Z Rechtsmed (1988) 101:219–227

Zeitschrift für
Rechtsmedizin

Originalarbeiten / Original Works

The Effect of the THV Bullet in Animal Tissue

Peter J. T. Knudsen*

Defence Medical Training Centre, Jægersborg Barracks, DK-2820 Gentofte, Denmark and Institute of Forensic Medicine, University of Aarhus, Finsensgade 15, DK-8000 Aarhus C, Denmark

Summary. The Très Haute Vitesse (THV) bullet was introduced to meet the requirements of law enforcement officers, as an alternative to larger calibre fully jacketed bullets, since expanding or exploding bullets are not relevant in Europe. To examine the effect of the THV bullet in tissue, especially the size of the lesion and the degree of overpenetration, 11 recently killed pigs were shot with the weapons used by the Danish Police Force and a 9-mm pistol for reference. The ammunition was THV in the calibres 7.65 mm, 0.38, and 9 mm, using conventional fully jacketed bullets for comparison. The lesions were considerably larger when the THV bullet was used, the entry wound in particular, being roughly twice the diameter in the case of the THV bullet as compared to the fully jacketed bullet of similar calibre. Only one 7.65-mm THV bullet overpenetrated the target when fired against the thorax or abdomen of the pigs and then with only minimal residual energy. All fully jacketed 7.65-mm bullets, all 0.38 bullets, with the exception of one THV bullet, and all 9-mm bullets overpenetrated the target. The 7.65-mm THV bullet produced a lesion which in its extent resembled that of the fully jacketed 9-mm bullet, and should be a suitable alternative for the Danish Police Force.

Key words: Wound ballistics – THV bullet, the effect in animal tissue

Zusammenfassung. Das Très Haute Vitesse (THV) Geschoß wurde entwickelt, um die Forderungen der Polizei zu erfüllen. Es stellt eine Alternative zu Vollmantelgeschossen größeren Kalibers dar, da ein Geschoß, das sich verformt und explodiert, in Europa nicht gestattet ist. Um den Effekt des Geschosses im Gewebe zu untersuchen – insbesondere die Größe der Verletzungen und die Möglichkeit, das Ziel zu durchschießen – wurde auf

* *Present address:* Institute of Forensic Medicine, University of Aarhus, Finsensgade 15, DK-8000 Aarhus C, Denmark

Offprint requests to: P. J. T. Knudsen at his present address

11 kurz vorher getötete Schweine mit den Waffen der Dänischen Polizei und mit einer 9-mm Referenz-Pistole geschossen. Die Geschosse waren THV vom Kaliber 7.65 mm, 0.38 und 9 mm. Vollmantelgeschosse wurden zum Vergleich benutzt. Die Verletzungen durch die THV-Geschosse waren erheblich größer, die Eintrittswunden waren ca. zweimal so groß im Durchmesser wie die Verletzungen mit den Vollmantelgeschossen von entsprechendem Kaliber. Nur ein 7.65 mm THV-Geschoß hat das Ziel durchschossen. Alle 0.38 Geschosse – abgesehen von einem THV – und alle 9 mm Geschosse hatten das Ziel durchschossen, ungeachtet des Geschoßtypes. Die Verletzungen des 7.65 mm Geschosses waren denen des 9 mm Vollmantelgeschosses ähnlich. Das 7.65 mm THV-Geschoß scheint deshalb eine brauchbare Alternative für die Dänische Polizei zu sein.

Schlüsselwörter: Wundballistik – THV-Geschosse, vergleichende Wirkung gegenüber Vollmantelgeschossen

Introduction

The Très Haute Vitesse (THV) bullet produced by the Société Française de Munitions (SFM) for use in the hand-guns of law enforcement officers was introduced in 1981. The design of the bullet, its composition as well as its shape, aims at answering the conflicting requirements of European police forces, many of whom, by adhering to The Hague Convention of 1899, cannot use hollow-point or other expanding bullets, neither can they use bullets which explode or fragment on impact [7].

Since it has been claimed for a number of years by Danish police officers that their service pistol – the 7.65 mm Walther PP and PPK – did not possess sufficient "stopping power", there has been a demand for a more potent weapon, or alternatively a more potent ammunition. To determine whether the THV bullet would satisfy the demand, the Office of the National Commissioner of Police requested the Army Combat School to conduct a series of experiments for which it has the facilities and the experience.

Material and Methods

To determine the effect of the THV bullet in tissue, it was decided to perform test shootings on recently killed pigs. If the pigs are shot within 30 min of death, the results will reliably imitate intravital shots [5]. For an evaluation of the wounds the assistance of the Defence Medical Training Centre was requested, the author performing the autopsies. The weapons used for the experiments were:

7.65 mm Walther PP, a World War II vintage German officer's pistol, used by the uniformed police officers.

7.65 mm Walther PPK, a short barrelled version of the Walther PP, used by plain clothes policemen.

0.38 Smith & Wesson revolver, 2" barrel. Used by the security forces when acting as body guards.

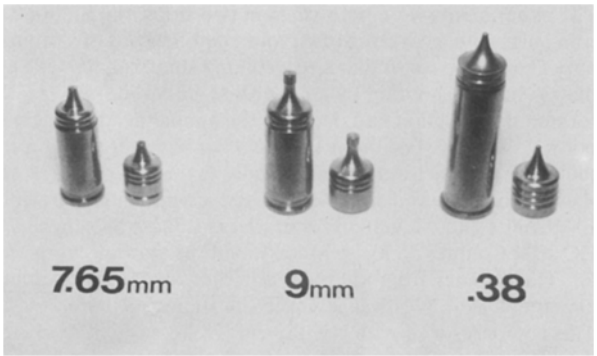

Fig. 1. THV ammunition as used in the experiments

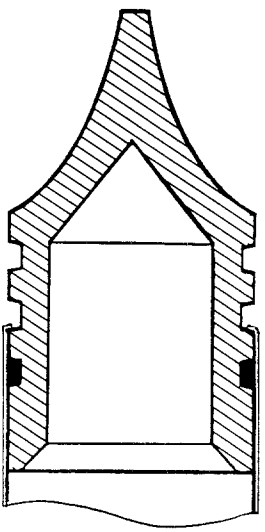

Fig. 2. Cross-sectional drawing of the THV bullet (not to scale)

9 mm Neuhausen pistol, standard officer's weapon in the Danish Armed Forces, used as a reference weapon in the experiment.

9 mm Heckler & Koch sub-machine gun, type M5A3, used by the anti-terrorist forces and special units of the Danish Police Force.

The special features of the THV bullet used in the experiment are, firstly, the negative paraboloid shape, aiming at rapid transfer of energy in the target and rapid deceleration in air giving a short range and, secondly, the cavity in the bullet making it lighter and giving space for a larger charge, leading to a high velocity (Figs. 1, 2). The bullet is made from a brass alloy and is solid apart from the cavity, minimizing the risk of the bullet breaking up on impact.

The ammunition used in the experiment was:

7.65 mm fully jacketed, weight 4.8 g.

7.65 mm THV, weight 1.6 g.

0.38 fully jacketed, weight 10.2 g.

0.38 THV, weight 2.9 g.

9 mm fully jacketed, weight 6.89 g.

9 mm THV, weight 2.9 g.

The experiments were performed in two steps, the first one using naked pigs, the second one using pigs with a covering of various combinations of clothing. The animals used were 11 ordinary Danish pigs of similar size weighing approximately. 45 kg, and they were put down immediately before shooting by an overdose of barbiturate. As soon as the veterinarian who performed the injection had declared the animal dead, it was suspended head down and marked out for shooting. For the first series, the pigs were shot in the thorax, in the abdomen and in the thighs, on each side symmetrically to the centre line, from the front. Entry and exit velocities were measured by photoelectric equipment conforming to NATO standards (OPOS Electronics Ltd.: EV 100 Photocell Transducer System, EV 120 IR Reflex Screen, and three CC 2000 Counter Velocity Meter), and the various energies were calculated.

The distance from the muzzle to the pig was approximately 7.5 m. The anterior-posterior diameter of the pigs was 25 cm in the thorax, 20 cm in the abdomen and 12 cm in the thigh. This compares well with the 183-cm, 78-kg author: 23 cm thorax, 20 cm abdomen and 15 cm thigh!

After the shooting the pigs were X-rayed so that the retained bullets could be identified. They were then taken to the autopsy room where a full autopsy was performed on the thorax and abdomen. A dissection of the wounds, including those of the thighs, was performed. The wounds were measured and described in detail and thereafter photographed as each succeeding layer of tissue was removed.

Studies of the results from the first series and test shootings at various combinations of clothing had given reason to believe that the addition of clothes, which caused deposition of energies in magnitudes of 10–20 Joules (J) using fully jacketed bullets and 20–60 J in case of the THV bullets, might have a significant effect on the retention of THV bullets fired by the small calibre pistols. Therefore, a second series of experiments was undertaken, for which shots at the thorax and abdomen were employed, as results from the first series had indicated that overpenetration and slight deceleration was seen in the thighs, no matter what type of weapon or ammunition.

The types of clothing were: (1) T-shirt and shirt, (2), T-shirt, shirt and denim jacket, and (3) T-shirt, shirt, woolen sweater and leather jacket. The numbering refers to the tables.

Results

In nearly all cases the muzzle velocity was determined, and in most cases where overpenetration took place the velocity at entry (V_{Entry}) and exit (V_{Exit}) was measured in m/s which permitted an estimation of the energy at entry (E_{Entry}), exit (E_{Exit}) and the retained energy (E_{Ret}) in Joules (J) and the percentage retained/entry energy. For comparative purposes the volume of the permanent cavity of the wound was estimated in cm^3. It was assumed that the volume of the wound produced by the fully jacketed bullet was equal to the volume of a cylindre with a diameter equal to the calibre of the bullet and a length equal to the thickness of the target [4]. In the case of the THV bullet, the volume of the wound was assumed to take the form of a truncated cone with its greater diameter corresponding to the entry wound. This shape is seen in experiments with plasticine, conserving the temporary cavity [1, 6, 8]. In the calculations the entry wound was measured, while the smaller diameter of the cone was that of the bullet's calibre, disregarding the tissues not traversed in cases without overpenetration.

The results of the ballistic measurements are most easily appreciated by looking at each type of weapon by itself (Tables 1–9). While all bullets fired at the thighs and all 0.38- and 9-mm bullets with one exception fired at the thorax

Table 1. Walther PP and PPK, fully jacketed ammunition

C	L	V_{Entry}	E_{Entry}	V_{Exit}	E_{Exit}	E_{Ret}	Vol	% Ret
0	Thigh	303	220	125	38	182	5.5	82
0	Abdomen	315	238	246	145	93	9.2	39
1	Abdomen	322	249	199	95	154	11.5	62
0	Thorax	308	228	151	55	172	11.5	76
1	Thorax	325	254	173	72	182	11.5	72
3	Thorax	316	240	161	62	178	11.5	74

C = clothing, L = location, V in m/s, E in J, Vol in cm^3

Table 2. Walther PP and PPK, THV ammunition

C	L	V_{Entry}	E_{Entry}	V_{Exit}	E_{Exit}	E_{Ret}	Vol	% Ret
0	Thigh	563	254	202	33	221	11.4	87
0	Thorax	595	283	60	3	280	26.0	99

Table 3. Smith & Wesson 0.38, fully jacketed ammunition

C	L	V_{Entry}	E_{Entry}	V_{Exit}	E_{Exit}	E_{Ret}	Vol	% Ret
0	Thigh	216	238	100	51	187	8.8	79
0	Abdomen	206	216	157	126	90	14.7	42
0	Thorax	210	225	100	51	174	18.3	77

Table 4. Smith & Wesson 0.38, THV ammunition

C	L	V_{Entry}	E_{Entry}	V_{Exit}	E_{Exit}	E_{Ret}	Vol	% Ret
0	Thigh	576	481	470	320	161	18.6	33
0	Abdomen	570	471	116	20	454	30.9	96

Table 5. Neuhausen 9 mm, fully jacketed ammunition

C	L	V_{Entry}	E_{Entry}	V_{Exit}	E_{Exit}	E_{Ret}	Vol	% Ret
0	Thigh	377	490	264	240	250	7.6	51
0	Abdomen	390	524	227	178	346	12.7	66
1	Abdomen	372	477	215	159	318	12.7	67
3	Abdomen	369	469	250	215	254	12.7	54
0	Thorax	354	432	205	145	287	15.9	66
2	Thorax	370	472	220	167	305	15.9	65

and abdomen overpenetrated the target, only one 7.65-mm THV bullet overpenetrated the thorax.

On the other hand, all 7.65-mm fully jacketed bullets overpenetrated the target. A single 0.38 bullet fired at the thorax was retained. Given the entry velocity and the weight of the bullet, it was possible to estimate the retained

Table 6. Neuhausen 9 mm, THV ammunition

C	L	V_{Entry}	E_{Entry}	V_{Exit}	E_{Exit}	E_{Ret}	Vol	% Ret
0	Thigh	590	505	323	151	354	12.7	70
0	Abdomen	592	508	200	58	450	21.1	89
1	Abdomen	596	515	128	24	491	21.1	95
3	Abdomen	600	522	206	62	460	29.7	88
2	Thorax	605	531	53	4	527	21.8	99

Table 7. Heckler & Koch M5A3 9 mm fully jacketed ammunition

C	L	V_{Entry}	E_{Entry}	V_{Exit}	E_{Exit}	E_{Ret}	Vol	% Ret
0	Thigh	395	548	340	398	150	7.6	27
0	Abdomen	402	557	256	226	331	12.7	59
0	Thorax	406	568	230	182	386	15.9	68

Table 8. Heckler & Koch M5A3 9 mm, THV ammunition

C	L	V_{Entry}	E_{Entry}	V_{Exit}	E_{Exit}	E_{Ret}	Vol	% Ret
0	Abdomen	668	647	233	79	568	29.7	88
2	Abdomen	651	615	104	16	599	27.4	97
0	Thorax	674	659	136	27	632	31.5	96

Table 9. Walther PP, PPK and Smith & Wesson 0.38[a], THV ammunition, bullets retained in the target

C	L	V_{Entry}	$E_{Entry} = E_{Ret}$	Vol
0	Thorax	558	249	21.4
1	Thorax	588	277	17.3
1	Abdomen	576	265	25.0
2	Thorax	590	278	17.3
2	Abdomen	588	277	15.4
3	Thorax	589	278	23.7
3	Abdomen	585	274	20.9
0[a]	Thorax	592	508	27.8

energy of those bullets that were retained in the target and the volume of the wound along lines similar to those above.

The injuries inflicted by the conventional fully jacketed bullets, on the one hand, and those produced by the THV bullets on the other were of a very consistent appearance. The entry wounds from the fully jacketed bullets were of slightly smaller diameter than the calibre of the bullet (Fig. 3), and the wounds were typical of their type with no discernible difference in the size of the lesion from entry to exit. The exit wounds were of differing diameters, most of them with ragged edges and distinctly larger than the entry wounds (Fig. 5).

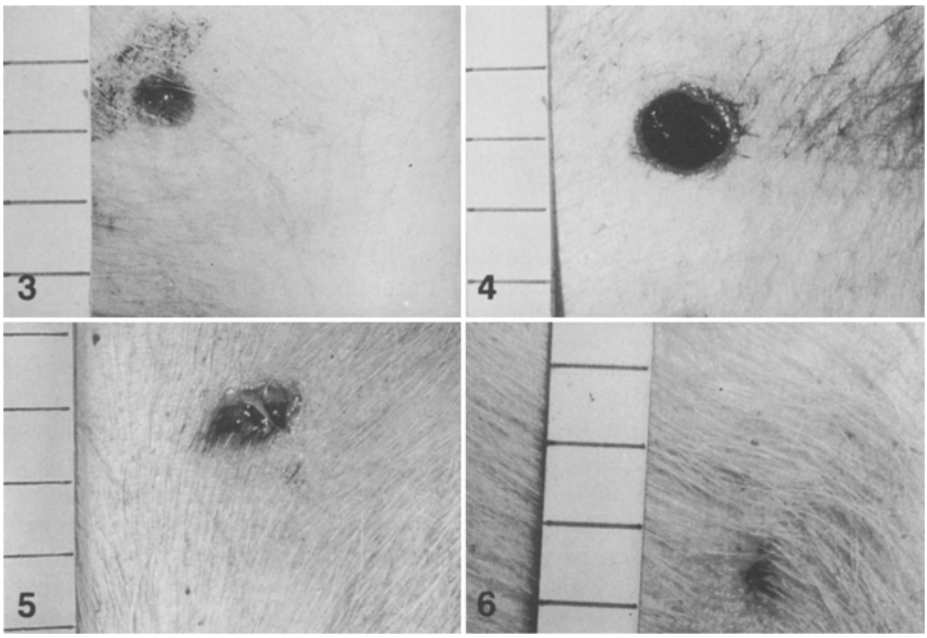

Fig. 3. Entry wound, 7.65 mm fully jacketed bullet

Fig. 4. Entry wound, 7.65 mm THV bullet

Fig. 5. Exit wound, 9 mm fully jacketed bullet

Fig. 6. Exit wound, 9 mm THV bullet

The entry wounds of the THV bullets were all round or slightly oval, with a diameter roughly twice the calibre of the bullet (Fig. 4), and none presented the star-shaped appearance illustrated by Fackler [5]. In the subcutis and deeper layers the size of the wound was retained for a short distance, quickly tapering off, and in the posterior wall of the thorax there was no subjective nor indeed measurable difference between the two types of bullets. While in some cases a quite considerable difference in the size of the lesion could be seen on the anterior aspect of internal organs, it was clearly seen that on the posterior aspect the difference was much less.

The exit wounds of the THV bullets were smaller in diameter, both as compared to those of the similar calibre fully jacketed bullets and as compared to the THV entry wound (Figs. 5, 6). As for the depth of penetration of the bullets that were retained in the target, all bullets reached the posterior wall of the thorax or of the abdominal cavity. They were found either embedded in the muscles dorsal to the spine and ribs or in the subcutaneous tissue of the back, in many instances leaving an impression from within on the skin. In others a bulge could be seen where the bullet had lodged itself. The retained bullets were intact apart from some compression, but this was so small that no expansion could be detected. There was no fragmentation of the bullet.

Discussion

The ideal ammunition for law enforcement use in Denmark possesses the following qualities:

1. Transfer of sufficient energy ("stopping power").
2. No overpenetration.
3. Short range.
4. Confirmation to The Hague Convention of 1899.
5. Certain technical points like precision, the ability to shoot through car doors, minimum recoil and acceptability by pistols, revolvers and sub-machine guns.

The reason for the investigation of the THV bullet was the alleged inferiority of the Walther PP and PPK, which have repeatedly been accused of having insufficient stopping power. Since stopping power may be defined as "... the amount of kinetic energy the impacting bullet transfers to the target" [2], the efforts to increase stopping power must lead to an increase in kinetic energy transfer, either by giving the bullet higher energy or by making it transfer a greater part of its energy to the target, or both. The THV bullet achieves higher kinetic energy by its higher velocity which more than compensates for its lower weight, and increased energy transfer by its design, which gives up more energy to the target. This obviously must result in greater lesions.

The same result might of course be attained by the use of conventional ammunition of a larger calibre, but as may be seen from Tables 2, 3, 5, and 9, the retained energies of the 7.65-mm THV bullets are higher than those of the fully jacketed 0.38 and not much lower than those of the fully jacketed 9-mm bullets, when exclusively considering shots at the thorax and abdomen. The estimated volume of the 7.65-mm THV wounds, as compared to the fully jacketed 9-mm wounds, are also on the same scale.

While the fully jacketed 9-mm bullet might thus have a slight edge in stopping power, the second consideration of overpenetration is clear-cut. Furthermore, when considering shots at the thorax and abdomen, only one 7.65-mm THV bullet overpenetrated the target, and had an E_{Exit} of only 3 J, making it harmless for all practical purposes. Even the 33 J of the 7.65-mm THV bullet passing through the thigh would hardly suffice to penetrate normal clothing and the skin. The 0.38- and 9-mm THV bullets were much more prone to overpenetration, only a single 0.38 THV bullet being retained in the target. The E_{Exit} of the large-calibre THV bullets fired at the body ranged from 4 to 79 J, which makes it unadvisable to rely on retention for these calibres.

The lack of overpenetration, which is one of the aims of the design of the THV bullet might conversely lead to a lack of penetration, rendering the bullet unable to deliver its energy to organs of a sufficient importance to stop the opponent [5]. In this set-up, all the retained bullets were found in the muscles of the back of the animal, having passed through or between the ribs, and in no cases was a vital organ in the path of the bullet spared.

Attention must be directed here to the limitations of the animal model, since the conclusions above rest on the acceptance of the range – 7.5 m – and the thickness of the animal as being representative of the real life situation. The set-

up has been chosen as the most likely for use in this country, with special reference to the use of the Walther pistol as the ordinary service weapon which is intended for the personal protection of the police officer. The addition of clothing does not appear to have a major effect on penetration, although it seems that any one of the three types of clothing does give slightly greater retention of energy when compared to no clothing. An important consideration when choosing ammunition for police use is that it should have a relatively short effective range, being often used in circumstances where many innocent bystanders may be at risk. The range of the THV bullet is much less than that of the comparable fully jacketed bullet, typically a third or so, the officially quoted ranges being: 7.65 mm: 1200 m/400 m, 0.38: 960 m/310 m, 9 mm pistol: 1550 m/500 m and 9 mm sub-machine gun: 1550 m/500 m.

The major legal constraint put upon the selection of ammunition for the Danish Police Force is the adherence to the Hague Convention of 1899, which forbids the use of expanding bullets in war [3]. It was required that the chosen bullet should not be expanding or exploding, thus outlawing hollow-point or semi-jacketed softpoint bullets, but since the THV bullet is not an expanding bullet, neither by design nor in actual use, it should not cause any legal problems. As, however, the bullet does produce more severe lesions than the comparable fully jacketed bullet hitherto used, it has been accused in the daily press of being a "dum-dum in disguise". Since the limitations of the Convention only describe the design of the bullet and not the effects, the consequences of the complaints raised would be to stop development of ammunition at the level of 1899, since it could be argued that any bullet producing larger lesions than that of a similar calibre bullet of 1899 vintage is illegal. Judging by the results of the investigation, I believe that the 7.65-mm THV bullet fulfils the criteria set for its acceptance in the Danish Police Force, on the assumption that the technical demands are met.

Whether the greater lesions, which are an inseparable consequence of the increase in retained energy, are politically acceptable will have to be seen.

Acknowledgements. The author wishes to thank the National Commissioner of the Danish Police for permission to publish the results of this investigation. The opinions expressed are those of the author exclusively, and should not be construed as being the official policy of the National Commissioner or of the Defence. The invaluable cooperation of Lt. Col. I.T. Jørgensen and Capt. C. O. Dahl of Research and Development, Army Combat School, who managed the experimental set-up, and of Mr. J. Svender, BSc, Army Artillery School, who performed the ballistic measurements, is greatly appreciated.

References

1. Clanet C (1984) A new type of high performance ammunition. Int Criminol Pol Rev 3:50–55
2. Di Mayo VJM (1974) Hollow-point pistol ammunition. Forensic Sci Gaz 5:1–2
3. Di Mayo VJM (1985) Gunshot Wounds. Elsevier, New York
4. Fackler ML, Malinowski JA (1985) The wound profile. J Trauma 25:522–529
5. Fackler ML (1987) Bullet performance misconceptions. Int Def Rev 3:369–370
6. Newman D, Yardley M (1986) New-generation small-arms ammunition. Int Def Rev 2:921–925
7. Ragsdale BD (1984) Gunshot wounds: a historical perspective. Military Med 149:301–315
8. Rolland A (1982) Die neue Patrone THV. Int Waffen-Spiegel 4:39–42

Received May 6, 1988