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Dependence Morphologic Characteristics Of Vault Bones Gunshot Fractures On Firing Range And Bullet Velocity

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Abstract: ***To discover dependence nature of entry gunshot fractures on firing range damage from point-blank, short range and long range fire was studied. Entry gunshot fracture of perforating wound and entry gunshot fracture of blunt wound caused by long range fire were studied separately. Dependence morphologic characteristics of gunshot fractures on firing range and bullet velocity was determined.***

Keywords: ***flat bones gunshot fractures, range of fire, velocity of the bullet.***

I. INTRODUCTION

The bullet with low or high velocity causes perforating or comminuted and perforating fracture [1-3]. A limited number of studies devoted to main damage (perforating fracture) [4-14].

II. METHODS

There were studied the data of 111 forensic medical examinations with fatal head gunshot (pistol Makarova). Examinations have been executed at Moscow municipal medico-legal office and Tver regional medico-legal office (table 1)

Range of fire	Wound nature	Quantity
Point-blank	Perforating	21
	Blunt	2
Short	Perforating	24
	Blunt	6
Long	Perforating	45
	Blunt	13
Sum total		111

Table 1

All cases were divided into 4 groups. Group A included cases with point-blank gunshot. Group B included cases with short range fire. Group C included cases with long range fire and perforating head wounds. Group D included cases with long range fire and blunt head wounds.

Characteristics of entry gunshot fractures were obtained by visual inspection and stereomicroscopy.

Wound hole diameters of thick outer table and thinner inner table were measured in four directions and average measure was computed.

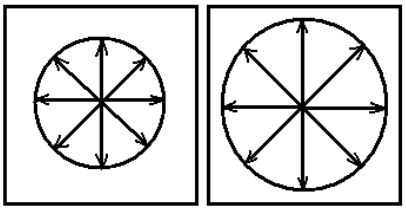


Figure 1: Wound hole diameters of thick outer table and thinner inner table determination

Quantitative assessment of bullet path shape was performed by it profile and capacity [15]:

- ✓ Bullet path capacity was obtained in terms of size.

- Cylindrical bullet path capacity was computed by formula

$$V_1=\pi d^2 h/4$$

d – inlet diameter, h – thickness of flat bone

- Cone-shaped bullet path capacity (cm^3) was computed by formula

$$V_1= \frac{1}{3}h\ (\pi d_1^2/4+ \sqrt{\pi d_1^2/4\ \pi d_2^2/4} + \pi d_2^2/4)$$

d_1 – inlet diameter, d_2 – outlet diameter, h – thickness of flat bone.

- Hour-glass shaped bullet path capacity was obtained as capacities sum of two truncated cones.

✓ After that there was obtained capacity of cylinder. Its diameter corresponds to caliber of the pistol.

$$V_2= \pi d_3^2 h/4$$

d_3 – caliber of the pistol (cm), h – thickness of flat bone.

✓ To eliminate effect of bone thickness bullet path capacity was obtained in signed numbers by formula

$$V=V_1/ V_2;$$

V_1 – bullet path capacity, V_2 – capacity of cylinder whose diameter corresponds to caliber of the pistol

Statistical data manipulation was performed.

Qualitative assessment of bullet path shape was performed by surface geometry.

III. RESULTS

In the cases with point-blank gunshot at lamina externa wound hole diameter was oval-shaped from 0.8-0.9cm to 1.0-1.4cm and it had uneven edges. (table 2, 3, figure 2, 3). On average diameter was 1,0 cm. There were three-cornered or trapezoid chips with uncovered the spongy diploe at lamina externa. Bone pieces of lamina externa were shifted out under epicranial aponeurosis which was detached and impregnated with blood. Maximal proportions of bone pieces were 2.2x0.7x0.4cm.

At lamina interna wound hole diameter was 1.5cm and it had irregular shape and uneven edges. At lamina interna three-cornered chips proportions were 0.1-0.3x0.1-0.3cm. Bullet path passed through cerebrum and accommodated flat small three-cornered and trapezoid bone pieces.

Relative number of bullet path capacity was 2.1±0.6. There were concentric ridges interchangeable with furrows onto the bullet path wall. All of the ridges and furrows were in transverse direction to bullet path axis.

In the cases with short range of fire wound hole diameter coincided with caliber of the bullet and was 0.9-1.0cm at lamina externa. It was regular and round (table 2, 3, figure 2, 3). There were equal ring-shaped chips at lamina externa 0.1-0.3cm in breadth.

At lamina interna wound holes with uneven edges were irregular and round and the diameter was 1.5cm. At lamina interna chips proportions were 0.1-0.3x0.1-0.3cm. Bullet path passed through cerebrum and accommodated flat small three-cornered and trapezoid bone pieces and crumbs of bones. Relative number of bullet path capacity was 2.1±0.3. Configuration and relief of the bullet path was like in cases with point-blank gunshot. In cases with thick bone injury irregular rectilinear one-sided chips were marked at lamina interna. At the same time oblique ridges were marked onto exit of bullet path wall.

In the cases with perforating head injuries and long range of fire at lamina externa wound holes were round with diameter 1.0cm. Irregular rectangular one-sided chips along the edges took place (table 2, 3, figure 2, 3)..

At lamina interna oval-shaped wound holes took place. On average diameter was 1,4 cm. Wound hole edges was like closed broken line with large three-cornered projection. Flat small irregular three-cornered rectangular and trapezoid bone pieces and crumbs of bones were inserted into the dura mater and bullet path wall of the cerebrum.

Relative number of bullet path capacity was 1.9±0.4. Initial part of bullet path had precipitous wall. On the middle of spongy diploe level considerable widening of path was marked. Concentric transversal ridges and furrows constituted the relief of bullet path in the initial part. Ridges and furrows of bullet path in the terminal part were oblique. There were short radial ridges and furrows at lamina interna.

In the cases with blunt head injuries and long range of fire at lamina externa wound holes were irregular and oval-shaped. Proportions of holes were from 0.9x1.1cm to 1.0x1.8cm(on average 1,0 cm). In a few cases wound hole contour was like bullet sideview (table 2, 3, figure 2, 3).

There were irregular round wound holes with diameter 1.7cm at lamina externa. Wound hole edges was like closed broken line with lengthy rectilinear sections 0.5-0.9cm length. Flat small irregular three-cornered rectangular and trapezoid bone pieces and crumbs of bones had proportions 0.6x0.3x0.1cm. Some of bone pieces were fixed and inserted into detached dura mater.

Relative number of bullet path capacity was 1.9±0.4. On spongy diploe level considerable widening of bullet path was marked. Concentric transversal ridges and furrows constituted the relief of bullet path in the initial part. Ridges and furrows of bullet path in the terminal part were radial.

Range of fire / Features	Point-blank (A)	Short (B)	Long	
			Perforating wounds (D)	Blunt wounds (C)
Wound hole diameter at lamina externa	1.0±0.3cm	1.0±0.1cm	1.0±0.1cm	1.0±0.2cm
Wound hole diameter at lamina interna	1.5±0.5cm	1.5±0.3cm	1.4±0.4cm	1.7±0.2cm
Bullet path capacity (accuracy index)	2.1±0.6 relative number	2.1±0.3 relative number (p_{1-2}=1.0)	1.9±0.4 relative number (p_{1-3}=0.23 p_{2-3}=0.07)	2.4±0.4 relative number (p_{1-4}=0.12 p_{2-4}=0.21 p_{3-4}<0.001)

Table 2: Morphologic description of vault bones gunshot fractures

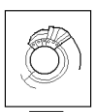
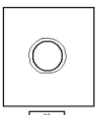
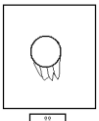
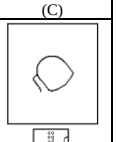
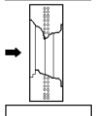
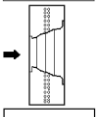
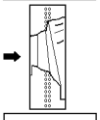
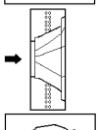
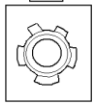
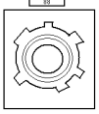
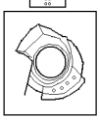
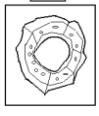
Range of fire / Location	Point-blank (A)	Short (B)	Long	
			Perforating wounds (D)	Blunt wounds (C)
lamina externa				
Canal				
lamina interna				

Table 3: Scheme of exit/entry vault bones wound hole

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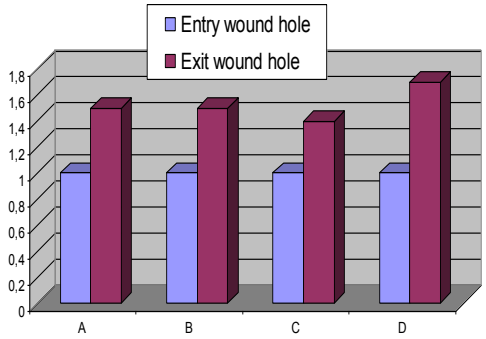

A – point-blank gunshot, B – short range of fire, C – perforating injuries and long range of fire, D – blunt injuries and long range of fire.

Figure 2: Exit/entry vault bones wound hole ratio in terms of range of fire and wound nature

IV. DISCUSSION

Dependence morphologic characteristics of gunshot (pistol Makarova) fractures on firing range and bullet velocity was established.

Dependence on firing range was characterized by permanent forming of additional lamina externa injuries which increase damage extent in cases with point-blank gunshot and short range of fire (figure 3).

In cases with point-blank gunshot and short range of fire dependence on bullet velocity was characterized by forming of exit/entry round wound holes and similar relief of bullet path wall constituted with concentric transversal ridges.

Established features are evidence of rectilinear bullet passing through the bone and synchronous fragile destruction of tissue. These features are morphologic equivalents of computed with tabular data bullet high velocity.

In cases with long range of fire change round entry wound hole for oval exit wound hole can be explained on the basis of exit wound hole deviation. It points to the fact that in bone the bullet revolves on its transverse axis with lesser velocity then it ordinarily has. Also the presence of oblique ridge on wall of terminal part of bullet path points to change of bullet line.

In cases with blunt injuries and long range of fire exit oval wound hole points to the fact that in bone the bullet revolves on its transverse axis with lesser velocity then it ordinarily has. This velocity can be experimentally computed. Also the presence of radial ridge on wall of terminal part of bullet path points to low bullet velocity.

Established features made authors study mechangenesis of gunshot fractures in detail.

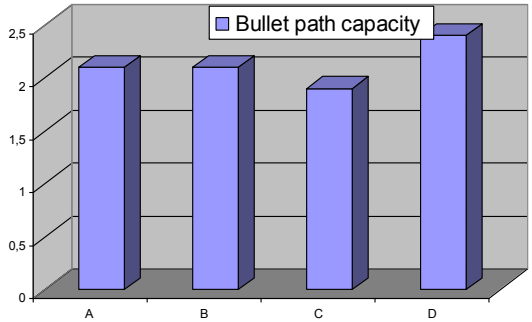

Figure 3: Bullet path capacity (in vault bones) ratio in terms of range of fire and wound nature: (relative number) A – point-blank gunshot, B – short range of fire, C – perforating injuries and long range of fire, D – blunt injuries and long range of fire

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