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Pellet Patterns Fired by Sawed-Off Shotguns

REFERENCE: Moreau, T. S., Nickels, M. L., Wray, J. L., Bottemiller, K. W., and Rowe, W. F., **"Pellet Patterns Fired by Sawed-Off Shotguns,"** *Journal of Forensic Sciences*, JFSCA, Vol. 30, No. 1, Jan. 1985, pp. 137-149.

ABSTRACT: To determine the effect of barrel length on pellet patterns fired by sawed-off shotguns, 00 buckshot, No. 2 shot, and No. 7½ birdshot cartridges were fired from 12-gage single-shot Harrington and Richardson shotguns with the barrel lengths progressively shortened to 152 mm (6 in.). The spread of the 00 buckshot pattern was found to increase as the barrel length of the firing weapon decreased. The spread of the pellet patterns increased or tended to remain constant as the barrel length decreased when other types of cartridges were fired from the shotguns; this depended on the brand of ammunition.

KEYWORDS: criminalistics, ballistics, shotguns

Criminals frequently shorten the barrels of rifles and shotguns to make them easier to conceal. It is also widely believed that shortening the barrel of a shotgun increases the spread of the pellet pattern. Few controlled studies on the effects of shortening shotgun barrels have so far been published. Kamaka [*1*] sawed off a 12-gage, single-shot shotgun with a 762-mm (30-in.) full choke barrel in 51-mm (2-in.) increments until a length of 127 mm (5 in.) was reached. The spread of the No. 2 shot patterns fired was found to increase as the barrel length of the shotgun decreased. Kamaka did not attempt to measure the spreads of the patterns, contenting himself with presenting photographs of the pellet patterns. The results of a similar experiment reported by DiMaio and Petty [*2*] apparently contradicted those of Kamaka. DiMaio and Petty fired both buckshot and 7½ birdshot from a 12-gage shotgun with the barrel shortened from 813 to 203 mm (32 to 8 in.). The spreads of the pellet patterns were measured by determining the area A of the smallest rectangle that would just enclose each pattern. For the 7½ birdshot pattern, A was found to decrease slightly as the barrel length decreased. A similar trend was observed for the 00 buckshot patterns, although here the trend was somewhat obscured by the shot-to-shot variation in A. These results have been confirmed in an unpublished study by Coe.[3]

The opinions or assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the Department of the Army, the Department of the Air Force, or the Department of Defense. Received for publication 30 March, 1984; accepted for publication 1 May 1984.

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[3] J. I. Coe, personal communication, chief of pathology and medical examiner, Hennepin County Medical Center, Minneapolis, MN, 1980.

Because of the apparently contradictory results obtained by Kamaka [*1*] and DiMaio and Petty [*2*], we have carried out a series of experiments in which shotguns with different initial barrel lengths and chokes were progressively shortened. These sawed-off shotguns were used to fire different types of shotgun ammunition.

Experimental Procedure

Two series of experiments (1 and 2) were conducted.

Series 1

Three shotguns were used in the first series of experiments:

1. A Harrington and Richardson single-shot 12-gage shotgun with a 914-mm (36-in.) full choke barrel.
2. A Harrington and Richardson single-shot 12-gage shotgun with a 762-mm (30-in.) full choke barrel.
3. A Harrington and Richardson single-shot 12-gage shotgun with a 711-mm (28-in.) modified choke barrel.

Two types of 12-gage shotgun ammunition were used:

1. Remington 12-gage 70-mm (2¾-in.) 00 buckshot cartridges, nine pellets to the load.
2. Winchester-Western 12-gage XX Magnum 70-mm (2¾-in.) No. 2 shot cartridges.

All firing was conducted on a 15.2-m (50-ft) indoor firing range at sheets of butcher paper measuring 914 mm (36 in.) square. Three shots of each type of ammunition were fired for each barrel length of each weapon at ranges of 3.0, 9.1, and 15.2 m (10, 30, and 50 ft). A total of 270 shots were fired.

After the requisite shots were fired with the unaltered weapons, each weapon was shortened 101.6 mm (4 in.). This length was selected because information from the manufacturer[4] indicated that the choke of each weapon was located in the last 95 mm (3¾ in.) of the barrel. After this first cut, each weapon was shortened to lengths of 508, 305, and 152 mm (20, 12, and 6 in.). Any burrs produced by sawing off lengths of barret were carefully removed before the weapons were fired.

Series 2

Two shotguns were used in the second series of experiments:

1. A Harrington and Richardson single-shot 12-gage shotgun with an 813-mm (32-in.) full choke barrel.
2. A Harrington and Richardson single-shot 12-gage shotgun with a 711-mm (28-in.) modified choke barrel.

Six types of ammunition were used:

1. Winchester Super X Magnum 12-gage 70-mm (2¾-in.) 00 buckshot cartridges, 12 pellets to the load.

[4] R. E. Chatigny, personal communication, Research and Development Department, Harrington and Richardson, Inc., Worcester, MA., 1980.

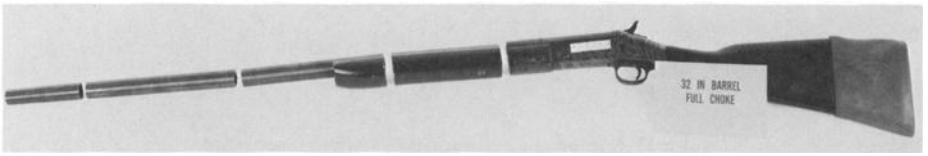

FIG. 1—*Harrington and Richardson single-shot 12-gage shotgun with 813-mm (32-in.) full choke barrel, showing segments cut from barrel.*

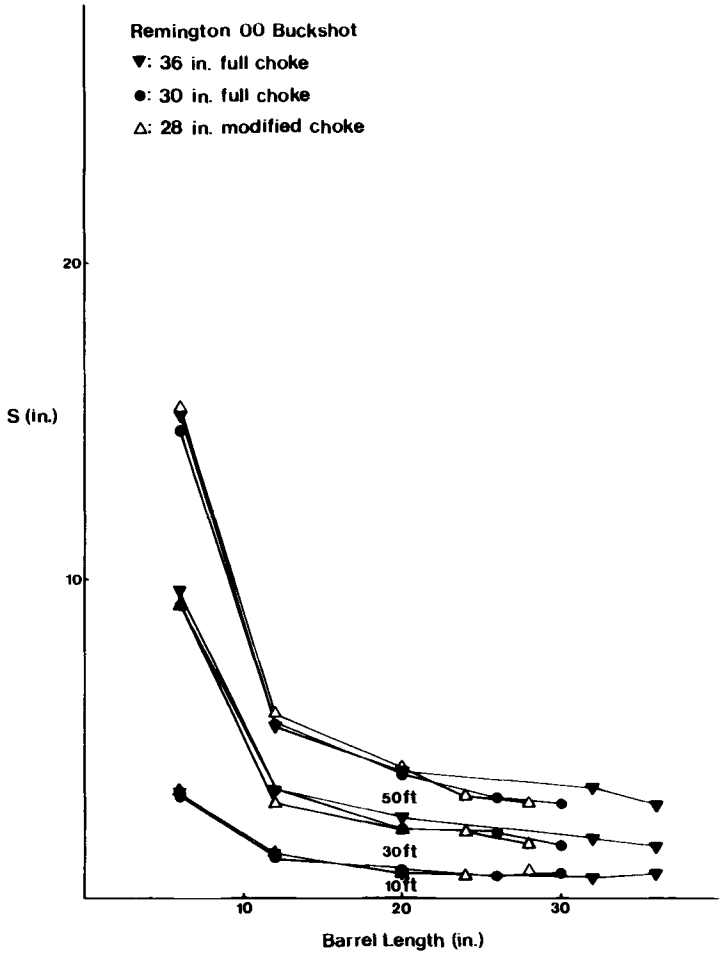

FIG. 2—*Dispersal S versus barrel lengths for 36-in. full choke, 30-in. full choke, and 28-in. modified choke Harrington and Richardson single-shot 12-gage shotguns firing Remington 00 buckshot cartridges. 1 in. = 25.4 mm; 1 ft = 0.3 m.*

TABLE 1—*Results of test firings of 00 buckshot cartridges.*[a]

Barrel Length, in.	Dispersal S, in.		
	10 ft	30 ft	50 ft
Remington 12-gage 00 buckshot cartridges (Series 1)			
36 (full choke)	0.8 (0.1)	1.7 (0.1)	3.0 (0.2)
32	0.7 (0.0)	1.9 (0.1)	3.5 (0.2)
20	0.8 (0.0)	2.6 (0.1)	4.0 (0.4)
12	1.4 (0.3)	3.4 (0.1)	5.4 (0.8)
6	3.3 (0.3)	9.7 (0.6)	15.2 (1.5)
30 (full choke)	0.8 (0.1)	1.7 (0.3)	3.0 (0.4)
26	0.7 (0.0)	2.1 (0.1)	3.2 (0.1)
20	0.9 (0.0)	2.2 (0.2)	3.9 (0.6)
12	1.3 (0.1)	3.4 (0.2)	5.5 (0.3)
6	3.2 (0.1)	9.2 (0.1)	14.7 (2.2)
28 (modified choke)	0.9 (0.3)	1.7 (0.1)	3.0 (0.4)
24	0.7 (0.1)	2.1 (0.2)	3.2 (0.4)
20	0.8 (0.1)	2.2 (0.2)	4.1 (0.3)
12	1.4 (0.1)	3.0 (0.3)	5.8 (0.4)
6	3.4 (0.3)	9.2 (0.8)	15.4 (0.5)
Winchester Western Super X 12-gage 00 buckshot cartridge (Series 2)			
32 (full choke)	0.5 (0.1)	1.2 (0.1)	2.3 (0.5)
28	0.8 (0.1)	2.8 (0.1)	5.7 (0.4)
20	0.8 (0.1)	2.4 (0.3)	4.9 (0.9)
12	1.1 (0.1)	3.5 (0.1)	5.6 (0.6)
6	2.6 (0.1)	7.8 (0.5)	13.5 (0.6)
28 (modified choke)	0.8 (0.0)	2.1 (0.1)	3.6 (0.5)
24	0.9 (0.1)	2.6 (0.3)	4.7 (0.2)
20	0.8 (0.0)	2.6 (0.4)	4.7 (0.4)
12	1.2 (0.1)	3.4 (0.2)	5.9 (0.2)
6	2.6 (0.1)	8.1 (0.2)	13.4 (0.5)
Winchester Western Super X Magnum 12-gage 00 buckshot cartridges (Series 2)			
32 (full choke)	0.7 (0.2)	1.3 (0.1)	2.8 (0.7)
28	0.8 (0.0)	2.5 (0.2)	4.7 (0.2)
20	1.0 (0.0)	3.0 (0.3)	4.7 (0.4)
12	1.6 (0.1)	4.7 (0.4)	7.2 (0.5)
6	3.6 (0.3)	8.3 (3.8)	17.5 (1.4)
28 (modified choke)	0.9 (0.0)	2.6 (0.2)	4.5 (0.5)
24	0.8 (0.0)	2.5 (0.2)	5.0 (0.4)
20	0.9 (0.1)	2.4 (0.2)	4.6 (0.2)
12	1.3 (0.4)	4.5 (0.3)	7.5 (0.6)
6	3.9 (0.3)	11.7 (0.2)	18.1 (0.7)

[a] Values given are mean (standard deviation); 1 in. = 25.4 mm; 1 ft = 0.3 m.

2. Winchester-Western Super X 12-gage 70-mm (3¾-in.) 00 buckshot cartridges, nine pellets to the load.
3. Winchester-Western Super X Magnum 12-gage 70-mm (2¾-in.) No. 2 shot cartridges.
4. Winchester-Western Super X 12-gage 70-m (2¾-in.) No. 2 shot cartridges.
5. Winchester-Western Super X 12-gage 70-mm (2¾-in.) No. 7½ shot cartridges.
6. Winchester-Western Upland 12-gage 70-mm (2¾-in.) No. 7½ shot cartridges.

The firing range used in the first series of experiments was also used in the second. Poster board and butcher paper were used as the target materials. As before, three shots were fired for each barrel length at ranges of 3.0, 9.1, and 15.2 m (10, 30, and 50 ft). Each weapon was shortened by 95 mm (3¾ in.) to remove the choke; each was then shortened progressively to 50.8, 30.5, and 15.2 mm (20, 12, and 6 in.). Figure 1 shows one of the shotguns used in this study, with the segments sawed from its barrel.

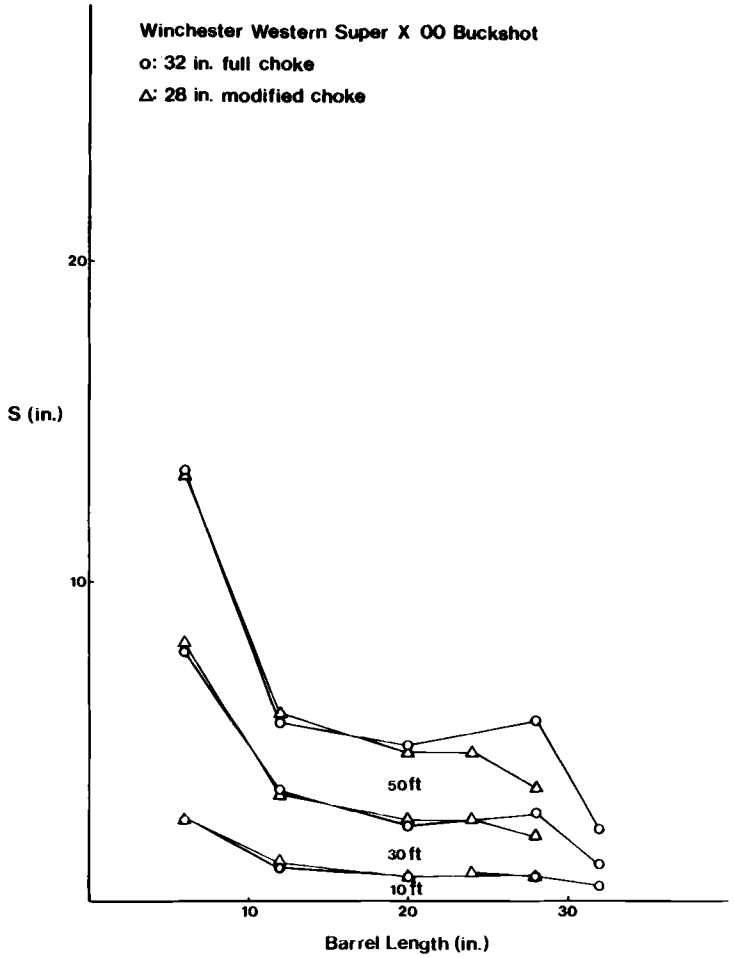

FIG. 3—*Dispersal S versus barrel length for 32-in. full choke and 28-in. modified choke Harrington and Richardson single-shot 12-gage shotguns firing Winchester Western Super X 00 buckshot cartridges. 1 in. = 25.4 mm; 1 ft = 0.3 m.*

The spreads of the 00 buckshot patterns were determined by a method first proposed by Mattoo and Nabar [3]. An overlay of engineering Mylar® ruled in a orthogonal grid was placed over each pellet pattern; the x and y coordinates of each pellet with respect to an arbitrary Cartesian coordinate system were recorded, and the coordinates of the center of mass of the pattern (x_{com}, y_{com}) and the dispersal S were then calculated from the following formulas:

$$x_{com} = \sum_{i=1}^{n} x_i/n \tag{1}$$

$$y_{com} = \sum_{i=1}^{n} y_i/n \tag{2}$$

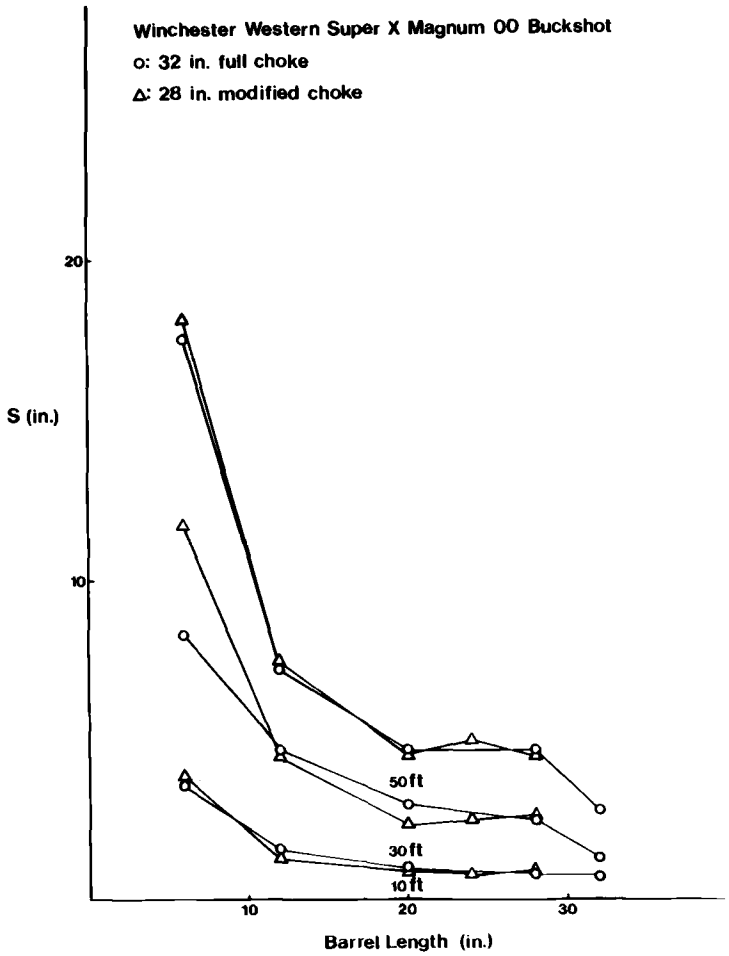

FIG. 4—*Dispersal S versus barrel length for 32-in. full choke and 28-in. modified choke Harrington and Richardson single-shot 12-gage shotguns firing Super X Magnum 00 buckshot cartridges. 1 in. = 25.4 mm; 1 ft = 0.3 m.*

TABLE 2—*Results of test firings of No. 2 shot cartridges.*[a]

Barrel Length, in.	$\sqrt{A}$, in.		
	10 ft	30 ft	50 ft
Winchester Western XX Magnum 12-gage No. 2 shot cartridge (series 1)			
36 (full choke)	4.0 (1.1)	11.0 (1.1)	16.0 (0.8)
32	3.6 (0.2)	14.5 (1.1)	24.7 (2.1)
20	4.7 (0.2)	14.7 (0.6)	28.2 (1.8)
12	8.7 (1.3)	25.0 (0.8)	38.7 (3.8)
6	19.8 (0.5)	59.7 (4.1)	84.7 (2.9)
30 (full choke)	5.5 (0.7)	13.0 (2.0)	20.7 (1.0)
26	3.8 (0.2)	13.7 (1.2)	24.7 (0.5)
20	4.8 (0.2)	15.0 (0.7)	26.4 (1.2)
12	9.2 (1.0)	24.2 (0.6)	41.6 (2.5)
6	20.5 (1.5)	57.0 (3.3)	84.0 (5.3)
28 (modified choke)	4.2 (0.2)	12.5 (0.4)	21.8 (1.3)
24	4.5 (0.4)	14.3 (0.9)	25.0 (0.4)
20	5.0 (0.0)	14.8 (1.3)	24.4 (0.8)
12	10.3 (3.0)	24.7 (0.5)	34.7 (0.9)
6	19.7 (1.4)	62.2 (0.6)	85.8 (6.5)
Winchester Western Super X 12-gage No. 2 shot cartridge (Series 2)			
32 (full choke)	2.0 (0.2)	7.2 (1.4)	15.0 (1.4)
28	4.2 (0.2)	16.2 (1.2)	32.6 (0.8)
20	3.4 (0.2)	14.8 (0.8)	31.0 (1.2)
12	3.4 (0.1)	15.0 (1.6)	28.2 (2.4)
6	6.2 (1.2)	17.6 (1.8)	33.6 (1.6)
28 (modified choke)	2.2 (0.2)	11.2 (0.2)	24.8 (2.2)
24	3.8 (0.6)	17.2 (0.4)	32.4 (2.0)
20	3.4 (0.2)	15.8 (0.6)	29.2 (0.9)
12	3.4 (0.2)	13.8 (2.2)	29.8 (1.8)
6	6.2 (0.6)	19.0 (1.8)	32.8 (2.6)
Winchester Western Super X Magnum 12-gage No. 2 shot cartridge (Series 2)			
32 (full choke)	2.6 (0.2)	8.8 (1.0)	16.2 (3.0)
28	3.8 (0.4)	16.7 (1.0)	30.6 (0.5)
20	3.2 (0.2)	16.4 (1.0)	28.8 (2.0)
12	3.6 (0.0)	14.6 (1.8)	28.0 (1.0)
6	8.2 (2.0)	25.4 (1.2)	38.6 (4.6)
28 (modified choke)	2.6 (0.4)	9.9 (0.5)	20.8 (1.2)
24	3.6 (0.2)	16.0 (1.0)	29.2 (1.8)
20	3.6 (0.2)	15.6 (1.0)	28.2 (1.4)
12	3.8 (0.2)	13.8 (1.4)	23.8 (2.1)
6	7.2 (0.5)	22.4 (1.8)	40.0 (4.6)

[a] Values given are mean (standard deviation); 1 in. = 25.4 mm; 1 ft = 0.3 in.

and

$$S = \frac{1}{n} \sum_{i=1}^{n} [(x_i - x_{com})^2 + (y_i - y_{com})^2]^{1/2} \quad (3)$$

where n = the number of 00 buckshot pellets per load.

The spreads of the No. 2 and No. 7½ shot patterns were determined by calculating the square root of the area of the smallest rectangle that would completely enclose each pellet pattern. Wray et al [*4*] have shown that using the square root of the area of the smallest circumscribed rectangle rather than the area itself diminishes the effect of shot-to-shot variations in the pellet patterns.

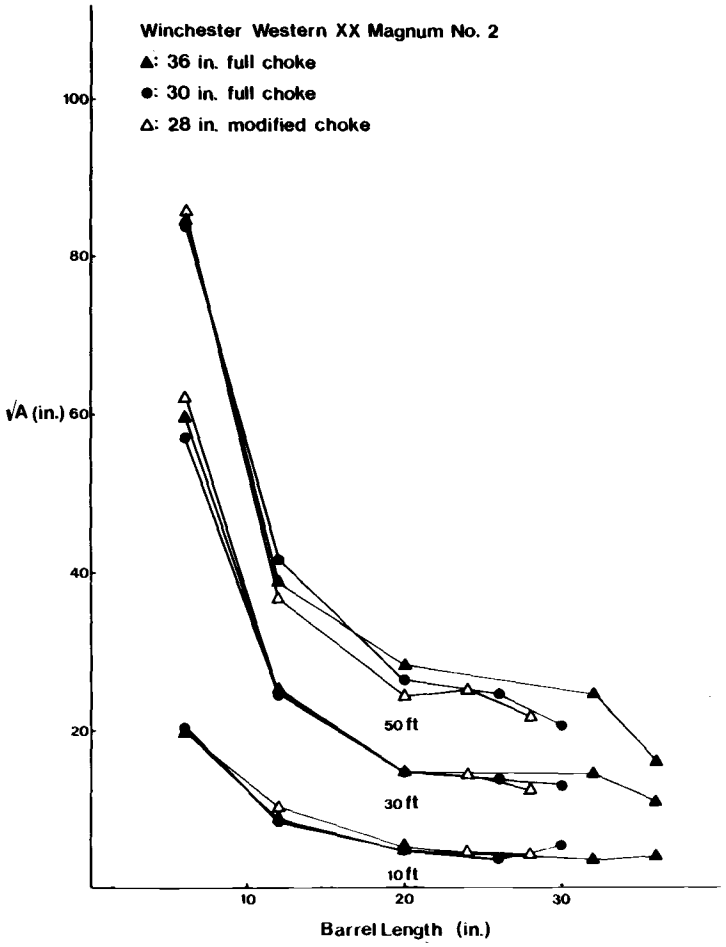

FIG. 5—√A *versus barrel length for 36-in. full choke, 30-in. full choke, and 28-in. modified choke Harrington and Richardson single-shot 12-gage shotguns firing Winchester Western XX Magnum No. 2 shot cartridges. 1 in. = 25.4 mm; 1 ft = 0.3 m.*

Results and Discussions

The results of the test firings of 00 buckshot cartridges are shown in Table 1 and Figs. 2 to 4. In both series of experiments, shortening of the shotgun barrel produced large increases in the size of the pellet pattern. In the first series of experiments, removal of the choke of the shotguns did not produce significant increases in the size of the pellet patterns, while in the second series of experiments the removal of the choke produced a noticeable increase in the size of the pellet patterns. This difference between the first and second series of experiments may reflect differences in the cartridges used.

The results of the test firings of No. 2 shot cartridges are shown in Table 2 and Figs. 5 to 7. Decreasing the barrel length of the shotgun increased the size of the pellet pattern of all three types of No. 2 shot cartridges. For barrel lengths of 305 mm (12 in.) and below, profound

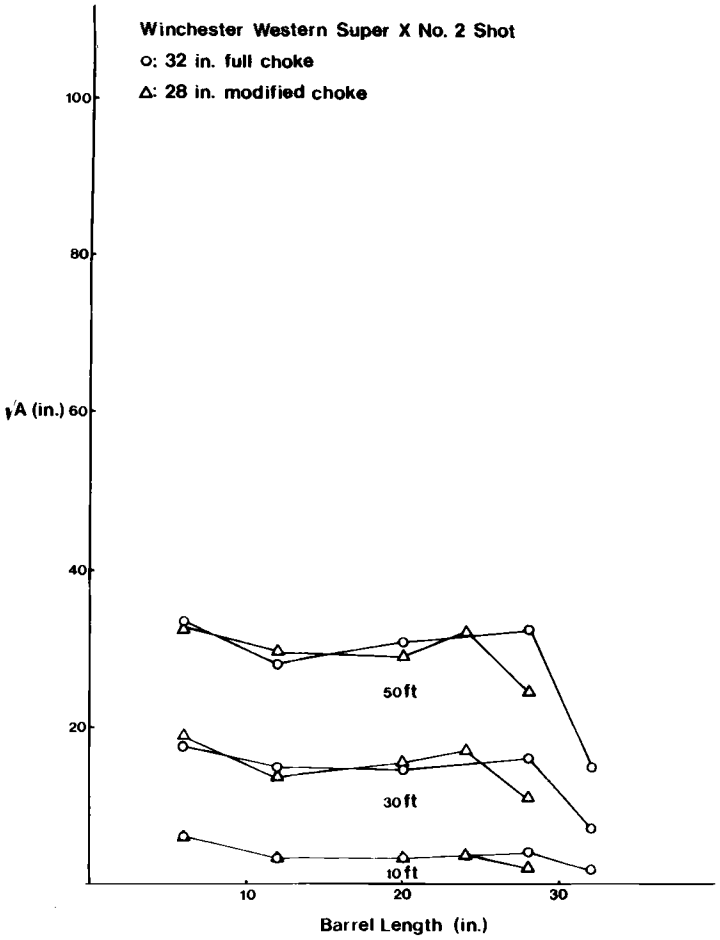

FIG. 6—$\sqrt{A}$ *versus barrel length for 32-in. full choke and 28-in. modified choke Harrington and Richardson single-shot 12-gage shotguns firing Winchester Western Super X No. 2 shot cartridges. 1 in. = 25.4 mm; 1 ft = 0.3 m.*

differences were found between the first and second series of experiments. The XX Magnum cartridges produced significantly larger pellet patterns than the Super X or Super X Magnum cartridges. The spreads of the pellet patterns of the Super X cartridges were nearly constant once the choke was removed.

The results of the test firings of the No. 7½ birdshot cartridges are shown in Table 3 and Figs. 8 and 9. After the removal of the chokes of the shotguns, the size of the pellet patterns tended to remain constant until a barret length of 305 mm (12 in.) was reached. A small increase in pattern size was seen for the 152-mm (6-in.) barrel length.

We conclude that no contradictions exist between our work and that of Kamaka [*1*] and DiMaio and Petty [*2*]. Like Kamaka, we have been able to produce great increases in the size of No. 2 shot pellet patterns when shotgun barrels are reduced below 279 mm (11 in.). Like DiMaio and Petty, we have produced No. 7½ birdshot patterns of almost constant size for

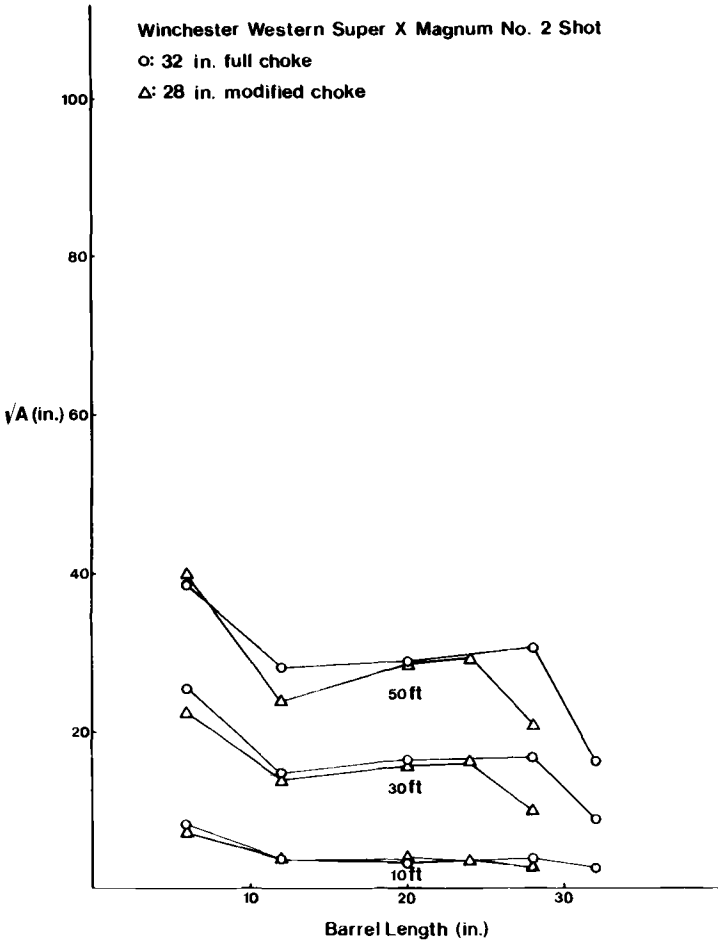

FIG. 7—$\sqrt{A}$ *versus barrel length for 32-in. full choke and 28-in. modified choke Harrington and Richardson single-shot 12-gage shotguns firing Winchester Western Super X Magnum No. 2 shot cartridges. 1 in. = 25.4 mm; 1 ft = 0.3 m.*

cylinder-bore weapons with barrel lengths between 711 and 305 mm (28 and 12 in.). When DiMaio and Petty's data for their Winchester No. 7½ shot patterns fired at 3 m (9.8 ft) are converted into the same form as our data, we find that no significant differences exist between their results and ours (Figs. 8 and 9). Only in the behavior of the patterns produced by our 00 buckshot cartridges do our results differ from those of DiMaio and Petty; however, the profound differences in behavior of different No. 2 shot cartridges show that in general, different types of ammunition may behave very differently in experiments of this type. DiMaio and Petty used Federal 00 buckshot cartridges in their test firings, while we used Remington and Winchester 00 buckshot cartridges. We believe at present no general statement can be made about the size of pellet patterns fired from sawed-off shotguns unless the ammunition is specified and has actually been test-fired from the sawed-off weapon.

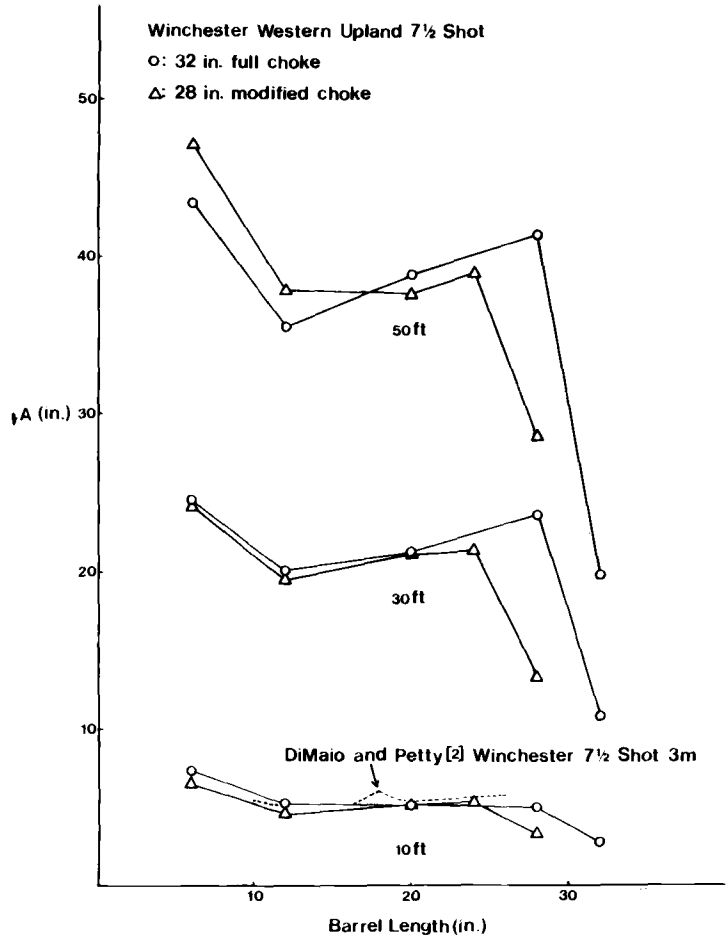

FIG. 8—$\sqrt{A}$ *versus barrel length for 32-in. full choke and 28-in. modified choke Harrington and Richardson single-shot 12-gage shotguns firing Winchester Western Upland No. 7½ shot cartridges. 1 in. = 25.4 mm; 1 ft = 0.3 m.*

Summary

Several brands of 12-gage 00 buckshot, No. 2 shot, and No. 7½ birdshot cartridges were fired from Harrington and Richardson 12-gage single-shot shotguns with the barrels progressively shortened to a length of 152 mm (6 in.). The spreads of the patterns of the 00 buckshot cartridges were found to increase as the barrel length decreased. The spreads of the patterns of the other cartridges were found to increase with decreasing barrel length or to remain constant, depending on the brand of cartridge being fired.

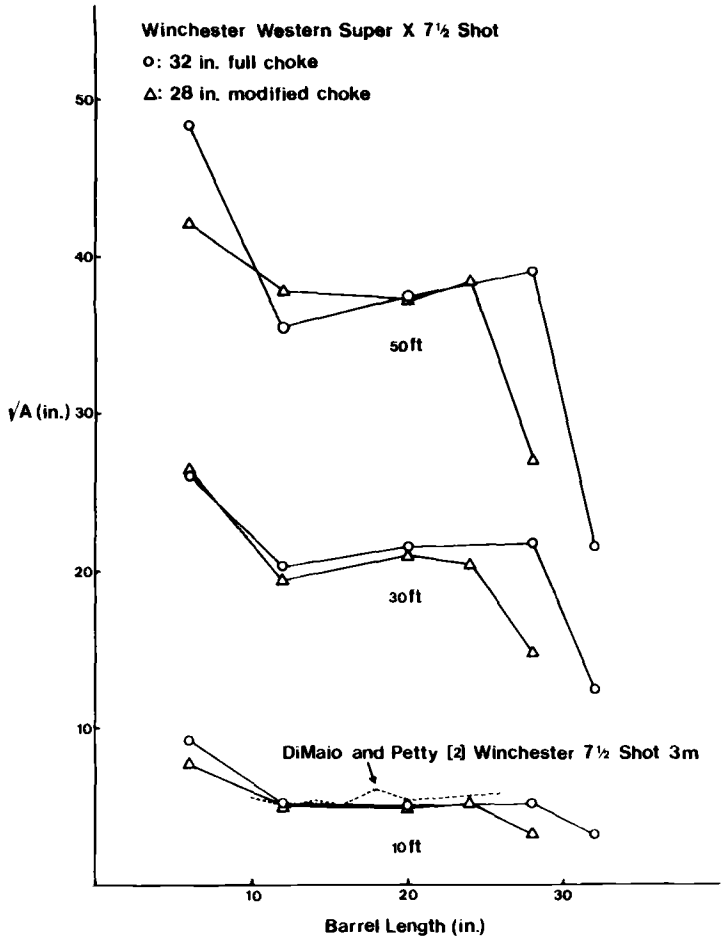

FIG. 9—$\sqrt{A}$ *versus barrel length for 32-in. full choke and 28-in. modified choke Harrington and Richardson single-shot 12-gage shotguns firing Winchester Western Super X No. 7½ shot cartridges. 1 in. = 25.4 mm; 1 ft = 0.3 m.*

TABLE 3—*Results of test firings of No. 7½ shot cartridges.*[a]

Barrel Length, in.	$\sqrt{A}$, in.		
	10 ft	30 ft	50 ft
Winchester Western Upland 12-gage No. 7½ shot cartridges (Series 2)			
32 (full choke)	2.9 (0.4)	11.0 (2.4)	19.9 (3.3)
28	5.1 (0.2)	23.7 (1.0)	41.4 (3.2)
20	5.2 (0.3)	21.3 (1.0)	38.8 (3.8)
12	5.3 (0.1)	20.1 (0.3)	35.5 (1.4)
6	7.4 (0.7)	24.6 (3.4)	43.4 (1.7)
28 (modified choke)	3.4 (0.2)	13.4 (0.8)	28.6 (2.9)
24	5.4 (0.1)	21.4 (0.9)	39.0 (1.1)
20	5.2 (0.3)	21.1 (0.8)	37.6 (2.7)
12	4.6 (0.1)	19.5 (0.5)	37.8 (0.7)
6	6.5 (0.2)	24.2 (2.4)	47.1 (10.5)
Winchester Western Super X 12-gage No. 7½ shot cartridges (Series 2)			
32	3.2 (0.6)	12.5 (0.3)	21.6 (2.4)
28	5.2 (0.2)	21.9 (0.2)	39.1 (1.2)
20	5.0 (0.3)	21.6 (1.4)	37.5 (0.8)
12	5.2 (0.2)	20.3 (1.1)	35.5 (1.1)
6	9.2 (1.1)	26.1 (2.0)	48.4 (1.7)
28 (modified choke)	3.2 (0.3)	14.8 (0.8)	27.2 (1.8)
24	5.2 (0.1)	20.5 (0.9)	38.5 (2.0)
20	4.9 (0.4)	21.0 (0.9)	27.5 (1.2)
12	5.0 (0.1)	19.4 (1.0)	37.8 (2.8)
6	7.7 (0.8)	26.6 (1.7)	42.1 (0.4)

[a] Values given are mean (standard deviation); 1 in. = 25.4 mm; 1 ft = 0.3 m.

References

[1] Kamaka, S. K., "Sawed-off Shotguns and Shotgun Patterns," *AFTE Journal*, Dec. 1970, pp. 26-32.

[2] DiMaio, V. J. M. and Petty, C. S., "The Effectiveness of the Sawed-off Shotgun," *The Forensic Science Gazette*, Vol. 9, No. 2, April-June 1978, pp. 5-6.

[3] Mattoo, B. N. and Nabar, B. S., "Evaluation of Effective Shot Dispersion in Buckshot Patterns," *Journal of Forensic Sciences*, Vol. 14, No. 2, April 1969, pp. 263-269.

[4] Wray, J. L., McNeil, J. E., and Rowe, W. F., "Comparison of Methods for Estimating Range of Fire Based on the Spread of Buckshot Patterns," *Journal of Forensic Sciences*, Vol. 28, No. 4, Oct. 1983, pp. 846-857.

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