ELEMENTARY RESEARCH ON THE MOST SUITABLE MODE FOR THE ARCHERS OF THE SHANDONG TEAM

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INTRODUCTION: Archery is an ancient sport. In recent years, the development of archery in China has been quite rapid. The practice of this sport in Shandong has also rapidly increased, but it is rare for archers' techniques to be quantitatively analyzed. Therefore the movement structure, kinematic features and influence on the performance of 6 archers on the Shandong team were comprehensively compared and analyzed in order to raise their technical level. The best movement techniques were found and combined in the most suitable mode of these six archers. According to this mode, their techniques were improved individually in training. The more rational movement techniques were performed, followed by an exploration of new ways of scientific training in archery.

METHOD OF RESEARCH: Thirty-six arrow shots of these six archers of the Shandong team were analyzed, and the data were processed by the more advanced video analysis system - Bewegungs Analysis System: Pentium 586 computer; 21 inch SAMSUNG advanced color monitor (1024%1024); Panasonic Video Cassette Recorder (AG-7355); the video tape is recorded with time code; the software program to be provided by Germany. The interval between the frames was 0.02 second. The digital filtering method was used for data smoothing and a cutoff frequency of 3 Hz was adopted. In measuring, x axis: the direction perpendicular to the target; y axis: the direction perpendicular to the horizontal plane; z axis: the direction parallel to the target.

RESULTS AND ANALYSIS:
1. A comparison and analysis of six archers in each phase period
1.1 The average time for an arrow to be shot by each varies greatly (from 4.812s to 10.956s). The average time for an arrow to be shot by the same archer is relatively stable. The movement rhythm of the six archers is not the same.

Table 1 The average time of each phase period for six archers

Name	Bow arm just to raise release		bow arm just to raise fixing		fixing release	
	t (s)	s	t1 s	(s)	t2 s	(s)
Li Changjun	6.127	0.972	4.657	0.890	1.470	1.026
Xin Lei	7.720	0.771	5.190	0.346	2.530	0.895
Li Meng	10.956	1.810	4.244	0.156	6.712	1.816
Tang Huan	4.812	0.662	3.893	0.457	0.847	0.449
Zhu Maodong	5.467	1.143	3.560	0.238	1.907	1.068
Sun Wie	7.024	0.657	3.932	0.445	3.092	0.253

When the shooting time for an arrow is analyzed, the shooting action is divided into two periods: bow arm just to raise   fixing; fixing   release. Table 1 shows that the average time for an arrow to be shot by Li Meng is the longest (10.956s), and by Tang Huan the shortest (4.812s); the standard errors of the shooting time for an arrow are all very small, except for Li Meng. The great variety of time in fixing the release period for six archers causes the variety of their shooting time for an arrow. The variety of time in bow arm just to raise the fixing period is not great. The time of Li Meng in the fixing - release period is too long, and time of Tang Huan in this period is too short. This is unfavorable to the stability of arrows. Comparatively speaking, the shooting time and the distribution of time of Li Changjun, Zhu Maodong and Xin Lei in each period are relatively rational. In training, the fast rhythm should be proposed, and time in fixing the release period should not be too long or too short, and should be controlled at about 2s-3s.

1.2 The shooting time of arrows hitting the ten-point ring is ordinarily from 4.897s to 7.84s, and the average value is 6.295s. The aiming time (not fixing the release period) is from 2.460s to 5.600s, and the average value is 3.804s. The shooting time of arrows hitting the eight-point ring is under 4.320s, and the aiming time is under 2.24s. Therefore the shooting time of Tang Huan and Li Meng should be controlled in training.

2. A comparison and analysis of the kinematic features of these six archers was made.
2.1 It was found that the drawing arms of these six archers move forward in varying degrees before the forcing to release period. Table 2 shows the range and time of this 'reverse action'. The direction of   x1 and   x2 is from the back to the front. The time of the reverse action of Li Changjun and Xin Lei is longer. The range of the right wrist joint points of Zhu Maodong and Xin Lei on x1 is greater. This reverse action influences the accuracy of hits, is a bad technique feature, and should be improved in training.

Table 2 The range and time of the reverse action

	time	right wrist			right elbow			left wrist		
	(s)	x1	y1	z1	x2	y2	z2	x3	y3	z3
		(cm)			(cm)			(cm)		
Li Changjun	0.30	0.28	0.05	0.20	0.17	0.46	0.21	0.07	0.16	0.22
Xin Lei	0.28	0.60	0.22	0.34	0.18	0.48	0.47	0.16	0.39	0.23
Li Meng	0.14	0.53	0.16	0.08	0.48	0.64	0.15	0.20	0.32	0.05
Tang Huan	0.14	0.49	0.10	0.14	0.23	0.51	0.30	0.11	0.07	0.20
Zhu Maodong	0.20	0.76	0.12	0.19	0.00	0.36	0.23	0.18	0.29	0.13
Sun Wei	0.12	0.42	0.21	0.31	0.10	0.25	0.53	0.06	0.32	0.10

2.2 Table 3 shows that the cooperating motion way of the bow arm and the drawing arm of Li Meng and Zhu Maodong is that two arms move towards the back side of the body. This technique is relatively rational. The way of Xin lei and Sun Wei is that the bow arm moves towards the belly of the body, and the drawing arm moves towards the back of the body, the so-called 'inner close'. The force of the bow arm is not big enough to make an 'inner close'. The direction of the bow arm (left wrist) motion on x axis of Li Changjun is not correct. The motion of the drawing arms of the six archers on the x axis and y axis are similar.

Table 3 The motion direction of each joint point in the forcing to release period

	right wrist			right elbow			left wrist			right trunk point		
	x1	y1	z1	x2	y2	z2	x3	y3	z3	x4	y4	z4
Li Changjun	←	↑↓	l	←	↓	rl	←	↑	r		↑	l
Xin Lei	←	↓↑	rl	←	↓	l	→	↓	r	←	↓	lr
Li Meng	←	↑	l	←	↑↓	l	→	↓	l	→	↑	l
Tang Huan	←	↑	r	←	↓	l	→	↓	l	←	↓	rl
Zhu Maodong	←	↑	l	←	↓	l	→	↑	l	→	↑↓	l
Sun Wei	←	↑	l	←	↓	l	→	↑	r	→	↓	r

←: backward　↑: upward　l: towards the left
→:forward　↓: downward　r: towards the right

2.3 Time in the forcing to release period is from 0.08s 0.140s (see Table 4). The range of right wrist and right elbow joint points of Zhu Maodong, Xin Lei and Sun Wei on the x axis is larger. The average velocity of the right wrist and right elbow joint points is higher in this period. The range of right wrist and left wrist joint points on y axis and z axis should be the smallest, and be favorable to arrow stability.

Table 4 The range and velocity of each joint point in the forcing to release period

	time (s)	right wrist x (cm)	y (cm)	z (cm)	v (cm/s)	right elbow x (cm)	y (cm)	z (cm)	v (cm/s)	left wrist x (cm)	y (cm)	z (cm)	v (cm/s)
Li Changjun	0.08	0.66	0.04	0.12	9.94	0.69	1.11	0.13	18.38	0.03	0.42	0.22	6.13
Xin lei	0.14	1.91	0.18	0.21	11.64	1.56	1.76	0.89	14.86	0.19	0.46	0.33	4.23
Li Meng	0.08	0.88	0.44	0.25	13.86	0.78	0.09	0.44	14.52	0.21	0.30	0.13	5.16
Tang Huan	0.08	1.32	0.82	0.08	20.94	0.72	1.11	1.49	19.73	0.15	0.15	0.06	3.13
Zhu Maodong	0.10	2.13	0.37	0.20	22.87	1.65	1.31	1.27	27.20	0.13	0.32	0.11	3.59
SunWei	0.08	1.56	0.39	0.48	23.66	1.45	1.16	1.23	31.71	0.21	0.46	0.09	7.47

CONCLUSION AND RECOMMENDATIONS:

1. The movement rhythm of Li Changjun, Tang Huan and Zhu Maodong is relatively fast. The movement rhythm of Xin Lei and Li Ming is relatively slow. The movement techniques of Li Meng and Zhu Maodong in the forcing to release period are a bit similar. The movement techniques of Xin Lei and Sun Wei in the forcing to release period are a bit similar.

2. The best movement techniques of each can be combined in the most suitable mode to train the archers.

3. In training, the movement techniques of some of the archers should be improved with rational technique features.

REFERENCE:

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