DOI: https://doi.org/10.17816/fm16086

Comparative characteristic of clothing and human body simulator gunshot damage after firing with 12-gauge cartridges loaded with expanding and non-expanding slug

Pavel V. Pinchuk[1, 2], Sergey V. Leonov[1, 3], Andrey V. Khodulapov[1], Artem S. Likhachev[4]

[1] Chief State Center for Forensic Medicine and Forensic Expertise 111, Moscow, Russia;
[2] The Russian National Research Medical University named after N.I. Pirogov, Moscow, Russia;
[3] Russian University of Medicine, Moscow, Russia;
[4] Russian Federal Centre for Forensic Expertise under the Ministry of Justice of the Russian Federation, Moscow, Russia

ABSTRACT

BACKGROUND: The study of gunshot damage after firing with 12-gauge cartridges loaded with expanding slugs is interesting, because it has been undescribed in the modern forensic literature.

AIM: To study clothing and the human body simulator experimental gunshot damage after firing with 12-gauge cartridges loaded with expanding and non-expanding slugs.

MATERIALS AND METHODS: Visual and metric methods were used. The process of slug penetration to target was recorded with a high-speed Phantom VEO video camera 710S, with a Zeiss Milvus 1.4/35 lens. Video shooting at a frequency of 24,000 frames per second was conducted.

RESULTS: Clothing and the human body simulators experimental gunshot injuries after firing with 12-gauge cartridges loaded with expanding and non-expanding slugs was analyzed. The main differences of the gunshot damage morphological features were determined by slug terminal ballistics.

CONCLUSION: The experimental study results can be used for forensic identification of structurally similar slugs of 12-gaude cartridges UNO 35 and UNO 35E by the morphological features of the biological tissues and clothing gunshot damage.

Keywords: gunshot damage; expanding slug; high-speed video; experiment.

To cite this article:
Pinchuk PV, Leonov SV, Khodulapov AV, Likhachev AS. Comparative characteristic of clothing and human body simulator gunshot damage after firing with 12-gauge cartridges loaded with expanding and non-expanding slug. *Russian Journal of Forensic Medicine.* 2024;10(3):295–304. DOI: https://doi.org/10.17816/fm16086

Received: 03.11.2023 **Accepted:** 15.12.2023 **Published online:** 06.09.2024

DOI: https://doi.org/10.17816/fm16086

Сравнительная характеристика огнестрельных повреждений имитаторов одежды и тела человека, причинённых экспансивными и неэкспансивными свинцовыми пулями патронов огнестрельного оружия 12-го калибра

П.В. Пинчук[1, 2], С.В. Леонов[1, 3], А.В. Ходулапов[1], А.С. Лихачев[4]

[1] Главный государственный центр судебно-медицинских и криминалистических экспертиз, Москва, Россия;
[2] Российский национальный исследовательский медицинский университет имени Н.И. Пирогова, Москва, Россия;
[3] Российский университет медицины, Москва, Россия;
[4] Российский федеральный центр судебной экспертизы при Министерстве юстиции Российской Федерации, Москва, Россия

АННОТАЦИЯ

Обоснование. Изучение огнестрельных повреждений, причинённых в результате выстрелов из гладкоствольного оружия пулями с экспансивными свойствами, т.е. разрушающимися при контакте с мишенью, представляет интерес, поскольку они практически не описаны в современной судебно-медицинской литературе.

Цель исследования — изучить в эксперименте особенности повреждений имитаторов одежды (бязевых мишеней) и тела человека (части туши свиньи) конструктивно сходными экспансивными и неэкспансивными пулями патронов для огнестрельного гладкоствольного оружия 12-го калибра (12×70) с последующим сравнительным анализом их морфологических особенностей.

Материалы и методы. Исследование проведено с использованием визуального и метрического методов. Процесс взаимодействия пуль с экспериментальными мишенями фиксировался на высокоскоростную видеокамеру Phantom VEO 710S с объективом Zeiss Milvus 1.4/35, видеосъёмка велась с частотой 24 000 кадров в секунду.

Результаты. Проведён сравнительный анализ морфологических особенностей экспериментальных огнестрельных повреждений имитаторов одежды (бязевых мишеней) и тела человека, причинённых экспансивными и неэкспансивными пулями для огнестрельного гладкоствольного оружия 12-го калибра. Установлено, что основные различия в морфологических особенностях рассматриваемых огнестрельных повреждений определяются терминальной баллистикой пуль.

Заключение. Результаты экспериментального исследования могут быть применены при экспертном решении вопроса о медико-криминалистической идентификации конструктивно сходных пуль к патронам 12-го калибра (12×70) «УНО 35» и «УНО 35Э» по морфологическим особенностям причинённых ими огнестрельных повреждений биологических тканей и одежды.

Ключевые слова: огнестрельная травма; экспансивная пуля; высокоскоростная видеосъёмка; эксперимент.

Как цитировать:
Пинчук П.В., Леонов С.В., Ходулапов А.В., Лихачев А.С. Сравнительная характеристика огнестрельных повреждений имитаторов одежды и тела человека, причинённых экспансивными и неэкспансивными свинцовыми пулями патронов огнестрельного оружия 12-го калибра // Судебная медицина. 2024. Т. 10, № 3. С. 295–304. DOI: https://doi.org/10.17816/fm16086

Рукопись получена: 03.11.2023 **Рукопись одобрена:** 15.12.2023 **Опубликована online:** 06.09.2024

DOI: https://doi.org/10.17816/fm16086

12 口径枪支的中空弹和非中空弹对衣服和人体仿制品造成枪伤的比较特征

Pavel V. Pinchuk[1, 2], Sergey V. Leonov[1, 3], Andrey V. Khodulapov[1], Artem S. Likhachev[4]

[1] Chief State Center for Forensic Medicine and Forensic Expertise 111, Moscow, Russia;
[2] The Russian National Research Medical University named after N.I. Pirogov, Moscow, Russia;
[3] Russian University of Medicine, Moscow, Russia;
[4] Russian Federal Centre for Forensic Expertise under the Ministry of Justice of the Russian Federation, Moscow, Russia

摘要

论证。研究具有中空弹（即在接触目标时会崩裂的子弹）从滑膛枪中发射所造成的枪伤是很有意义的，因为现代法医学文献中几乎没有关于这种子弹的描述。

该研究的目的是在实验中调查 12 口径（12×70）滑膛枪支子弹的建设性相似中空弹和非中空弹对衣服仿制品（粗平布靶）和人体仿制品（猪胴体的一部分）的破坏特征，随后对其形态特征进行比较分析。

材料与方法。研究是采用目视和度量方法进行的。使用配备 Zeiss Milvus 1.4/35 镜头的 Phantom VEO 710S 高速摄像机记录子弹与实验目标之间的相互作用过程，视频记录速度为每秒 24 000 帧。

结果。对 12 口径滑膛枪支的中空弹和非中空弹造成的衣服仿制品（粗平布靶）和人体实验枪伤的形态特征进行了比较分析。实验结果表明了，枪伤形态特征的主要差异是由子弹的终点弹道决定的。

结论。实验研究的结果可用于专家解决医学和法医学鉴定问题，即根据 12 口径（12×70）“UNO 35”和“UNO 35E”子弹对生物组织和衣物造成的枪伤的形态特征，鉴定与这两种子弹结构相似的子弹。

关键词：枪伤；中空弹；高速录像；实验。

引用本文：
Pinchuk PV, Leonov SV, Khodulapov AV, Likhachev AS. 12 口径枪支的中空弹和非中空弹对衣服和人体仿制品造成枪伤的比较特征. *Russian Journal of Forensic Medicine.* 2024;10(3):295–304. DOI: https://doi.org/10.17816/fm16086

收到：03.11.2023 **接受：**15.12.2023 **发布日期：**06.09.2024

BACKGROUND

Gunshot bullet damage to clothing and human body simulators has been well-studied concerning rifled [1–3] and limited-damage firearms [4]. Gunshot damage caused by smoothbore weapons, especially using bullets with expanding properties (i.e., disintegrating upon contact with the target), has not been described extensively in modern forensic literature [5–8]. Concurrently, hunting cartridges for 12-gauge smoothbore weapons, including those loaded with expanding bullets, are easily available in the Russian civil weapons market and can be used during crimes. Identification of a wound-causing projectile based on the morphological features of gunshot damage to tissues and clothing is a vital task in forensic medical and criminalistic examination. In the presence of a firearm projectile in the lumen of a dull wound channel, an accurate analysis by the expert may be difficult. However, in the case of a through-and-through wound (especially with structural similarity to several projectiles), identification may be difficult [1].

The study experimentally investigated the characteristics of damage to clothing (coarse calico targets) and the human body imitators by structurally similar expanding and non-expanding lead caliber bullets of 12-gauge (12×70) smoothbore firearm cartridges with a subsequent comparative analysis of their morphological characteristics.

MATERIALS AND METHODS

Study design

An experimental single-center, one-stage, selective, uncontrolled, unblinded study was conducted. Research stages included a study of the medical literature, the creation of experimental targets, shooting at the experimental targets in forensic shooting ranges while filming using high-speed video, a description of the experimental damage to clothing and human body imitators, their comparative analysis, and a discussion of the results.

Criteria of conformity

Experimental gunshot damage to clothing (cotton calico) and human body (parts of a pig carcass) imitators were studied. The selection criteria were the central location of the experimental damage on the targets. Objects with marginal damage were excluded.

Study conditions

Experimental shooting of targets was performed in the indoor shooting ranges of the 111 Main State Center for Forensic and Criminalistic Examinations of the Ministry of Defense of the Russian Federation as well as the Russian Federal Center for Forensic Examination under the Ministry of Justice of the Russian Federation.

Study duration

The one-time study was conducted in May and June 2023.

Experiment description

The shots were fired from fore-end reloading smoothbore shotguns of the Hatsan Escort and Winchester model 1300 Defender 12-gauge with a barrel without a tapered bore (cylinder). The shots consisted of UNO 35E cartridges (Fig. 1) with expanding (frangible) bullets (according to the manufacturer's declaration) and UNO 35 loaded with bullets without expanding properties, as declared by the manufacturer.

The bullets of the specified cartridges were almost completely identical from the design point of view. They were of a full bore, lead, turbine type, 1.8 cm in diameter at the base, 1.8 cm in height, weighing 35±0.1 g, and having a green polymer paint coating on the outside. Into the rear part of the bullets, green polymer shanks were integrated, which could not be separated manually. The visible part of the shank was cylindrical with six wedge-shaped notches in the upper part. The shank diameter at the base was 1.8 cm, and the height of the visible part was 1.8 cm. The fore part of the expanding bullet had a hemispherical depression with a diameter of 0.5 cm and a depth of 0.4±0.1 cm, ensuring its fragmentation into at least five fragments upon hitting the target. The fore part of the bullet without expanding properties had a hemispherical protrusion with a basal diameter of 1 cm and a height of 0.5 cm (Fig. 1).

The targets were multi-component structures consisting of a wooden block (or a rigid substrate made of chipboard), to which biological imitators of the human body, namely parts of a pig carcass (pork belly, brisket with ribs, and breastbone) with a thickness of 5±0.5 cm were attached. These were wrapped in white cotton fabric (coarse calico) with an admixture of viscose (⩽5%).

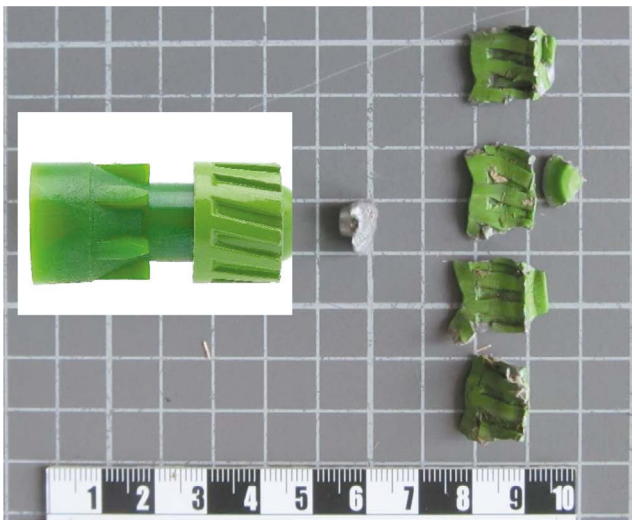

Fig. 1. UNO 35E cartridge slug before (*left*) and after (*right*) target penetration.

DOI: https://doi.org/10.17816/fm16086

Multi-component targets were assembled, representing parts of the pork belly and brisket, separated by a block of sculpted plasticine 3±0.1 cm thick, fixed in a rigid frame, and covered with calico fabric on one side to study the morphological features of the wound channel and exit wounds on the bioimitator skin. The coarse calico and bioimitators were examined visually and metrically to ascertain the dimensional and morphological characteristics of the gunshot damage.

In total, ten shots were fired at the experimental targets with UNO 35 and 35E cartridges. During the experiments, a bullet trap with a kevlar filler was installed behind the targets. The distance from the muzzle of the weapon to the targets in all experiments was 5 m (to exclude the impact of the accompanying factors of the shots).

Methods of recording the outcomes

The process of interaction of the bullets with the targets was video recorded with a Phantom VEO 710S high-speed video camera equipped with a Zeiss Milvus 1.4/35 lens at a frequency of 24,000 frames per second. The dimensions of the experimental gunshot damage were measured with a metal ruler with a 1 mm division value. The gunshot damage was photographed with a Canon PowerShot SX 130 IS digital camera, equipped with a Canon Zoom lens 12xIS 5.0–60.0 mm 1:3.4–5.6, per the rules of forensic and scientific photography.

Statistical analysis

The results were not statistically analyzed.

Ethical considerations

The studies were conducted per the principles outlined in the Helsinki Declaration of the World Medical Association, taking into account the prevailing editions. When analyzing the materials, the requirements of the Federal Law of July 27, 2006, No. 149-FZ were considered[1].

RESULTS

Study objects (participants)

Cuts of cotton calico (20 samples), biological imitator carcasses (30 samples), and plasticine blocks (30 pieces) with experimental gunshot wounds were used.

Main results

Damage to the experimental targets by a bullet of a cartridge without expanding properties. When shooting on experimental targets with a bullet of the UNO 35 cartridge (without expanding properties), through gunshot wounds on the calico and in the tissue material in the form of round-shaped defects with a diameter of 1.7±0.1 cm without radial ruptures were observed in all cases (Fig. 2*a*). The damage edges were formed by unevenly interrupted, unbraided, and flattened edge threads with deformed fibers interrupted at different levels.

On the skin of biological imitators, the gunshot entry wounds appeared as rounded defects (minus tissue) with a diameter of 1.7±0.1 cm (Fig. 2*b*). The abrasion collar had a width of ⩽0.1 cm. The exit holes had a stellate shape with a centrally located, round tissue defect (minus tissue) with a diameter of 1.8±0.2 cm (Fig. 2*c*). In the distal part of the gunshot wound lumen, small (⩽0.1×0.1×0.1 cm) bullet particles with a polymer coating were identified.

In the plasticine block, the gunshot damage had the form of a tapered expanding channel with oblique longitudinal (relative to the channel axis) tracks, which are a negative display of the relief of the bullet side surface. The entrance holes were round with a diameter of 2.1±0.1 cm. The exit holes were also round but slightly larger, with a diameter of 2.3±0.1 cm.

In the bullet trap behind the target, a bullet with a deformed (expanded to a diameter of 2±0.1 cm) head part with a worn polymer coating was caught.

Damage to the experimental targets with a bullet of a cartridge with expanding (frangible) properties. When experimental targets were hit with bullets from the UNO 35E cartridge, irregular stellate-shaped through-and-through gunshot wounds along with rounded fabric material defects in the center having a diameter of 1.8±0.1 cm were observed on the calico. From the defects, 3–5 radial ruptures with a length of 1.5±0.5 cm were extended, which passed along the warp and weft lines of the material (Fig. 3*a*). The defect edges were formed by unevenly interrupted, unbraided, and flattened edge threads with deformed fibers interrupted at varying levels. The radial rupture edges were created by unbraided edge threads with elongated fibers interrupted at different levels.

On the skin of the biological imitators, the gunshot entry holes appeared as rounded defects (minus tissue) with a diameter of 1.7±0.1 cm (Fig. 3*b*). The abrasion collar had a width of ⩽0.1 cm. In one-third of the cases, mainly with damage to the biological imitators without bone structures, 3±1 radial skin ruptures with a length of 1±0.5 cm and a depth penetrating up to the muscle tissue extended from the tissue defect edges (Fig. 3*c*).

In the plasticine block, the gunshot wounds appeared as conically expanding channels with oblique longitudinal (relative to the channel axis) tracks, which are a negative reflection of the lateral surface relief of the bullet, as well as recessed, centrifugally diverging sections with tracks

[1] Federal Law of 27.07.2006 N 149-FZ "On Information, Information Technologies and Information Protection" (with amendments and additions). Access mode: https://base.garant.ru/12148555/?ysclid=lztocxd2e4734924924.

Fig. 2. Experimental gunshot damage after firing UNO 35 cartridge: *a* — on cotton fabric; *b* — an entrance gunshot hole at biological simulator skin; *c* — an exit gunshot hole at biological simulator skin.

Fig. 3. Experimental gunshot damage after firing UNO 35E cartridge: *a* — on cotton fabric; *b* — an entrance gunshot hole without pronounced radial tears at biological simulator skin; *c* — an entrance gunshot hole with pronounced radial tears at biological simulator skin; *d* — exit gunshot holes at biological simulator skin (*marked with red arrows*).

indicating the bullet opening. The entrance holes were round with a diameter of 2.5±0.1 cm. The exit holes were also round but had a slightly larger diameter of 3±0.2 cm.

The formation of 2–5 exit wounds, mostly slit-shaped, measuring 2±0.5×0.5±0.3 cm was registered on the skin (Fig. 3d). An irregularly shaped tissue defect (minus tissue), measuring 0.6±0.4×0.2±0.1 cm was detected in half of the cases; while in the remaining, the exit wounds edges showed no tissue defects. Multiple (≤0.5×0.3×0.2 cm) bullet particles with a polymer coating were found in the distal part of the gunshot wound lumen. In one-third of the cases with damage to several bone-containing structures of the biological simulators (ribs and sternum), blunt-through wounds were formed containing the bullet shank and/or its large-sized fragments measuring 1.7±0.5×1.6±0.1×0.6±0.3 cm in the wound lumen.

Bullet fragments were noted in the bullet trap behind the target.

A characteristic comparison of the morphological features of the gunshot wounds of the experimental targets is presented in Table 1.

DISCUSSION

The main differences in the morphological characteristics of the gunshot wounds were determined based on the terminal ballistics of the bullets. Due to the presence of a recess in the head part, the UNO 35E bullet was destroyed upon hitting the biological simulator and its fragments penetrated the tissues as independent missiles, forming several exit wounds. The non-expanding bullet UNO 35 was unfragmented, but only deformed in the head part, forming classical gunshot damage with a rectilinear, tapered expanding channel along the bullet movement and one exit hole. The destruction of UNO 35E transfers a greater part of the kinetic energy in comparison with UNO 35, as indicated by variations in the morphological characteristics of the exit damage. The UNO 35 bullet exits the target with kinetic energy sufficient to achieve penetrating action (minus-tissue defect in 100% of the exit wounds), compared to 50% with the UNO 35E bullet, including blunt-through damage. The high-speed video revealed that (Fig. 4), when an expanding bullet hits, an extensive temporary pulsating cavity is formed in the soft

Table 1. Experimental gunshot injuries morphology comparative characteristic

Characteristic	UNO 35	UNO 35E
	without expanding properties	expanding
The shape of the entry injury on the calico	Rounded	Stellate
Radial ruptures in calico	No	Yes, from 3 to 5
The shape of the entry hole on the skin	Rounded	Rounded
Radial ruptures in the skin, spreading from the entry hole	No	Yes, 30% of the cases
Features of the wound channel	Rectilinear, wedge-shaped expanding	Branching
Maximum size of bullet fragments in the wound channel	0.1×0.1×0.1 cm	2.2×1.7×0.9 cm
Exit hole on the skin	Single	Multiple
The shape of the exit hole on the skin	Stellate with a rounded tissue defect (minus tissue) in the center	Mostly slit-shaped with or without a tissue defect
Minus tissue defect in the exit hole on the skin	Yes, corresponding to the diameter of the head of the deformed bullet	Yes, 50% of the cases

Fig. 4. Frame-by-frame reproduction of the target hit process by the UNO 35E cartridge slug.

tissues, causing marginal radial ruptures both on the clothing and the skin of the biological imitators adjacent to the entry hole, highly similar to the damage caused in the first zone of the close range of the shot (Fig. 4).

CONCLUSION

The results of this study can be used by experts in the forensic medical identification of structurally similar bullets for 12-gauge (12×70) cartridges, UNO 35 and UNO 35E, based on the morphological features of the gunshot damage they cause to biological tissues and clothing.

ADDITIONAL INFORMATION

Funding source. This study was not supported by any external sources of funding.

Competing interests. The authors declare that they have no competing interests.

Authors' contribution. All authors made a substantial contribution to the conception of the work, acquisition, analysis, interpretation of data for the work, drafting and revising the work, final approval of the version to be published and agree to be accountable for all aspects of the work. S.V. Leonov, P.V. Pinchuk, A.V. Khodulapov, A.S. Likhachev — organization and experimental shooting, review and approve the final manuscript; A.V. Khodulapov — draftig of the manuscript; P.V. Pinchuk, S.V. Leonov, A.S. Likhachev — critical revition of the manuscript for important intellectual content.

REFERENCES

1. Popov VL, Shigeev VB, Kuznetsov LE. *Forensic ballistics.* Saint Petersburg: Gippokrat; 2002. 656 p. (In Russ).

2. Molchanov VI. *Some issues of forensic medical examination of gunshot injuries (Determination of the type and features of the wounded projectile. Influence of obstacles on the character of injuries)* [dissertation abstract]. Place of defence: Military Medical Academy of the Order of Lenin named after S.M. Kirov. Leningrad; 1965. 20 p. (In Russ).

3. Molchanov VI, Popov VL, Kalmykov KN. *Gunshot injuries and their forensic medical expertise.* Moscow: Meditsina, 1990. 270 p. (In Russ).

4. Gonikshtein YG, Kislov MA, Leonov SV, et al. *Forensic medical examination of injuries caused by shots from non-lethal (traumatic) weapons.* Moscow: Mozartika; 2020. 346 p. (In Russ).

5. Smusin YS. *Forensic medical examination of injuries by shots from hunting rifle.* Leningrad: Meditsina; 1971. 191 p. (In Russ).

6. Lisitsyn AF. *Materials of forensic examination of injuries from smooth-bore hunting weapons* [dissertation abstract]. Place of defence: Military Medical Academy of the Order of Lenin named after S.M. Kirov. Leningrad; 1959. 16 p. (In Russ).

7. Gusentsov AO, Kil'dyushov EM. Impact of projectile incidence angle with obstacle during ricochet on the damage characteristics formed in smoothbore weapon shot. *Forensic medical expertise.* 2023;66(3):14–17. EDN: ZDRIUU doi: 10.17116/sudmed20236603114

8. Makarov IY, Potapov EA, Lorents AS. Possibility of determining «Paradox» and «Lancaster» barrel boring type by human body gunshot wounds morphology and clothing defects. Forensic medical expertise. 2022;65(3):54–58. EDN: DRCTVP doi: 10.17116/sudmed20226503154

СПИСОК ЛИТЕРАТУРЫ

1. Попов В.Л., Шигеев В.Б., Кузнецов Л.Е. Судебно-медицинская баллистика. Санкт-Петербург: Гиппократ, 2002. 656 с.

2. Молчанов В.И. Некоторые вопросы судебно-медицинской экспертизы огнестрельных повреждений (Определение вида и особенностей ранившего снаряда. Влияние преград на характер повреждений): Автореф. дис. ... д-ра мед. наук. Место защиты: Воен.-мед. ордена Ленина акад. им. С.М. Кирова. Ленинград, 1965. 20 с.

3. Молчанов В.И., Попов В.Л., Калмыков К.Н. Огнестрельные повреждения и их судебно-медицинская экспертиза. Москва: Медицина, 1990. 270 с.

4. Гоникштейн Ю.Г., Кислов М.А., Леонов С.В., и др. Судебно-медицинская экспертиза повреждений, причиненных выстрелами из нелетального (травматического) оружия. Москва: Мозартика, 2020. 346 с.

5. Смусин Я.С. Судебно-медицинская экспертиза повреждений выстрелами из охотничьего ружья. Ленинград: Медицина, 1971. 191 с.

6. Лисицын А.Ф. Материалы судебно-медицинской экспертизы повреждений из гладкоствольного охотничьего оружия: Автореф. дис. ... канд. мед. наук. Место защиты: Воен.-мед. ордена Ленина акад. им. С.М. Кирова. Ленинград, 1959. 16 с.

7. Гусенцов А.О., Кильдюшов Е.М. Влияние угла встречи пули с преградой при рикошете на характеристику повреждений, образующихся при выстреле из гладкоствольного оружия // Судебно-медицинская экспертиза. 2023. Т. 66, № 3. С. 14–17. EDN: ZDRIUU doi: 10.17116/sudmed20236603114

8. Макаров И.Ю., Потапов Е.А., Лоренц А.С. О возможности судебно-медицинской диагностики типа сверловки канала ствола «Paradox» и «Lancaster» по морфологии огнестрельных ранений тела человека и повреждений одежды // Судебно-медицинская экспертиза. 2022. Т. 65, № 3. С. 54–58. EDN: DRCTVP doi: 10.17116/sudmed20226503154

AUTHORS' INFO

*** Sergey V. Leonov,** MD, Dr. Sci. (Medicine), Professor;
address: 3 Hospitalnaya square, 105094 Moscow, Russia;
ORCID: 0000-0003-4228-8973;
eLibrary SPIN: 2326-2920;
e-mail: sleonoff@inbox.ru

Pavel V. Pinchuk, MD, Dr. Sci. (Medicine), Professor, Assistant Professor;
ORCID: 0000-0002-0223-2433;
eLibrary SPIN: 7357-3038;
e-mail: pinchuk1967@mail.ru

Andrey V. Khodulapov;
ORCID: 0000-0001-7165-2960;
eLibrary SPIN: 5174-8374;
e-mail: andrey-corsar@yandex.ru

Artem S. Likhachev;
ORCID: 0000-0003-0816-0204;
e-mail: sbl@sudexpert.ru

* Corresponding author / Автор, ответственный за переписку

ОБ АВТОРАХ

*** Леонов Сергей Валерьевич,** д-р мед. наук, профессор;
адрес: Россия, 105094, Москва, Госпитальная площадь, д. 3;
ORCID: 0000-0003-4228-8973;
eLibrary SPIN: 2326-2920;
e-mail: sleonoff@inbox.ru

Пинчук Павел Васильевич, д-р мед. наук, профессор, доцент;
ORCID: 0000-0002-0223-2433;
eLibrary SPIN: 7357-3038;
e-mail: pinchuk1967@mail.ru

Ходулапов Андрей Васильевич;
ORCID: 0000-0001-7165-2960;
eLibrary SPIN: 5174-8374;
e-mail: andrey-corsar@yandex.ru

Лихачев Артем Сергеевич;
ORCID: 0000-0003-0816-0204;
e-mail: sbl@sudexpert.ru