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A Comparative Study of Entry Impact of Projectiles on Ballistic Gel Body by using Different Firearms of the Same Calibre

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Abstract: ***Ballistics is the study of action, motion, and behavior of the projectile in any given medium. Firearms are the most commonly used weapons in cases of homicide and suicide. Currently, forensic ballistics uses the scientific methods in the courtroom to prove or disprove the involvement of alleged firearm as well as also uses the technological advancement to calculate the approximate range of firing with greater accuracy along with the possible type of firearm used. The findings of the present study show the significant difference in the impact entry hole among different firearm and projectile caliber used over several distances by the use of same caliber ammunition from the same source. The use of ballistics gel body in the study of projectile motion has been of great interest and benefit for ballistic experts and investigators. In this study use of same caliber bullets on a Ballistic Gel body (imitating the human body) by different firearms has been studied in order to assess the behavior of a particular projectile to estimate the approximate type of projectile used and also the range of firing. This was achieved by studying the entry impact on the gel body. It was established that the dimensions of the entry wound vary in case of different firearms at different distances even though the ammunition caliber remains the same.***

Keywords: Ballistics, Ballistic Gel Body, Entry impacts, Shooting distance

I. INTRODUCTION

Firearms are the most common weapons used in several homicide and suicide cases. According to the FBIin 2012, there were 8,897 total firearm-related homicides in the US, with 6,404 of those attributed to handguns[1]. Handguns are the most commonly used guns in homicide cases due to their small size which allows for easier concealment and disposal, along with less experience and training required to use them in comparison to other firearms [2].

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The terminal and wound ballistics still lack much research and improvement due to the overall difficulty of carrying out experiments in this field as per the unavailability of selected animal targets; therefore the findings of this research on ballistic gel body will be beneficial to law enforcement in some instances. The nature of gunshot wounds (GSW) over the

Fig. 1 Ballistic gel body torso (Synthetic gelatin to imitate human tissue)

The distance between the firearm and the target (gel body) has been alteredranging from 6meters, 10 meters, and 30 metersrespectively to study varying effects of the same caliber at different distances. These distances were selected as per the availability of fixed distance stations at the shooting range.

III. RESULTS AND DISCUSSIONS

The findings were mainly focused upon the entry impact formed on the target. The diameter of the entry wounds differs for each type of firearm, even though the same caliber bullets has been used.The following tables shows the variations of the measurement of the entry wounds with respect to the difference types of firearms:

For distance 6.0 m

Table 1: Variation in the entry impact in respect to different types of firearms at distance of 6.0 meter

Firearm	Glock 17 Pistol	Berretta Pistol	Carbine Rifle
Caliber (mm)	9	9	9
Entry Wound (mm)	4	5	8
Figure	2	3	4

The target is influenced by the dynamics of the projectile and the local reaction of the penetrated tissue [3].
Previously it has been observed in one study one characterization of a visco-hyperelastic synthetic gel for ballistic impacts assessment in which a study of human body response in the field of ballistics was done by using SEBS (synthetic gel-based systems) [3].
In another study on the soft body armor back face deformation with ballistics gel backing, efforts have been made to understand the deformation of personal armor systems (PAS) during an impact event using the gel body [3]. The focus of this experiment was to study the entry impact effects of different firearms with the same calibers projectile and their behavior (cavitation) inside during their travel through the ballistic gel body. For this specific purpose, a customized ballistic Gel torso made from silicone which represents the similar tensile strength of the human body was considered[4]. However, there were limitations as of not imitating the bones, flesh, etc. The study will be useful in case of the soft tissue injuries involved in the shooting incidents. Different weapons with the same caliber were utilized in this work with varying firing distances.

II. MATERIALS AND METHODS

The experiments were conducted on clear ballistic gel torso (imitating human target) (Figure 1) at Sharjah shooting range, UAE with all the due precautions and under the guidance of the firing experts. The gel body has been firmly mounted with the help of ballistics stands at each distance with stationary mounts. Two handguns were used, i.e. Glock 17 and Berretta pistol along with one Carbine rifle. In all the firearms a 9mm bullet cartridge (ammunition) was used from the same source to observe the consistency and differences on the impact entry hole. The single cartridge box was used for all three weapons to maintain the flexibility in the findings and to avoid any variations due to different ammunition source. The ballistics gel body (torso) made of synthetic ballistic gelatin which meets the FBI protocol for calibrating ballistic gelatin to match human tissue was used [5,6].
Table 1 shows that even if the same caliber of bullet is used with different firearms, the diameter of the entry wound will definitely vary and usually be larger in comparison to the farther distances. This also means the impact of the bullet on the surface does not depend only on the caliber but also on the type of the firearm and as well as the distance.

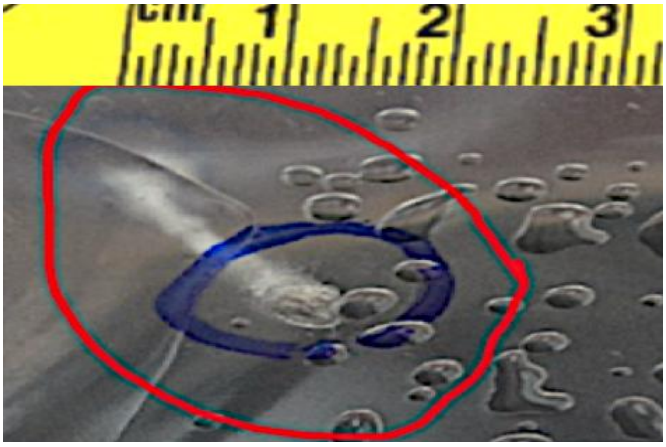

Figure2. Glock 17 Pistol (9mm) entry impact 4 mm

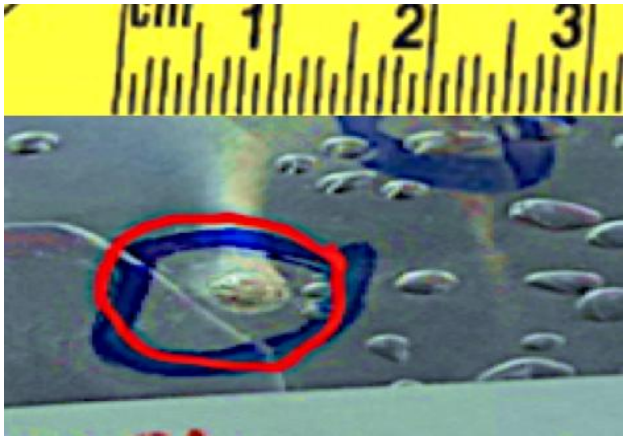

Figure3. Berretta Pistol (9mm) entry impact 5 mm

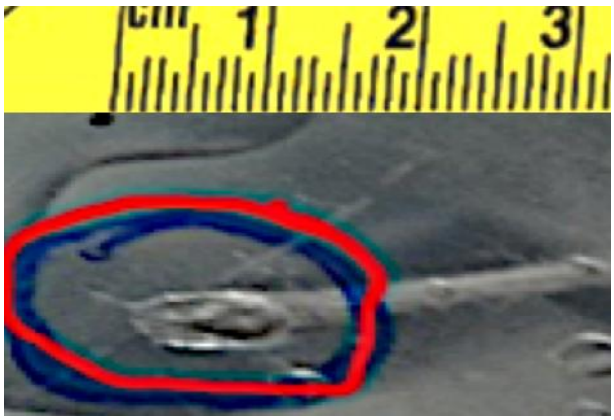

Figure 4. Carbine Rifle (9mm) entry impact 8mm

For distance 10 m
Table 2: Variation in the entry impact in respect to different types of firearms at distance of 10 meter

Firearm	Glock 17 Pistol	Berretta Pistol	Carbine Rifle
Caliber (in mm)	9	9	9
Entry Wound (in mm)	3	3.5	6.5
Figure no.	5	6	7

As we can see in the table 2, that the diameter of the entry wound decreases in all the three cases with an increase in the range of firing.

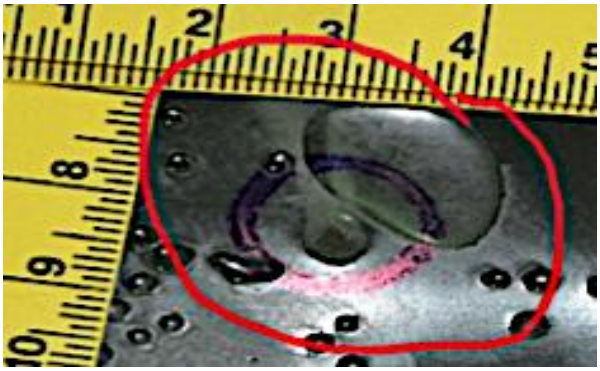

Figure 5. Glock 17 Pistol (9mm) entry impact 3 mm

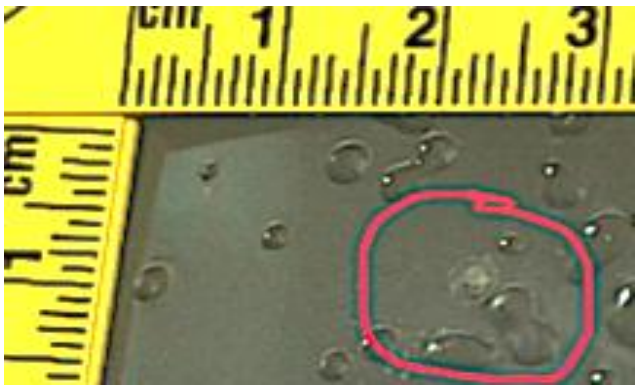

Figure 6. Berretta Pistol- 9mm entry impact is less than 3.5 mm

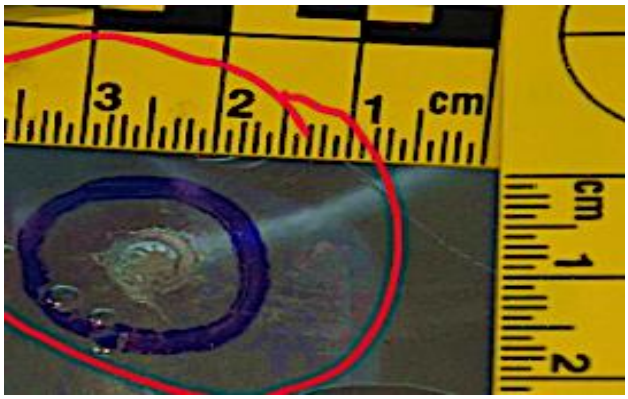

Figure7. Carbine Rifle- 9mm entry impact 6.5mm

For distance 30 m

Table 3: Variation in the entry impact in respect to different types of firearms at distance of 30 meter

Firearm	**Glock 17 Pistol**	**Berretta Pistol**	**Carbine Rifle**
Caliber (in mm)	9	9	9
Entry Wound (in mm)	2	2.5	4.5
Figure no.	8	9	10

Furthermore, in table 3 the diameter of the entry wound decreases additionally with an increase in the range of firing of 30 meters.

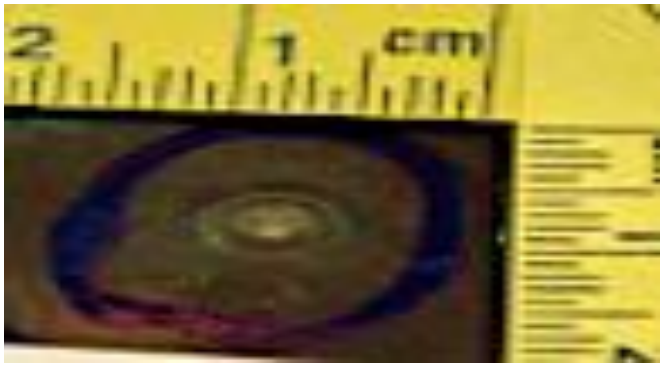

Figure 8. Glock 17 Pistol entry impact 2 mm

Figure9. Berretta Pistol- 9mm entry impact 2.5mm

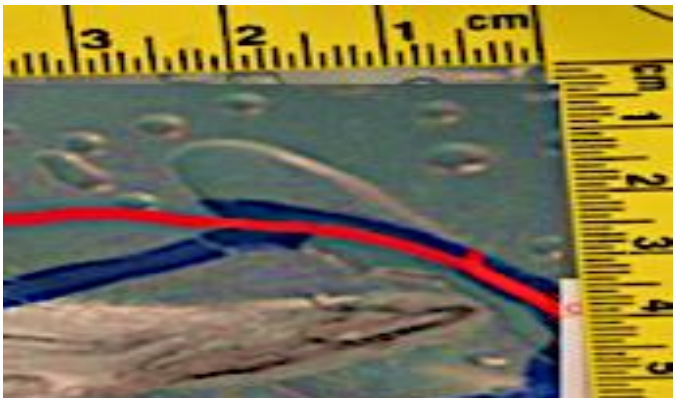

Figure 10. Carbine Rifle- 9mm entry impact 4.5 mm

The following table 5 gives the comparative study of entry impact created by the use of different firearms with same caliber ammunition at different distances.

Fire Arm	Entry Wound		
	6.0 m	10m	30m
Glock 17 Pistol	4	3	2
Berretta Pistol	5	3.5	2.5
Carbine Rifle	8	6.5	4.5

Here the factors of variation are Fire arm and Entry wound.
Null Hypothesis 1 (H_{01}): There is no significant difference in the entry impact used at different distances.
Null Hypothesis 2 (H_{02}): There is no significant difference between fire arms.
Alternate Hypothesis1 (H_{11}):: There is a significant impact of entry wound used at different distances.
Alternate Hypothesis 2 (H_{12}) : At least two of the fire arms differ significantly.
This experiment has yielded many suggestive and beneficial results. Using the same caliber bullets with different weapons and changing the distance to produced various effects that were interpreted as follows:

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Row 1	3	9	3	1
Row 2	3	11	3.666667	1.583333
Row 3	3	19	6.333333	3.083333
Column 1	3	17	5.666667	4.333333
Column 2	3	13	4.333333	3.583333
Column 3	3	9	3	1.75

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*
Rows	18.66667	2	9.333333	56	0.001189
Columns	10.66667	2	5.333333	32	0.00346
Error	0.666667	4	0.166667		
Total	30	8			

From the above tables it can be seen that
$F_{cal(0.05)}$ for (2,4) degree of freedom = 56
$F_{tab\ (0.05)}$ for (2,4) degree of freedom = 6.94
Since the calculated value of F i.e 56 is greater than tabulated value. Therefore we reject our null hypothesis at 5% level of significance and conclude that there is significant difference in the entry impact used at different distances.
Also from the table we can see that
$F_{cal(0.05)}$ for (2,4) degree of freedom = 32
$F_{tab(0.05)}$ for (2,4) degree of freedom = 6.94
Again it is observed that the calculated value of F i.e 32 is greater than tabulated value. Therefore it is significant and null hypothesis (H_{02}) is rejected at 5% level of significance. Hence we may conclude conclude that there is significant difference in the entry impact with respect to different types of fire arms.

IV. CONCLUSION

The study was based upon the entry impact using different types of firearms with the same caliber ammunition (9mm cartridges). The results have concluded that there is a significant difference in the entry impact used at different distances with respect to different types of firearms. Hence, it is observed that there are always exists specific differences in the entry impact due to different range or distance of firing. Usually, it has been noted in the experiment that with the increase in the distance of firing, the dimensions of the entry impact decreases. Therefore, the distance at which a target is standing or kept during shooting will influence the effects and the aspects of the entry impact [7,8]. The findings of this experiment can be used as a suggestion in legal cases involving firearms of the same caliber and may help to narrow down the suspected firearm list in shooting incidents.

ABBREVIATIONS

GSW – Gun Shot Wounds
FBI- Federal Bureau of Investigation
SEBS- Synthetic Gel Bases Systems
PAS – Personal Armor System
UAE – United Arab Emirates
mm- milli meters
m - meters
K.E – Kinetic Energy

REFERENCE

1. Expanded Homicide Data. Available Online. https://ucr.fbi.gov/crime-in-the-u.s/2014/crime-in-the-u.s.-2014/tables/ expanded-homicide-data/expanded_homicide_data_table_8_murder_victims_by_weapon_2010-2014.xls
2. Baracq and Haugou (2017) characterixation of a visco-hyperelastic synthetic gel for ballistic impacts assessment, Dynamic behavior of materials vol.1 Annual Conference on Experimental and Applied Mechanics, Springer USA.
3. Goode and Tyler W (2017) Soft Body Armor Back Face Deformation with Ballistics Gel Backing.
4. Moss GM et al., Military ballistics: a basic manual. London: Brassey's; 1995,p.9-22.
5. Hopkinson and Marshall (1967). Firearm injuries. Br J Surg; 54(5): 344-353.
6. Stefanopoulos et al. (2014), Gunshot wounds: A review of ballistics related to penetrating trauma Panagiotis. Journal of Acute Disease 178-185
7. Hollerman et al (1990) Gunshot wounds: Bullets, ballistics, and mechanisms of injury. AJR Am J Roentgenol;155(4): 685-690.
8. Bellamy RF and Zajtchuk R (1991). Conventional warfare:ballistic, blast, and burn injuries. Washington, DC: Walter Reed Army Medical Center, Office of the Surgeon General; p.107-162
9. .

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