INDIVIDUALIZED OPTIMAL RELEASE ANGLE IN DISCUS THROWING

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INTRODUCTION: Release angle is a parameter that significantly influences the official distance through its effects on the vacuum flight distance and the aerodynamic distance (distance gain or lose due to aerodynamic effect) in discus throwing. Significant efforts have been made to determine the optimal release angle for discus throwing. Previous studies on the optimal release angle in discus throwing were based on two critical assumptions: (1) the release angles and the release speeds were independent of each other, and (2) the optimal release angle was the same for all discus throwers. These two assumptions may have been violated in previous studies on the optimal release angle (Hubbard et al., 2001; Linthorne, 2001; Viitasalo et al., 2007). The violation of these two assumptions may have resulted in significant errors in the optimal release angles for discus throwers reported in the current literature. The purposes of this study were: (1) to determine the relationships between the release speed and the release angle for individual discus throwers, (2) to determine the relationships between the aerodynamic distance and the release angle for individual discus throwers, and (3) to determine the optimal release angles for individual discus throwers; using data collected in competition.

METHOD: Three male and three female right-handed elite discus throwers were used as the subjects for this study. Each of these six subjects had at least 10 legal trials videotaped during the men's and women's discus throw competitions of the USA Track & Field National Outdoor Championships from 1997 to 2006. Two video camcorders were used to record the discus throwers' performances at a frame rate of 60 fields per second and a shutter speed of 1/1000 seconds using a setup for Direct Linear Transformation (DLT) procedure. Real-life three-dimensional (3-D) coordinates of the centre of the discus were estimated using the DLT procedure. The release speed and release angle of the discus, and the vacuum flight distance, the aerodynamic distance, and the distance lost at release were estimated from the 3-D coordinates of the discus. The original data set of each subject was randomly re-sampled to form 10 new data sets using a Bootstrapping method. The number of samples in each new data set was the same as the number of trials in the original data set. Multiple regression analyses were performed for each data set to express the release speed of the discus and the aerodynamic distance as a function of the release angle. The official distance of each subject was then expressed as the sum of vacuum and aerodynamic distances which were expressed as a function of the release angle using the regression relationships between the release speed and angle and between aerodynamic distance and release angle. Official distances were determined for each data set with the release angle varied from 30 to 50 degrees. The release angle corresponding to the longest official distance was considered as the optimal release angle for a given data set. The mean optimal angle of the 10 new data sets was considered as the optimal angle for a given subject. The 95% confidence interval around the mean optimal release angle for the 10 data sets for a given subject was used as the uncertainty measure of the estimated optimal release angle for a given subject.

RESULTS: The relationship between the release speed and the release angle was linear for all subjects. The regression coefficients in the equations relating the release speed to the release angle were different among subjects. The relationship between the aerodynamic distance and the release angle was also linear for all subjects. The regression coefficients in the regression equations relating the aerodynamic distance to the release angle were different among subjects.

Each subject had a single estimated optimal release angle corresponding to the longest calculated official distance (Table 1). The estimated optimal release angles were different among subjects and ranged from 35 to 44 degrees with uncertainties within 2 degrees (Table 1).

Table 1. Observed and Optimal Release Angles (degrees).

		Observed			
Subject	Gender	Minimum	Mean ± SD	Maximum	Optimal ± 95%CI
A	M	31	36 ± 2	38	40 ± 1
B	M	34	38 ± 2	41	44 ± 2
C	M	33	39 ± 3	41	39 ± 1
D	F	35	38 ± 2	43	44 ± 1
E	F	30	37 ± 3	44	35 ± 1
F	F	32	36 ± 3	44	37 ± 1

DISCUSSION: The relationships between release speed and angle of individual discus throwers observed in this study are consistent with those for javelin throwers (Viitasalo et al., 2007) and shot putters (Hubbard et al., 2001; Linthorne, 2001). These relationships indicate that the throwers' abilities to generate the speed of the implement change as the release angle changes.

The release angles preferred by elite discus throwers may not necessarily be optimal for themselves, and certainly not for all discus throwers. The optimal release angle is different for different discus throwers. The optimal release angles for individual discus throwers could be beyond the observed range of the release angles they currently used. Further wind tunnel studies are needed to determine the aerodynamic effects on optimal release angles with the consideration of the relationship between release speed and release angle. Future studies are also needed to determine the factors that affect the relationship between release speed and release angle. These studies will provide significant information for the technical and physical training of discus throwing.

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