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EXPANSION WEAPONS AND THEIR WOUNDING POTENTIAL

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Abstract

In the world, there is an increasing trend in the use of weapons. This trend is also reflected in expansion weapons. For example, in the Czech Republic, the increase is quite marked. This is both legal use in defense and illegal use. This fact needs to be addressed. This article deals with the wounding potential of expansion weapon. A ballistic experiment was used to Assess the potential of the expansion weapon. A non-homogeneous block of ballistic gelatin was shot by an expansion weapon from a relative proximity. Sprue tracking was recorded using a high-speed camera. The monitored parameters were the shape, dimensions and volume of the permanent and temporary cavity created in ballistic gelatin. Subsequently, the injury profile method was applied. The results were subjected to quantitative and qualitative assessment. The acquired findings can be used in the field of forensic medicine, war surgery, traumatology and experimental ballistic balancing.

Keywords: ballistics; expansion weapon; ballistic experiment; injury profile

1. Introduction

Weapons that are included in the Czech Republic in category D have a demonstrably lower wounding potential than weapons from categories A, B or C. This is one of the reasons why wounding ballistics do not pay as much attention to them as to weapons of other categories. Still, some attention is paid to them, for example: C.M. Milroy and his collective achieved interesting results in the article Air Weapon Fatalities [1]. In the article, the authors focused gas firearms. In their article Analysis of the Wounding Effect of Elementary Weapons of Category D [2], M. Gracla, A. Chocholatý and Z. Maláník analysed the wounding effect of selected weapons of category D. The findings are particularly valuable for police forces.

Wounding potential was also the focus of authors Carr, D. J., T. Stevenson, and P. F. Mahoney in their publication The use of Gelatine in Wound Ballistics [3], or Mahoney, P., D. Carr, R. Arm, I. Gibb, N. Hunt, and R. J. Delaney in their article Ballistic Impacts on an Anatomically Correct Synthetic Skull with a Surrogate Skin/Soft Tissue Layer [4]. Both articles bring important findings. Interesting results have been achieved in the article Evolution of indoor bullet trap design by Tikal, F. [5] Mac Phee, N., A. Savage, N. Noton, E. Beattie, L. Milne, and J. Fraser examined the wounding potential of bows in their article A Comparison of Penetration and Damage Caused by Different Types of Arrow heads on Loose and Tight Fit Clothing [6]. This publication is particularly interesting, as bows are also considered weapons of category D, and the article brings valuable findings in this area.

The relatively new publication Wounding Ballistics – Technical, Forensic and Criminological Aspects by Ludvík Juříček and the collective [7] is so significant in terms of wounding ballistics that it can be described as a ballistic bible. In the article Comparison of Depth of Incomplete Penetration for Different Types of Pellets for Shooting Weapon of Category D [8], Mikuličova, M., M. Gracla, M. Ficek and A. Kunčar examine the effect of ammunition on the wounding potential of a selected weapon of category D and bring interesting findings, as they focus on ammunition and its effect on wounding potential. As you can see, there is some attention being paid to weapons of category D in terms of ballistics, but this field still has some areas that have been relatively unexplored. This is mainly due to gas firearms, which are only capable of causing an injury at a relatively close range. This is probably the reason why they have not been paid the same amount of attention as other weapons of category D. Our article is focused on the wounding potential of gas firearms and the methods of its quantitative evaluation.

2. Evaluation Methods

A method of indirect identification was used in conjunction with a ballistic experiment to determine the wounding potential (WP) of selected types of gas firearms. The experiment involved shooting a block of non-homogeneous substitute model made of substitute materials of biological tissue at close range where the barrel of the gas pistol was pressed against the surface of the block. The subsequent motion dynamics were recorded using a high-speed camera. The resulting cavity was then filled with water and its size (volume) was measured and supplemented by the profile affecting its geometrical shape.

The Powerfix Z11155 digital caliper with an accuracy of ± 0.02 mm was used to measure the distance. Umarex Walther P22 with 9 mm Walther blank rounds was selected as the test gas pistol. The substitution material block was scanned from the right side in the firing direction at a distance of 3 metres by the Olympus I-SPEED FS high-speed camera with a resolution of 1280 x 1024, aperture selectable from 200 nanoseconds and a maximum speed of 1,000,000 FPS. A scanning frequency of 20,000 FPS was used for the experiment. The substitution material consisted of ballistic gelatin in two concentrations: 20% (corresponding to skeletal muscle) and 10% (corresponding to somewhat more delicate parenchymatous tissues, such as kidneys, liver or lungs). The ballistic gelatin test block was created according to the following procedure:

The gelatin was mixed in with water at room temperature and with constant stirring (to avoid the creation of bubbles). Then the block was left for 2 hours in a refrigerator at a temperature of 10 °C. The vessel with the gelatin was then put into 40 °C water bath where it was left until the gelatin completely melted. After that, the gelatin was poured into a mould (treated with transparent vaseline) and placed into a refrigerator to solidify at 10 °C. After solidification and inspection, the gelatin block was taken out of the mould, wrapped into polyethylene film and placed into a cooling device with a set temperature of 4 °C for 36 hours (according to M. L. Fackler) to condition. The gelatine block prepared using this method was used for the experimental shooting.

Substance	t	ρ	K	η	v	c
	[°C]	[Kg.m^{-3}]	[Pa^{-1}]	[Pa.s]	[m^2.s^{-1}]	[m.s^{-1}]
Gelatin 10 %	20	1021	4,04.10^{-10}	36.0	0,03	1514
Gelatin 20 %	20	1053	3,67.10^{-10}	0,85.10^2	0,09	1535

Table 1. Physical parameters of ballistic gelatine

t – temperature, ρ – density, K – compressibility, η – dynamic viscosity, v – kinetic viscosity, c – speed of sound

The gelatin was dimensionally modified: the 20% gelatin was cut into 10 x 10 cm pieces with a thickness of 2.5 cm, which corresponds to the average thickness of back muscles (musculus latissimus dorsi) of an adult male in the lumbar area. The 10% gelatin was cut into 10 x 10 cm pieces with a thickness of 5 cm, which corresponds to the thickness of an average kidney of an adult man. The wound profile method according to M. L. Fackler and A. Malinowski is a graphical description of the effect of the shot in the block of ballistic gelatin. The wound profile describes the maximum disruption of living tissue that can be expected from the respective shot. Four components of the shot's effect on the gelatin block are evaluated: penetration of the projectile into the test bloc, size (volume) of the temporary cavity, size of the permanent cavity, and the presence of fragments (if the body of the projectile decomposes).

3. Results

Upon completion of the shooting, it was discovered that only the first layer made up of the 20% ballistic gelatin suffered damage. The resulting cavity was filled with water. The volume of water was measured to be 0.71 ml, which represents a cavity volume of 0.71 cm3.

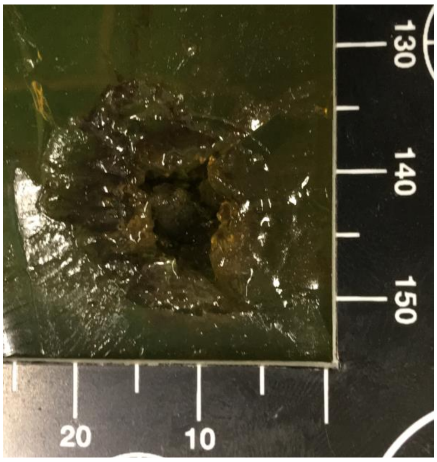

Fig. 1. Photograph of the ballistic gelatin after firing at it – permanent cavityin the 20% gelatin block made by a 9 mm gas pistol.

The figure shows the oval-shaped fracture. The cavity reached a depth of 2 cm and a diameter of 0.6 to 0.9 cm. The shape of the cavity is hard to describe, irregular and shifting with its depth. With its geometrical arrangement, the cavity is perhaps the closest to a rotating body.

Fig. 2. Photograph of the transparent ballistic gelatin after the shooting – permanent cavity in the gelatin block – penetration depth.

For the measure, the pixel size principle was used. The size of the resulting channel was measured, the number of pixels was counted, and the size of one pixel was calculated based on that. Due to the fact that the images were of the same quality, this information could be used for all the pictures taken by the high-speed camera.

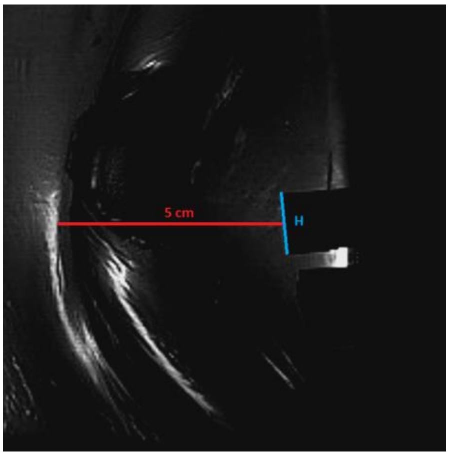

Fig. 3. Shockwave in the 20% gelatin block.

Figure 3 shows the shockwave in the ballistic gelatin block. The maximum wavelength distance from the barrel is represented by the red line that is 5 cm in length. The blue line and the letter H represent the muzzle of the gas pistol.

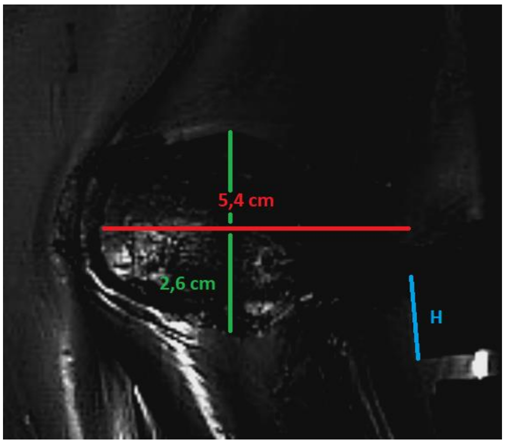

Fig. 4. Picture of the temporary cavity in the gelatin test block.

The temporary cavity is shown in Figure 4. Again, the blue line and the letter H represent the muzzle of the gas pistol. Here, too, the maximum depth is shown, which is represented by the red line that is 5.4 cm long. The diameter maximum is illustrated by the 2.6 cm long green line. The cavity is temporary and after it reached its maximum, it contracted into the size of the permanent cavity.

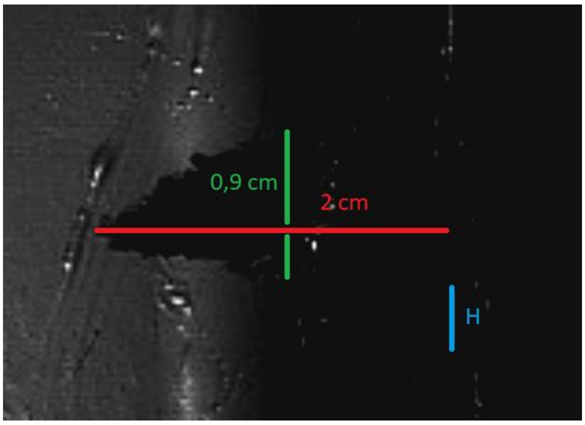

Fig. 5. Permanent cavity.

Figure 5 shows the absolute maximums of the permanent cavity. The muzzle of the pistol is also represented by the letter H and blue colour. The depth of the shot is represented by red colour with the size of 2 cm and a green height of 0.9 cm. The picture shows the permanent cavity. The stage of shrinking and expansion is over and the resulting cavity would correspond to a muscle tissue injury.

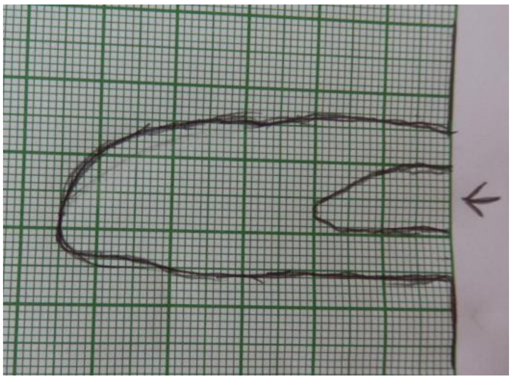

Fig. 6. Schematic view (drawing) of the wound profile.

Fig. 6 shows a graphical representation of the permanent cavity and the temporary cavity (wound profile). This is displayed on a millimetre paper. The figure makes it easy to see the difference between the size and shape of the permanent and the temporary cavities.

4. Conclusion

This article was focused on the wounding potential of a gas pistol and the evaluation of its wound ballistics. The gas firearm causes injury only at close range and the clinical severity of the injury depends on the distance. For this reason, the experiment was conducted in a way where the muzzle of the gas pistol was pressed against the surface of the substitution material and the shooting took place at an absolute close range. Sprue tracking was recorded using a high-speed camera. The monitored parameters were the shape, dimensions and volume of the permanent and temporary cavity created in ballistic gelatin. Subsequently, the injury profile method was applied. The permanent cavity caused a relatively serious injury. This can be seen on Figures 1, 2 and 5. The depth of the permanent cavity reaches up to 2 cm, and the diameter had a maximum of 0.9 cm. The average muscle tissue in an adult male reaches a thickness of approximately 2.5 cm in the lumbar area. This area is mentioned intentionally, as kidneys, which are a vital paired organ, are behind it. The substitution physical model was designed with regards to this fact: a 2.5 cm thick block of 20% ballistic gelatin substituted back muscle and the 5 cm thick block of 10% ballistic gelatin represented the kidneys. Despite the fact, as has already been said, the permanent cavity is only in the first part of the substitution (i.e. in the muscle tissue area), the temporary cavity reached more than twice the depth. The difference between both cavities is apparent on Figure 6, which represents the graphical profile of the wound. This is very dangerous, as the shock suffered by the tissues – especially the parenchymatous tissue (kidneys) – is very significant and may lead a collapse of the organ. Acute kidney failure is a possible result, which can lead to the death of the individual. It is necessary to notice that the conducted experiment did not take into account the skin, which significantly decreases the effect of the weapon. Currently, we are preparing a ballistic experiment that takes this fact (the presence of skin) into account. It will be very interesting and beneficial to observe the differences in the wounding potential of the expansion weapon in the substitution material with and without skin. In the Czech Republic, gas firearms are freely available at 18 years of age. These weapons are relatively safe. They become dangerous only when used at a very close range. In general, according to the ammunition used, the dangerous range is at tens of centimetres (up to 50 cm) up to absolute proximity (pressing the firearm against the skin). According to the distance, the firearms cause light burns (thermal injuries) up to significant tissue damage (devastating injuries). In this article, the variant with the maximum wounding potential was selected. The results obtained by this experiment may be beneficial for the field of forensic medicine, war surgery, traumatology, but also experimental wounding ballistics.

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