TECHNIQUES STUDY OF RAPID SHOOTING FOR CHINESE ELITE SHOOTERS IN THE RAPID FIRE PISTOL EVENT

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Techniques of chinese shooters have been improving in recent years, but the chinese level still falls some short of the world level. The purpose of this study was to investigate techniques of three chinese elite shooters in the rapid fire pistol event. They were measured by the Selspot II system during 21 rapid fire sequences of five shots per string. For each shooter, three of the strings were fired with an 8-second time limit; two strings had a 6-second limit and two strings had a 4-second limit. Four LEDs were attached on the muscle, the rear of muscle, the centre of the right elbow joint and the centre of the right shoulder joint. Sampling frequency was 50Hz, raw data were transformed and Kilman filtered on the PDP11/73 computer, cut-off frequency was 8Hz. Three dimensional data and graphics were obtained.

Lifting characteristics, firing rhythm of each string, moving rifle characteristics and recoil and recovery of the muscle were analyzed, the timing sequences and hold arm position were analyzed. Chinese techniques were compared with techniques for East Germany and USSR. Chinese shooters showed the firing rhythm of uniform accelerations when they fired in the string for five shots, there were differences of three shooters' firing rhythm in three kinds of time limit groups. In the time of lifting to first shot and the time elapsed to fire each of the five shots, times of the chinese shooters were shorter than times of USSR's shooters. Compared to foreign elite shooters, the Chinese shooters showed that their speed of lifting was higher, but the time of aiming before first shot was longer. It was found that the muscle recoiled larger and the recovery time of rifles were shorter.

It was relative to the grip force and the tension of the hold arm muscles, so it could be an important index of technical evaluation.

This paper, however, focuses upon primarily the analysis of the lifting characteristics, the firing rhythm and pattern, as well as upon the comparison with the foreign counterparts.

In the light of the pistols rapid firing characteristics, we have carried out a time phase / interval analysis of each string over the shooters' complete technical movements in an attempt to find out the pistol lifting time, the intermittently distributed times of the five shots and the total time of each string. The movements of a string, as shown in Fig. 1 ("s" stands for shooting point), fall into the following stages: from the lifting to aiming (T_0), from aiming to the first target (T_1), from the first to the second (T_2), from the second to the third (T_3), from the third to the fourth (T_4), from the fourth to the fifth (T_5), from the fifth to putting down the gun (T_6).
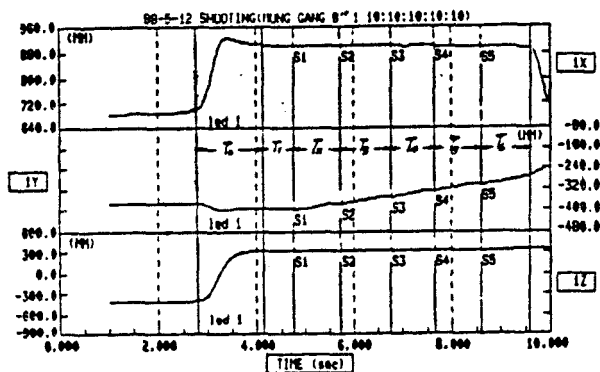
Figure 1: Time Phases /Interval of Shooting Movements/

The data of three Chinese shooters are hereby listed along with those of the East German shooter Weffer, which were extracted from [2].

TABLE 1
Average Times of Firing Segments

Group	8-sec. strings (s)			6-sec. strings (s)			4-sec. strings (s)		
Segment / Name	Meng Gang Xiao dong	Zhang Li Zhong qi	Wef-fer	Meng Gang / Zhang Xiao dong	Li Zhong qi	Wef-fer	Meng Gang Xiao dong	Zhang Li Zhong qi	Wef-fer
T0	0.90 1.10	0.87	1.03	0.97 0.95	0.76	0.91	0.66 0.78	0.75	0.84
T1	1.34 1.23	1.36	0.93	0.64 1.26	0.78	0.58	0.84 0.60	0.68	0.43
T0+T1	1.34 2.33	1.33	1.96	1.61 2.21	1.54	1.53	1.48 1.38	1.43	1.27
T2	0.99 1.34	1.19	1.21	0.90 0.87	0.95	0.92	0.59 0.60	0.60	0.63
T3	0.93 1.38	1.39	1.13	0.81 0.86	0.88	0.94	0.54 0.56	0.54	0.58
T4	0.87 0.94	1.13	1.07	0.69 0.82	0.93	0.91	0.55 0.48	0.52	0.56
T5	0.87 0.97	1.09	1.12	0.84 0.77	0.73	0.91	0.52 0.50	0.47	0.60
T6	0.82 1.15	3.49	0.57	0.42 1.01	0.52	0.57	0.42 0.79	0.41	0.47
Total of T5	5.6 6.16	5.43	6.46	4.85 5.13	5.03	5.20	3.68 3.46	3.56	3.64
% of To-tal Time Used	70 % 79.5%	84.4%	80.9%	80.9% 88.9%	83.8%	88.2%	92 % 86.5%	89 %	91 %

Note: T_0 means Movement from the pistol lifting to aiming
$\quad T_1 \quad$ "   "   "   aiming to shot 1
$\quad T_2 \quad$ "   "   "   shot 1 to shot 2
$\quad T_3 \quad$ "   "   "   shot 2 to shot 3
$\quad T_4 \quad$ "   "   "   shot 3 to shot 4
$\quad T_5 \quad$ "   "   "   shot 4 to shot 5
$\quad T_6 \quad$ "   "   "   shot 5 to putting down the pistol

I. Characteristics of the movements from pistol lifting to the first target

We can see from the above table that compared with our shooters, technically Weffer is fairly slow at the movement (1) from pistol lifting to aiming, but quite quick at the movement (2) from aiming to the first target; whereas the Chinese shooters are just vice versa. Viewing the motional mechanism, a swift lifting produces a stronger inertia upon the arm. For the purpose of fast immobilizing the pistol and ensuring the accurate aiming direction, it demands the upper arm and the shoulder deltoid muscules to exercise a braking moment of force, this being doubtlessly a tough subject to the control power of the muscles concerned. In practice, the lack of sufficient muscular control often effects an inefficiency of the pistol's pointing to the aiming area, wasting long time in aiming adjustment.

TABLE 2
Kinematic Data for Pistol Lifting

Group	Name	Index Data	T [s]	θ [deg]	W [deg/s]	V [mm/s]	W max [deg/s]	V₂max [mm/s]
8	Meng Gang		0.88	48.4	54.6	779.0	110.4	1577.1
	Zhang Xiaodong		0.99	51.5	51.4	712.3	108.8	1564.9
	Li Zhongqi		0.90	56.5	61.8	788.7	133.4	1711.6
6	Meng Gang		0.89	48.5	53.5	767.9	109.7	1570.3
	Zhang Xiaodong		1.06	52.1	48.4	667.0	112.0	1605.3
	Li Zhongqi		0.87	55.1	62.3	812.5	140.2	1781.0
4	Meng Gang		0.93	48.8	51.5	737.5	117.5	1660.2
	Zhang Xiaodong		0.93	52.1	55.0	758.7	120.7	1738.9
	Li Zhongqi		0.81	56.3	68.1	859.9	147.9	1868.3

Note: "θ" refers to the angle between the pistol vertical
      axis and the horizontal plane XOY
      "T" refers to the time from the start of lifting pistol
      to reaching the horizontal level
      "W" refers to the angular velocity of θ
      "V₂" refers to the displacement velocity of muzzle in
      direction Z

The pistol rapid shooting is restricted by time in the match. How to make the best of the allowed time for is a decisive skill to accomplish a sharp shooting. Therefore, the serial movements of gun lifting, aiming and the first firing are none rather than high techniques of this nature, especially in the 4-second limit shooting. The pistol moving tendency is vertical from the lifting to the first target shooting, and then horizontal from the second to the fifth shooting. The proper operation of the vertical movements henceforth affects the following four shots drastically. Table II demonstrates the three Chinese shooters' pistol lifting data of sport science. Their upper arm moving angles share a high similarity from standby position to the completion of the lifting, regardless of the three time-limit groups they shoot. This suggests that the movements of the masters bear much resemblance, although they still vary somewhat in the maximum rate and the rate of the angular displacement, as well in the average muzzle linear velocity in the direction Z and the maximum speed. The lifting time of the Soviet sharpshooters usually ranges between 0.8-0.9 second, while that of the Chinese ones is close to this timespan from 0.84 ~ 1.60 in three groups of shooting. If judging by the time used upon the movements from lifting to the first shot, the Chinese shooters consume less time, namely 1.43 -2.07 second as compared with Soviets, i.e. 1.61-2.30 seconds. (Tab. III).

II. The Time Phase Analysis of the First to Fifth Firing

In every string, a reasonable time division for each shot is a key technique in rapid shooting. The highly trained masters present a rhythmic movement of a uniform motion or even acceleration in the whole process of every string. Basically, the Chinese and the Soviet firers shoot in even acceleration, as in Table III, though the former are faster in the acceleration.

TABLE 3
Comparison of Average Times for Firing Segments between Chinese and Soviet Shooting Masters.

Group	Index Motion	pistol-lifting to shot	shot 1 to 2	shot 2 to 3	shot 3 to 4	shot 4 to 5	Total time of a string
8-sec string	China	2.07	1.07	1.03	0.98	1.01	6.16
	U.S.S.R.	2.30	1.21	1.13	1.07	1.03	6.74
6-sec string	China	1.72	0.91	0.85	0.81	0.78	5.07
	U.S.S.R.	2.02	0.93	0.86	0.83	0.78	5.42
4-sec string	China	1.43	0.60	0.55	0.52	0.50	3.60
	U.S.S.R.	1.61	0.59	0.54	0.51	0.50	3.75

The shooting rhythm has an affinity with shooters' sense of time. For this reason, the East Germany and the Soviet Union place emphasis on the training of this aspect. Their endeavours turn out to be quite fruitful in that they are capable of keeping an advanced world level in this sport.

Table III. The muzzle Motional Pattern and the Time of Post-shooting Recovery

The recoil of the shooting pistol is conditional with several factors, such as the gun design, ammunition, the gripping strength at the moment of firing, and the tension in the upper arm and shoulder deltoid muscles. A powerful grip and muscular strain maintains a small muzzle displacement; nevertheless too strong grip may impair the coordination of the movement at different parts of body. A small pistol displacement can determine a more concentrated area of potential impact, hence a more ideal result frequently. To a certain extent, the height of recoil reflects the gripping strength and the degree of the muscular tension upon the arm. Table IV here shows the vertical muzzle recoil and recovery time of the Chinese shooters. From the table, we are aware that Mr. Li's pistol muzzle recoils the most, but recovers the fastest; Mr. Meng's eases are just opposite. The illustration enables us to discover such fact that the more violently the muzzle reacts, the sooner it is restored. As a matter of fact, the two chief variables of the gripping strength and the muscular strain of the pistol-holding arm are closely related to the time of pistol recovery.

TABLE 4
Indexes of Muzzle Recoil and its Recovery

Group	Index / Name Data	Z1 (mm)	Z2 (mm)	Z3 (mm)	Z4 (mm)	Z5 (mm)	T1 (s)	T2 (s)	T3 (s)	T4 (s)	T5 (s)
8-sec	Meng Gang	2.1	1.9	2.1	2.5	2.4	0.16	0.16	0.15	0.13	0.13
string	Zhang Xiadong	2.0	2.1	2.0	1.9	2.0	0.21	0.20	0.19	0.15	0.23
	Li Zhongqi	1.0	1.0	1.4	1.1	1.5	0.25	0.27	0.27	0.26	0.18
6-sec	M.G.	2.3	2.6	2.5	2.1	1.9	0.14	0.15	0.14	0.16	0.15
string	Z.X.	1.8	1.7	1.6	2.0	1.9	0.19	0.13	0.12	0.17	0.14
	L.Z.	1.9	0.9	1.0	1.0	0.7	0.26	0.27	0.31	0.25	0.20
4-sec	M.G.	1.6	1.7	2.2	2.2	2.5	0.15	0.13	0.15	0.18	0.22
string	Z.X.	1.5	1.7	2.1	1.9	2.2	0.14	0.16	0.15	0.17	0.14
	L.Z.	1.2	0.9	1.0	0.3	0.1	0.21	0.11	0.19	0.21	0.17

Note: Z refers to vertical displacement of the muzzle recoil
    T refers to the recovery time of the muzzle recoil

Now that a firing produces muzzle kickback, it naturally influences the shifting to the next target and the time of its aiming. So the length of time spent upon the post-shooting recovery of the gun brings certain effects on the shooting score. Table V is a comparison of the recovery time data between the Chinese and the Soviet shooters.

In short, the muzzle recoil height and the post-shooting recovery time should be indexes to evaluate the techniques of a shooter.

TABLE 5
Means of Muzzle's Recovery Time in 10 Rings

	8-sec. strings [s]	6-sec. strings [s]	4-sec. strings [s]
U.S.S.R International Master Sportmen	0.15	0.15	0.15
U.S.S.R. National Master Sportmen	0.18	0.18	0.18
Meng Gang	0.15	0.15	0.15
Zhang Xiaodong	0.20	0.15	0.15
Li Zhongqi	0.25	0.26	0.18

CONCLUSION

1. The shooting ryhthm of the Chinese shooters demonstrates an acceleration in the whole sequences of the rapid shooting, despite that there still exist some distinctions from person to person. They take less time on the movements from the lifting to the first firing, and on the interval of targets shooting as opposed to the Russian shooters.

2. The Chinese shooters lift the pistol faster, but aim and fire slower. Sometimes they even have to make a pause to the pistol.

3. The recoil height of the muzzle has something to do with the recovery time of the gun. That is to say, within certain muzzle recoil area, a greater reaction may be favorable to a quicker gun recovery. This circumstance is closely related to the gripping strength and the collective muscular strain of the gun-holding arm. These techniques can be employed to serve as the technique evaluating indexes.

REFERENCES

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