» ТА «AE 790G1» У КОМПЛЕКС З ІМІТАТОРОМ ТІЛА ЛЮДИНИ

Анотація. Поведінка додаткових чинників пострілу та залишкових компонентів пострілу при застосуванні різних видів вогнепальної зброї та набоїв до неї є предметом дискусій впродовж довгого часу серед експертів в сфері балістики. Дослідження їх впливу на слідоприймаючу поверхню, якою може бути як тіло людини так і її одяг чи інші предмети стало центральним елементом сучасних наукових робіт у цій сфері. Досить малозрозумілим і непередбачуваним є поводження додаткових чинників пострілу та набоїв при контакті з різними видами одягу, що здебільшого пов'язано з різними моделями експериментів, що застосовуються у сфері балістики. Перспективним і найбільш наближеним до реальних умов є проведення експерименту де одяг є складовою комплексу з тілом чи імітатором тіла людини. Мета дослідження – встановити особливості пошкодження джинсової тканини при пострілах з пістолетів «Форт 12R» та «AE 790G1» у

комплекс «одяг + небіологічний імітатор тіла людини». 30 желатинових блоків було виготовлено за загальноприйнятою методикою, що надалі покривалися імітатором шкіри та шаром джинсової тканини. Надалі виконували постріли з пістолетів «Форт 12Р» та «АЕ 790G1» з дистанцій впритул, 25 та 50 см. Для опису пошкоджень одягу використовували загальноприйняті криміналістичні методи. Аналіз отриманих даних показав, що як у випадку використання «Форт 12Р» так і «АЕ 790G1» при пострілах впритул утворювався дефект найбільшого розміру, проте розриви спостерігали тільки при пострілах з «АЕ 790G1»; при пострілах з дистанції 25 см практично не виявлено жодних відмінностей у макроскопічній картині пошкодження джинсової тканини; при пострілах з дистанції 50 см виявлено більші значення дефекту при застосуванні «АЕ 790G1» порівняно з «Форт 12Р». Таким чином проведене нами дослідження показало, що при макроскопічному дослідженні зразків джинсової тканини після пострілів з пістолетів «Форт 12Р» так «АЕ 790G1» практично не виявлено відмінностей, окрім як при пострілах впритул, що в свою чергу вимагає від експерта застосування додаткових методів дослідження при необхідності ідентифікації пістолету чи дистанції пострілу.

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

Statement of the problem. Firearms have become widespread in the last century, and there is still a trend of increasing access to them among civilians around the world. Accordingly, this growth leads to an increase in the number of injuries or fatalities among citizens. In the United States, about 67,000 people are injured by firearms every year, and 32,000 people die [1].

The analysis of autopsies in Mumbai (India) from 2011 to 2013 revealed 43 cases of deaths from the use of firearms. In 74.4% of cases, the deceased were victims of an attack, in 21% of cases - suicide and in 4.6% of accidents. Most often, the deceased were men aged 21 to 30 [2].

In France, data from 2015 to 2018 on injuries from the use of cutting objects and firearms were analyzed. A total of 8128 cases were recorded that met the inclusion criteria. In 31.9% of cases, the injury was caused by the use of firearms [3].

Equally important is the study of non-lethal firearms. Although this type of weapon is equipped with rubber bullets, it is still life-threatening and can cause fatalities or severe injuries when shot at the projection areas of vital organs [4]. A meta-analysis of 26 publications revealed 1984 cases of non-lethal use of firearms, of which 53 people died as a result of this injury, and 300 people had a permanent disability. In almost half of the fatal cases, the area of injury was the head and neck [5].

Another aspect that deserves attention is the analysis of the impact of clothing on the formation of an injury and changes in its parameters. In particular, it has been established that different types of clothing have different capacities for accumulating residual components of the shot [6]. A promising area of research is the study of the

interaction of clothing and the human body together in a gunshot injury and the impact of the latter on the formation of the former's injury.

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 purpose of the article is to identify the features of denim defects formed as a result of shots from the «Fort 12R» and «AE 790G1» pistols in a complex with a non-biological human body simulator.

Research objects and methods. During the experimental shooting, a ballistic gel block was used as a non-biological simulator of the human body covered with denim. To create a simulation of the human body, a 10 % solution of food gelatin type A 270 Bloom (TM «Junca Gelatines SL», Spain) was used, which was made according to the method of Fackler and Malinowski [6]. In total, 30 blocks with dimensions of 30x15x15 cm were made for the experiment, which were wrapped in a 200 µm thick plastic film before performing the experimental shots to simulate human skin and then covered with denim.

Shots were fired at such target complexes in the shooting range of the Vinnytsia Research and Forensic Expert Center of the Ministry of Internal Affairs of Ukraine. The shots were fired at close range, 25 and 50 cm (10 blocks for each distance) using «Fort 12R» and «AE 790G1» pistols (5 blocks for each pistol out of 10 blocks for each distance), armed with 9 mm ammunition (elastic bullets of traumatic effect) within 30 minutes of removing the blocks from the refrigerator. The pistols were fixed in a vice before firing.

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

The Committee on Bioethics of National Pirogov Memorial Medical University, Vinnytsia (protocol No. 11 of 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. Shots fired at close range from the AE790G1 caused damage (minus fabric) to the jeans material (Fig. 1), irregularly rounded, with dimensions ranging from 1.1x1.1 cm to 1.3x1.3 cm. The edges of the damage are uneven, fringed, in the form of small flaps. There are tears extending from the edges of the defect, sometimes cross-shaped, from 0.4 cm to 2.1 cm long at 12, 3, 6, or 9 o'clock, respectively, on the imaginary clock face. The threads of the fabric protrude into the lumen to different lengths, are disheveled, thinned, and of light gray and gray colors. The edges of the damage are slightly turned inward (in

the direction of the bullet's flight). 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 1.9 cm. Also, around the damage and on the threads inside the damage, single (1-2 pcs.) half-burnt and unburnt gunpowder particles of irregular oblong and hemispherical shape, gray in color were found.



Fig.1. Damage to denim fabric caused by a point-blank shot from the AE790G1.

Shots fired from the AE790G1 from a distance of 25 cm result in damage (minus fabric) to the denim material (Fig. 2), rectangular or square in shape, with dimensions ranging from 0.9x0.9 cm to 0.9x1.0 cm. The end ends of the threads are disheveled and thinned, directed in the direction of the bullet's flight. There is no melting of the fibers. Around the damage, there is soot deposition up to 7 cm, which is detectable only under microscopy. Also, unburned powder particles of spherical and elongated shapes were found around the damage (10 to 15 pieces).



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

Shots from the AE790G1 from a distance of 50 cm result in damage (minus fabric) to the denim material (Fig. 3), square and rectangular in shape, measuring 0.9x0.9 cm to 0.9x1.0 cm. The end ends of the threads are disheveled and thinned, directed in the direction of the bullet flight. There is no melting of the fibers. Also, single (2-3 pcs.) half-burned dust particles were found around the damage.

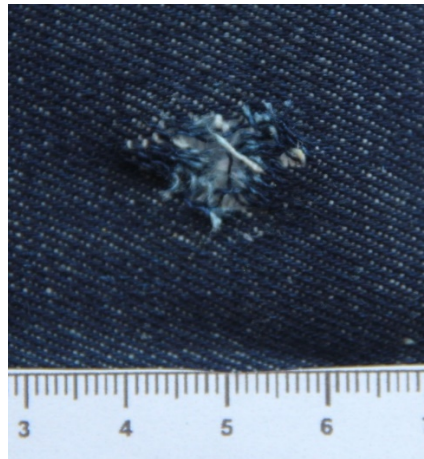


Fig.3. Damage to denim fabric when shot with the AE790G1 from a distance of 50 cm.

Shots fired at close range from Fort 12R caused damage (minus fabric) to the jeans material (Fig. 4), round in shape, measuring from 0.9x0.9 cm to 0.8x1.0 cm. The edges of the damage are uneven, fringed, in the form of small flaps. The threads of the fabric base protrude into the lumen to different lengths, are disheveled, thinned, light gray and gray in color. The edges of the damage are slightly turned inward (in the direction of the bullet's flight). Around the damage there is a concentric deposition of soot of dark gray and blackish gray colors 0.2 cm wide with an outer diameter of up to 1.1 cm. Also, around the damage and on the threads inside the damage, single (2-4 pcs.) half-burnt and unburnt gunpowder particles of irregular oblong and hemispherical shape, gray in color, were found.



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

Shots from the Fort 12R from a distance of 25 cm resulted in damage (minus fabric) to the jeans material (Fig. 5), square in shape, measuring 0.9x0.9 cm. The end ends of the threads are disheveled and thinned, directed in the direction of the bullet flight. There is no melting of the fibers. Around the damage, there is soot deposition at a distance of up to 6 cm, which is detected only by microscopy. Also, unburned powder particles of spherical and elongated shapes (5-10 pieces) were found around the damage.



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

Shots from Fort 12R from a distance of 50 cm result in damage (minus fabric) to the jeans material (Fig. 6), rectangular in shape, measuring 0.7x0.9 cm. The end ends of the threads are disheveled and thinned, directed in the direction of the bullet flight. There is no melting of the fibers. Also, single (2-3 pcs.) half-burned dust particles were found around the damage.



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

The study of clothing in the domestic and foreign literature is mostly limited to determining the accumulation of residual shot components [8], while the analysis of the damage itself is often overlooked. Such works are few in number.

Thus, in Ukraine, one of the first publications in this area was the study by Gunas V.I. with co-authors [9], where a human torso simulator made of 10% gelatin and dressed in cotton knitwear was used. Legin G.O. and others [10] conducted a study to investigate the features of damage to eyeglasses when shot from different types of non-lethal weapons at different shot distances, which allowed them to form typical damage patterns that can be used to identify the specified parameters.

In Ukraine, Shcherbak V.V. studied the damage to denim fabric [11]. In his work, he made point-blank shots from a Fort 12 pistol at samples of denim fabric with a subsequent macroscopic description of the resulting damage. The size of the damage ranged from 1.0×0.9 to 1.2×1.0 cm; the number of described tears ranged from 2 to 4, with a length of 0.7 to 1.5 cm. Compared to the data we obtained (Fort 12R), Fort 12 causes a larger defect and the formation of tears in clothing, which we did not detect at all, indicating a significant effect of additional factors of the shot.

Conclusions. Thus, as a result of a series of experimental shots, we have established the existence of minor differences in the macroscopic picture of denim when it is shot as a component of the complex «clothing + non-biological human body imitator». The most striking differences are observed at close range shots, where AE790G1 creates larger fabric defects with the formation of tears. At other shot distances, the differences are insignificant, which does not allow macroscopic examination to be used independently to determine the shot distance and identify the weapon.

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