AV TÜFEĞİ NAMLU UZUNLUĞUNUN SAÇMA DAĞILIMINA ETKİSİ VE ATIŞ MESAFESİNİN BELİRLENMESİNDE ÖNEMİ

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ÖZET

Amaç:

Ateşli silahla meydana gelen yaralanma ve ölüm olaylarında, aydınlatılması gereken konulardan biri atış mesafesi tayinidir. Ateşli silah yaralanmalarında, atış artıklarının ulaşamadığı mesafelerde atış mesafesi tayininde saçmaların hedef üzerinde gösterdikleri dağılımdan yaralanılmaktadır. Uzak atış mesafesinden av tüfeği saçma yaralanmalarında, atış mesafesinin belirlenmesinde, saçmaların hedef üzerinde gösterdikleri dağılımdan yararlanılmaktadır. Bununla birlikte namlu uzunluğu, saçma boyutu, tüfeğin şok durumu, tapa yapısı, ortam koşulları gibi saçma dağılımını etkileyen birçok faktör olup mesafe tayini yapılırken bu faktörlerin de göz önünde bulundurulması gerekmektedir.

Bu çalışmada, namlu uzunluğunun saçma dağılımına etkisinin incelenmesi amaçlanmıştır.

Yöntemler:

Bu amaçla, yivsiz, setsiz ve şoksuz 12 kalibre, namlu uzunluğu 70 cm olan bir av tüfeği ile 9 ayrı mesafeden, 3,5 ve 7,5 mm çaplı saçmalar içeren fişekler kullanılarak, özel bir düzenekle bez hedefler üzerine dikey atışlar yapılmıştır. Tüfeğin namlu uzunluğu 45 ve 20 cm olacak şekilde iki kez kısaltılarak tüm atışlar tekrarlanmıştır.

Bulgular:

Elde edilen saçma dağılımları, namlu uzunluğuna göre karşılaştırıldığında, namlu uzunluğu 45 cm iken oluşan saçma dağılımı 70 cm'ye göre daha fazla olmakla birlikte aradaki farkın istatistiksel olarak anlamlılığının değişken olduğu görülmüştür. Namlu uzunluğu 20 cm iken yapılan atışlardaki saçma dağılımının, 70 cm ve 45 cm namlu uzunluğundan yapılan atışlara göre anlamlı şekilde daha fazla olduğu, atış mesafesi 100 cm'nin üzerine çıktığında saçma dağılımındaki farklılığın daha belirgin olduğu görülmüştür.

Sonuç:

Saçma dağılımındaki farklılığın, namlu uzunluğunun önemli oranda kısaltılması ile belirgin hale geldiği sonucuna varılmıştır. .

Anahtar Kelimeler: ateşli silahlar, av tüfekleri, adli balistik

THE EFFECT OF BARREL LENGTH ON PELLET DISPERSION AND ITS IMPORTANCE IN DETERMINATION OF RANGE OF FIRE

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ABSTRACT

Objective:

An important issue in need of investigation is the determination of the shooting range in cases of death and injury that occur through the use of firearms. In shotgun injuries, in distances beyond which the residue of gunpowder cannot reach, the dispersion of pellets on the target is used to determine the firing distance. In shotgun injuries with a long discharge range, the dispersion of shot on the target is also used to determine the firing distance. Nonetheless, there are a number of factors that affect the size of the shot pattern, such as barrel length, shot size, degree of choking, type of wadding and environmental conditions. It is important to consider these factors when determining the range.

In this study, we aimed to investigate the effect of barrel length on the dispersion of shot.

Methods:

With this aim, we fired at linen targets from nine different distances using a non- choked 12 gauge shotgun with a 70 cm barrel using cartridges containing 3.5 and 7.5 mm pellets. We repeated all the discharges after altering the shotgun barrel length to 45 cm and 20 cm.

Results:

When we compared the obtained dispersion of shot according to the length of the barrel, the dispersion of shot from the 45 cm barrel was no more than that from the 70 cm barrel and this difference was variable statistically. The dispersion of shot with the 20 cm barrel was more than that with the 70 cm and 45 cm barrels, and when the firing distance was above 100 cm, the variance on dispersion of the shot was more marked.

Conclusion:

We came to the conclusion that the difference in the dispersion of shot is more marked with a distinctly shortened length of barrel.

Key words: *firearms, shotguns, forensic ballistic*

INTRODUCTION

Besides hunting and sporting purposes, shotguns are firearms bought by people who have an interest in guns with the aim of causing injury or for defensive purpose due to their lower cost and the fact that they can be obtained legally and more easily than other firearms (1). In addition, shortening the barrels of shotguns makes them easier to conceal (1, 2).

In death and injury cases, the determination of the shooting range is very important to determine the type of occurrence and the origin of the case (3). In shots fired from a shotgun from a long distance where the gunpowder residue cannot reach the distribution area of pellets on target is used to determine the shooting distance. When a shotgun is fired, the pellets are transported in compact mass up to about one meter. As the range increases the individual pellets continue at their direction but spreading in a cone-like manner.. There are a number of variables that affect the size of the shot pattern such as barrel length, shot size, range of fire, degree of choking and type of wadding. (1–2, 4–12).

An important part of a gun that affects the shot dispersion is the barrel, which orients the pellets to the target by means of gas compression (1, 13, 14). There is a high probability that firing with a shotgun with a shortened barrel can hit the mark, especially over short distances. With the length of barrel shortened (generally between 20-30 cm), pellets will be dispersed immediately upon leaving the barrel and the dispersion will be great. Also, a shortened gun barrel is easily transported and covered (1, 2). Furthermore, because small-sized pellets have a smaller mass, they are more affected by air resistance (higher deceleration). For all the above-mentioned reasons, small size pellets show a greater dispersal than large size pellets (2, 4, 6, 9).

Studies that have focused on this issue have reported that documented formulas concerning the determination of the shooting range based on the dispersion of pellets on a body were not alone sufficient to obtain reliable results. Test shoots should be conducted using the same type of shotgun and ammunition; besides the dispersal of the pellets obtained with the test shoots should be compared with the dispersion of pellets obtained in the first case (8, 9, 13, 15-17). Nonetheless, in conditions where details of the type of gun and ammunition used are not available, we need tables obtained based on test shoots conducted with all variables to determine the shooting range.

A study which dispersion of pellets was evaluated with experimental shoots that were practiced by shortening the barrels of various rifles was conducted by Moreau et al (18). In this study, researchers pointed out that they had used different brand-name cartridges.

In this present study which aimed at evaluating the dispersal of pellets in shoots from a manually shortened barrel, all conditions except for the length of barrel (shotguns and cartridges used etc.) were planned to be standardized. Thus the study conducted has been thought to contribute to the study presented by Moreau et al and to provide future studies with tables that can be used on the dispersion of pellets.

METHODS

Shotgun

A Yılmaz brand single-shot 12-gauge shotgun with 70 cm non-choked barrel, 8489 serial numbered was used in this study (Fig. 1). After the requisite shots were fired with this shotgun the barrel was shortened to lengths of 45 cm and 20 cm (Fig. 2-3). After each cut, burrs on the muzzle of the barrel were carefully removed.

Ammunitions

Two types of 12-gauge shotgun ammunition were used:

1- Imperial brand, 12-gauge shotgun shells, 7 cm with plastic tube, No. 3 shot (3.5 mm in diameter).

2- Imperial brand, 12-gauge shotgun shells,6.5 cm with plastic tube, No. 1 buckshot (7.5 mm in diameter).

Shooting Range

Shooting Range of Police Department, Eskisehir, Turkiye.

Air Condition

Open air, 23oC average temperature, mild breeze, and normal atmosphere pressure

Target

Unbleached and coarse calicos stretched into 0.5 x 0.5 m, 1.5 x 1.5 m, and 2 x 2 m wood frame (depending on shooting range)

Test Fires

Five shots of each type of ammunition were fired for each barrel length of weapon at ranges 0.4, 0.6, 0.8, 1, 2, 3, 5, 10, and 15 m. A total of 270 shots were fired.

Shooting Mechanism

To avoid the possibility of any rebound effect, we constructed a gun mechanism controlled remotely in serial with shortened barrel shoots. This gun mechanism was fixed to a metal table (Fig.4).

We recorded the size of holes made on the target that occurred collectively by the spent pellets and the dispersion areas of the pellets on target. While recording the dispersion area, we calculated the distance between the furthest entrance holes on the horizontal and vertical locations on targets and we took the average of these measurements. During these measurements we did not consider entrance holes that showed abnormal deviation from general dispersal (satellite entrance holes). We did not record the presence or absence of these satellite entrance holes.

All statistical assessments were performed using SPSS software. As diameter of pellets dispersion in every shoot, the average of vertical and horizontal diameters is taken. For the assessment of differences in pellets dispersion according to the length of barrel ANOVA analysis was used. For multiple comparisons, Tukey HSD test was used. If the P value was under 0.05, it has been considered to be meaningful.

Fig. 1: *Used shotgun with 70 cm barrel*

Fig. 2: *The shotgun with 45 cm barrel*

Fig. 3: *The shotgun with 20 cm barrel*

Fig. 4: *Shooting Mechanism*

Table 1: *Pellet dispersion ± standard deviation of shoots based on the barrel length conducted using pellets of 3.5 mm diameter.*

Distance	Mean ± Standard Deviation			Statistical significance P Value		
	Barrel Length =70 cm	Barrel Length =45 cm	Barrel Length =20 cm	Barrel Length =70 cm	Barrel Length =45 cm	Barrel Length =20 cm
40 cm	2.22 ± 0.13	3.20 ± 0.20	3.30 ± 0.33	P←0.001	P→0.05	P←0.001
60 cm	3.08 ± 0.40	3.42 ± 0.23	4.26 ± 0.36	P→0.05	P←0.01	P←0.001
80 cm	3.08 ± 0.41	3.48 ± 0.08	5.20 ± 0.44	P→0.05	P←0.001	P←0.001
100 cm	2.76 ± 0.17	3.58 ± 0.14	6.02 ± 0.74	P←0.05	P←0.001	P←0.001
200 cm	4.57 ± 0.14	5.82 ± 0.80	11.56 ± 0.40	P←0.01	P←0.001	P←0.001
300 cm	8.90 ± 0.29	9.44 ± 0.40	16.24 ± 1.30	P→0.05	P←0.001	P←0.001
500 cm	17.26 ± 0.99	17.22 ± 1.06	29.44 ± 3.24	P→0.05	P←0.001	P←0.001
1000 cm	41.40 ± 2.94	38.94 ± 2.35	55.12 ± 7.04	P→0.05	P←0.001	P←0.001
1500 cm	74.32 ± 4.54	64.02 ± 4.46	85.52 ± 6.72	P←0.05	P←0.001	P←0.05

Table 2: *Pellet dispersion ± standard deviation of shoots based on the barrel length conducted using pellets of 7.5 mm diameter.*

Distance	Mean ± Standard Deviation			Statistical significance P Value		
	Barrel Length =70 cm	Barrel Length =45 cm	Barrel Length =20 cm	Between 70 and 45 cm	Between 45 and 20 cm	Between 70 and 20 cm
40 cm	2.15 ± 0.12	2.88 ± 0.17	3.12 ± 0.34	P←0.01	P→0.05	P←0.001
60 cm	2.57 ± 0.12	3.18 ± 0.24	4.06 ± 0.52	P←0.05	P←0.01	P←0.001
80 cm	2.62 ± 0.19	3.74 ± 0.69	5.22 ± 1.56	P→0.05	P→0.05	P←0.01
100 cm	2.65 ± 0.07	5.25 ± 0.48	6.78 ± 0.53	P←0.001	P←0.001	P←0.001
200 cm	3.56 ± 0.26	5.72 ± 0.72	7.66 ± 0.79	P←0.001	P←0.01	P←0.001
300 cm	5.80 ± 0.48	6.12 ± 0.85	10.62 ± 2.27	P→0.05	P←0.01	P←0.001
500 cm	8.04 ± 0.75	8.42 ± 0.66	13.62 ± 1.37	P→0.05	P←0.001	P←0.001
1000 cm	21.58 ± 2.51	16.74 ± 2.67	31.60 ± 4.04	P→0.05	P←0.001	P←0.01
1500 cm	32.64 ± 8.57	24.08 ± 3.88	48.58 ± 9.51	P→0.05	P←0.01	P←0.05

RESULTS

In shoots conducted using pellets with diameter of 3.5 mm and 7.5 mm, the average of the pellet dispersion ± standard deviation and statistically significant differences of pellet dispersion among each barrel length based on shooting range and size of pellet has been presented in Tables 1 and 2 and Figures 5 and 6.

The average pellet dispersion with shoots conducted using a barrel of 20 cm was greater than those with 70 and 45 cm barrel length from the same distance, and this difference was significant statistically. When the length of barrel was 45 cm, the pellet dispersion was no more than the dispersion with a barrel length of 70 cm at a distance of 300 cm and the relationship between the averages of the pellet dispersions was variable. Also on shoots conducted using a barrel length of 45 cm from 500 cm, 1000 cm and 1500 cm, the pellet dispersion was less than that from a barrel length of 70 cm.

When we looked at the pellet dispersion based on the same distance and barrel length, the pellet dispersion area was greater on shoots conducted using small diameter pellets than larger diameter pellets, and this difference was more marked in shoots conducted from over 100 cm.

Independently from the length of barrel and the diameter of pellet, pellet dispersion showed a clear homogeneity in shoots below a range of 5 m, with non-homogeneity on pellet dispersion in shoots from 10 m and 15 m.

DISCUSSION

In this study, we used one of the most popular shotguns nationally for the test shoots. In a study performed in Turkiye by Uner et al, the authors found that most of the shotguns evaluated ballistically had been used in criminal cases with shortened barrels of 15-25 cm (1). In our study, we considered this information when we were shortening the barrel lengths. We shortened the barrel lengths to 70 cm, 45 cm and 25 cm. Thus, when the length of barrel was 70 cm, 45 cm and 20 cm we conducted test shoots from different ranges with pellet diameters of 3.5 and 7.5 mm. We found a statistically significant difference between the length of barrel of 20 cm and those of 45 and 70 cm; pellet dispersion from 20 cm was greater than that from 45 and 70 cm, thus it was deemed that this difference could be used for forensic science applications.

In another experiment the authors reported that when decreasing the diameter of pellet and reducing the length of barrel, pellet dispersion could become greater (19). However, in this study, the authors used various shotguns of different barrel lengths, without shortening the length of barrels. Moreau and et al (18) conducted a similar study using different shotguns with shortened barrels and different shotgun shells, shooting from various distances. In Moreau's study the authors found that pellet dispersion increased statistically in shoots that used 00 (8.3 mm diameter) large pellets with the increase being more marked in shoots using 3.8 mm diameter pellets with a barrel length of 30.5 cm or less, commenting that by shortening the length of barrel, pellet dispersion increased. However, in our study, which did not use the same make of shotgun, we found that when using pellets of 3,5 and 7.5 mm, up to 300 cm distance, the pellet dispersion was greater when the length of barrel was 45 cm than with a barrel length of 70 cm. Nonetheless, the difference was not significant statistically over all distances. Also, we have found that pellet dispersion was less from a greater distance with a barrel length of 45 cm than with a barrel length of 70 cm. In shoots using both types of pellet, with a barrel length of 20 cm, the dispersion was greater than with barrel lengths of 70 cm and 45 cm and the difference was more marked from a distance of 100 cm. Our results reflect the results of Moreau et al. As a consequence, significant differences of pellet dispersion have become more marked while shortening barrel length to 20 cm not 45 cm.

In a study using a shotgun with 12 and 16 gauge and a barrel length of 71 cm with number 2 and 5 pellets, the authors found that pellet dispersion increased with small-scale pellets than large scale pellet and this increase was more statistically significant especially

from 500 cm and 1000 cm (20). Relating to size of pellet we found a correlation with the above study.

Finally, in our study we found that shortening the length of barrel of a shotgun increased pellet dispersion with a length of barrel of 20 cm, and it was more significant than with 70 cm and 45 cm barrel lengths; we have shown our results as tables and figures. In some criminal cases, for security and ease of transportation, shortened non-standard shotguns are used, with the most common length of barrel ranging between 15 and 25 cm. When we consider this information, and based on our tables and findings, we estimate that the shooting range can be determined, especially from distances greater than 1 m, but this is not definite.

Future studies should be conducted with all variables that affect pellet dispersion for the determination of shooting ranges in shotgun injuries. In our study, we evaluated pellet dispersion using a shortened length of barrel. But, using tables obtained from our study, it will not be possible to evaluate shooting ranges with various other guns. Thus, further experiments are needed using various shotguns and experimental tables obtained with standardized experimental shoots. We believe that future studies, using various shotguns and pellets, would be of benefit in the determination of shooting range.

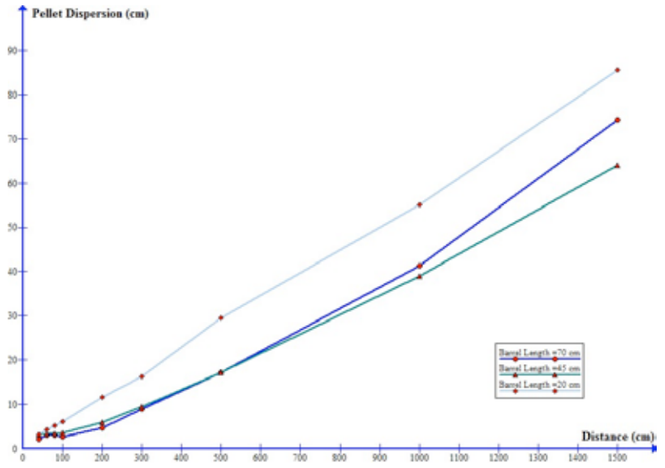

Fig. 5: *Pellet dispersion versus firing distances for 70 cm, 45 cm, and 20 cm 12-gauge shotguns firing Imperial No. 3 shot (3.5 mm in diameter) cartridges.*

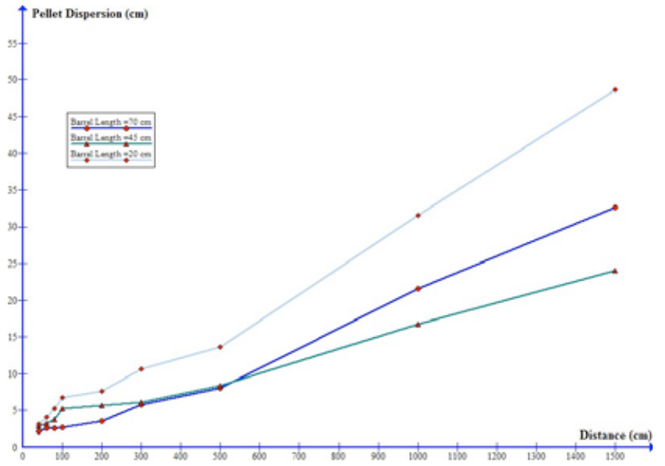

Fig. 6: *Pellet dispersion versus firing distances for 70 cm, 45 cm, and 20 cm 12-gauge shotguns firing Imperial No. 1 buckshot (7.5 mm in diameter) cartridges.*

REFERENCES

1. Uner HB, Koc S, Kurtas O, Alkan N, Batuk G. Short barrel shotguns without rifling. II. Forensic Sciences Symposium Book (Ballistic). Ege University Press (Turkish), Izmir, 1998;124-128.

2. Cassidy M. Smoot-bore firearm injuries. In: Maison JK, Purdue BN, editors. The pathology of trauma. New York, 2000; 61-72.

3. Koc S. Atypical gunshot wounds. II. Forensic Sciences Symposium Book (Ballistic). Ege University Press (Turkish), Izmir, 1998;28-35.

4. Uner HB, Sam B, Kurtas O, Uysal C, Cerkezoglu A. The factors that effect on dispersion of shotgun pellets. The Bulletin of Legal Medicine (Turkish) 2000; 5(2):65-69.

5. Agır E.G. The evaluation of deaths from the shotgun wounds in related to forensic medicine. Thesis, Council of Forensic Medicine (Turkish), Istanbul, 1996

6. Uner HB, Cakır I. Forensic Ballistic (Turkish), Arikan Press, Istanbul, 2007;1–41, 55–67.

7. Ordog JG, Wasserberger J, Balasubramaniam S. Shotgun wound ballistics. The Journal of Trauma. 1988; 28(5):624-631.

8. Balci Y. Firearm injuries. In: Forensic Medicine (Turkish), Arion Press, Istanbul, 2004; 27-35.

9. Uner HB, Uysal C, Kurtas O, Sam B. The effect of the degree of shotgun choke on the pattern of pellets. Journal of Forensic Medicine (Turkish) 1996; 12:127-133.

10. Warlow TA. Terminal/wound ballistics and distance of firing. In: Firearms, The Law and Forensic Ballistics, CRC Press London, UK, 1996;114-116.

11. Uner HB, Sam B, Kurtas O, Atasoy C. The Effect of Clothing As An "Intermediate Target" On Dispersion of Shotgun Pattern on The Body, The Bulletin of Legal Medicine (Turkish) 1997; 2(3): 124-6.

12. Uner HB, Polat O. The evaluation of the billiard ball effect in close- range shots with shotgun. Poster presentation: I. Forensic Sciences Congress Book (Turkish), Adana, 1994;334.

13. Di Maio VJM. Wounds from Shotguns, In: Gunshot Wounds Practical Aspects of Firearms, Ballistics, and Forensic Techniques, 2nd ed., CRC Press LLC, Boca Raton, New York, 1999; 203-251.

14. Turkish Standards of Shotguns, TS 870/1998.

15. Knight B. Gunshot and Explosion Deaths, In: Forensic Pathology, London, Melbourne, Auckland, 1991; 222-247.

16. Mattoo BN, Nabar BS. Evaluation of Effective Shot Dispersion in Buckshot Patterns. The Journal of Forensic Sciences 1969; 14(2): 263-69.

17. Cakır I, Cetin G, Uner HB, Albek E. Shot Range Estimation Based on Pellet Distribution in Shots With a Pump-Action Shotgun, Forensic Science International 2003; 132 (3): 211-215.

18. Moreau TS, Nickels ML, Wray JL, Bottemiler KW, Rowe WF. Pellet Patterns Fired by Sawn-off Shotguns. The Journal of Forensic Sciences 1985; 30(1): 137-149.

19. Yucel F. The Determination of the Discharge Distance After Discharges Done With Different Kinds Of Shotguns And Cartridges. Journal of Forensic Medicine (Turkish) 1997; 13: 27-35.

20. Arslan M, Determination of Range Fire Using Pellet Dispersion Patterns, Medical Specialist Thesis (Turkish), Council of Forensic Medicine, Istanbul, 2002.