BIOMECHANICAL ANALYSIS OF THE MEN'S DISCUS THROW IN THE ATHENS 2006 I.A.A.F. WORLD CUP IN ATHLETICS

Vassilios Panoutsakopoulos, M.A. Aristotle University
Department of Physical Education Thessaloniki, Greece
and Sport Science

Introduction

The purpose of the present research was to present the time analysis and the biomechanical parameters of the men's discus throw in the 10th I.A.A.F. World Cup in Athletics (Athens, Greece; 18 Sept. 2006).

The technique of the discus throwing consists of the preliminary swings, the preparation, the entry, the airborne, the transition, the delivery and the recovery [1]. Under the perspective of leg support, the discus technique is structured as the double and single support starting phases, the supportless phase, and the single and double support delivery phases [2]. Research concerning the throws in major track and field competitions includes time analysis (i.e. the duration) of the above mentioned phases as useful information concerning the technique of the discus throw; the release velocity, height and angle are presented as important biomechanical parameters [3-10].

Methods

All four trials of the nine participants were recorded with two JVC GR-DVL9600E (Victor Company, Japan) digital video cameras. The best attempt of the throwers was selected for further study (Table 1). For the 7th place athlete, only his first throw (56.38m) was suitable for analysis.

Table 1. The participating athletes, the result, their personal best (PB) and the result as percentage (%SB) of the season best record (SB@2006) before the competition [11].

Rank	Athlete	Nation	Result (m)	Trial	PB (m)	SB@2006 (m)	%SB
1	ALEKNA	LTU	**67.19**	3	73.88	71.08	94.5
2	HADADI	IRI	**62.60**	4	65.25	61.32	102.1
3	WALTZ	USA	**62.12**	3	68.91	68.91	90.1
4	EL GHAZALY	EGY	**61.50**	2	65.33	65.33	94.1
5	MARTIN	AUS	**60.93**	2	64.00	64.00	95.2
6	PETEL	FRA	**58.18**	2	68.90	61.15	95.1
7	PISHCHALNIKOV	RUS	**58.17**	1	64.19	64.19	90.6
8	KONSTAS	GRE	**58.17**	2	61.41	60.70	95.8
9	TUNKS	CAN	**56.92**	2	67.88	65.82	86.5

A 3D analysis was conducted using the methodology proposed by Ariel et al. [9]. The sampling frequency was set at 50 frames per second. Data processing was accomplished using the APAS-XP software (Ariel Dynamics Inc., Trabuco Canyon, CA). Due to the selected sampling frequency, the accuracy of the present time analysis was ±0.01sec.

Results

In the 2006 I.A.A.F. World Cup in Athletics, the best discus throws ranged from 67.19m to 56.92m and the medals were decided by throws over 62.12m (Table 1).

Table 2 presents the time analysis for the preparation (P; double support starting phase), the entry (E; single support starting phase), the airborne (A; supportless phase), the transition (T; single support delivery phase) and the delivery (D; double support delivery phase – see figure 2).

Table 2. Duration (in seconds) of the discus throw phases, the sum (S1) of phases P→D and the sum (S2) of phases E→D.

Rank	Athlete	Throw (m)	P	E	A	T	D	S1	S2
1	ALEKNA	67.19	0.70	0.40	0.08	0.18	0.20	**1.56**	0.86
2	HADADI	62.60	0.70	0.36	0.04	0.22	0.18	**1.50**	0.80
3	WALTZ	62.12	0.64	0.38	0.10	0.16	0.22	**1.50**	0.86
4	EL GHAZALY	61.50	0.50	0.42	0.06	0.20	0.22	**1.40**	0.90
5	MARTIN	60.93	0.48	0.40	0.10	0.20	0.16	**1.34**	0.86
6	PETEL	58.18	0.46	0.36	0.08	0.20	0.22	**1.32**	0.86
7	PISHCHALNIKOV	56.38	0.50	0.34	0.06	0.22	0.16	**1.28**	0.78
8	KONSTAS	58.17	0.66	0.32	0.16	0.16	0.18	**1.48**	0.82
9	TUNKS	56.92	0.76	0.34	0.08	0.24	0.20	**1.62**	0.86

In the starting phase, the entry had a shorter duration than the preparation. Five of the participants (1st, 3rd, 4th, 6th & 8th) exhibited a longer delivery compared to the duration of the transition. There was no clear evidence of the existence of a consistent movement pattern among the participants, since a large variability (7-15%) was noticed in the time distribution of each phase in the throw (Figure 1).

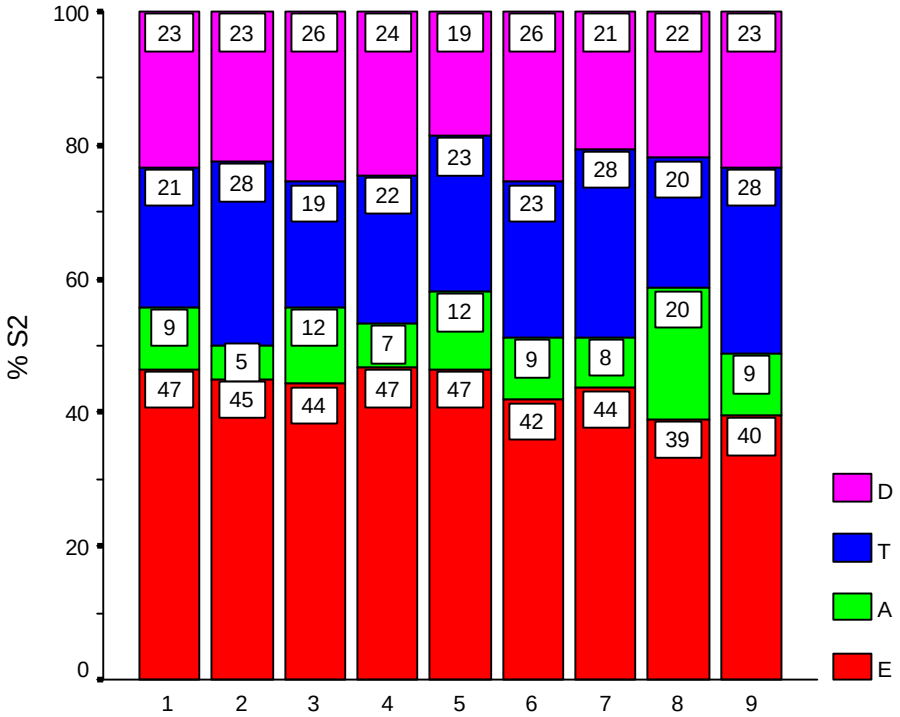

Figure 1. The duration of each discus technique phase as percentage of the sum (S2) of the duration of the entry (E), the airborne (A), the transition (T) and the delivery (D).

The biomechanical parameters of the release are presented in Table 3. Alekna (LTU) won despite the fact that the 2nd place athlete had larger values in all three release parameters. It is also worth noting that the lower release angle was presented by Martin (AUS) during his one and only valid attempt.

Table 3. Release velocity (U), angle (AngPr) and height (H) for the analyzed throws.

Rank	Athlete	Throw (m)	U (m/sec)	AngPr (deg)	H (m)
1	ALEKNA	67.19	26.9	32.9	1.71
2	HADADI	62.60	27.7	35.7	1.84
3	WALTZ	62.12	26.1	32.7	1.60
4	EL GHAZALY	61.50	28.3	27.4	1.68
5	MARTIN	60.93	30.0	22.8	1.60
6	PETEL	58.18	23.4	39.0	1.79
7	PISHCHALNIKOV	56.38	23.9	36.5	1.79
8	KONSTAS	58.17	28.5	24.2	1.53
9	TUNKS	56.92	23.7	36.8	1.60

Discussion

The duration of the discus throw from the entry to the release in the present study (0.78 – 0.90sec) was in agreement with those (0.57 – 0.93sec) reported in the literature [6-8, 10]. The average duration of the entry (0.37sec) was equal to the average duration reported [5-8]. The same consistency with reported data [3-4, 7-10] was observed for the release velocity, angle and height (see Table 5).

Table 5. Range of performance and the reported average release parameters of the medal winners in major Track & Field competitions (1976-2006).

Competition	Gold (m)	Silver (m)	Bronze (m)	U (m/sec)	AngPr (deg)	H (m)
1976 Olympic Games [3]	67.50	66.22	65.70	26.1	35.8	1.76
1984 Olympic Games [4]	66.60	66.30	65.46	24.7	35.6	1.73
1988 Olympic Games [7]	68.82	67.48	67.38	25.1		
1993 World Champs [8]	67.72	66.90	66.12	25.6	36.4	1.86
1996 Olympic Games [9]	69.40	66.60	65.80	28.1	32.6	
1997 World Champs [10]	68.54	66.70	66.14	24.5	33.9	
2006 World Cup	**67.19**	**62.60**	**62.12**	**26.9**	**33.8**	**1.71**

As mentioned in the results section, the athlete with the favourable largest values in the three biomechanical parameters of the release lost the gold medal in the 2006 World Cup. This finding brings to mind the research done concerning other variables (i.e. angle of attack, axial spin, pitch attitude, roll angle, relative wind velocity) which influence the discus trajectory [12-13].

During the last support, the transition and the delivery where almost equally divided (49.5% and 50.5% respectively). This ratio was reported as 55% vs 45% in previous studies [5-8, 10]. The main goal of the thrower at that point is to optimize the delivery conditions [2] and the release velocity [8]. In order to achieve this, the following have been suggested:

1. to drive vigorously during the entry [14],
2. to take advantage of the ground reaction forces during the entry and the transition by developing angular momentum about the vertical axis (and to be transferred to the discus later on in the throw) [15], and

3. to maintain proper hip-shoulder and shoulder-arm separations after the airborne phase, although these parameters may not differentiate performances in elite male discus throwers [16]

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Author's biography

Vassilios Panoutsakopoulos is a member of the International Track & Field Coaches Association. He is currently a Ph.D Candidate in Biomechanics and teacher of Track and Field at the Dept. of Physical Education and Sport Science at the Aristotle University of Thessaloniki, Greece. His research interests are Teaching Methodology and the optimization of sport performance (e-mail: panouts01@yahoo.com).

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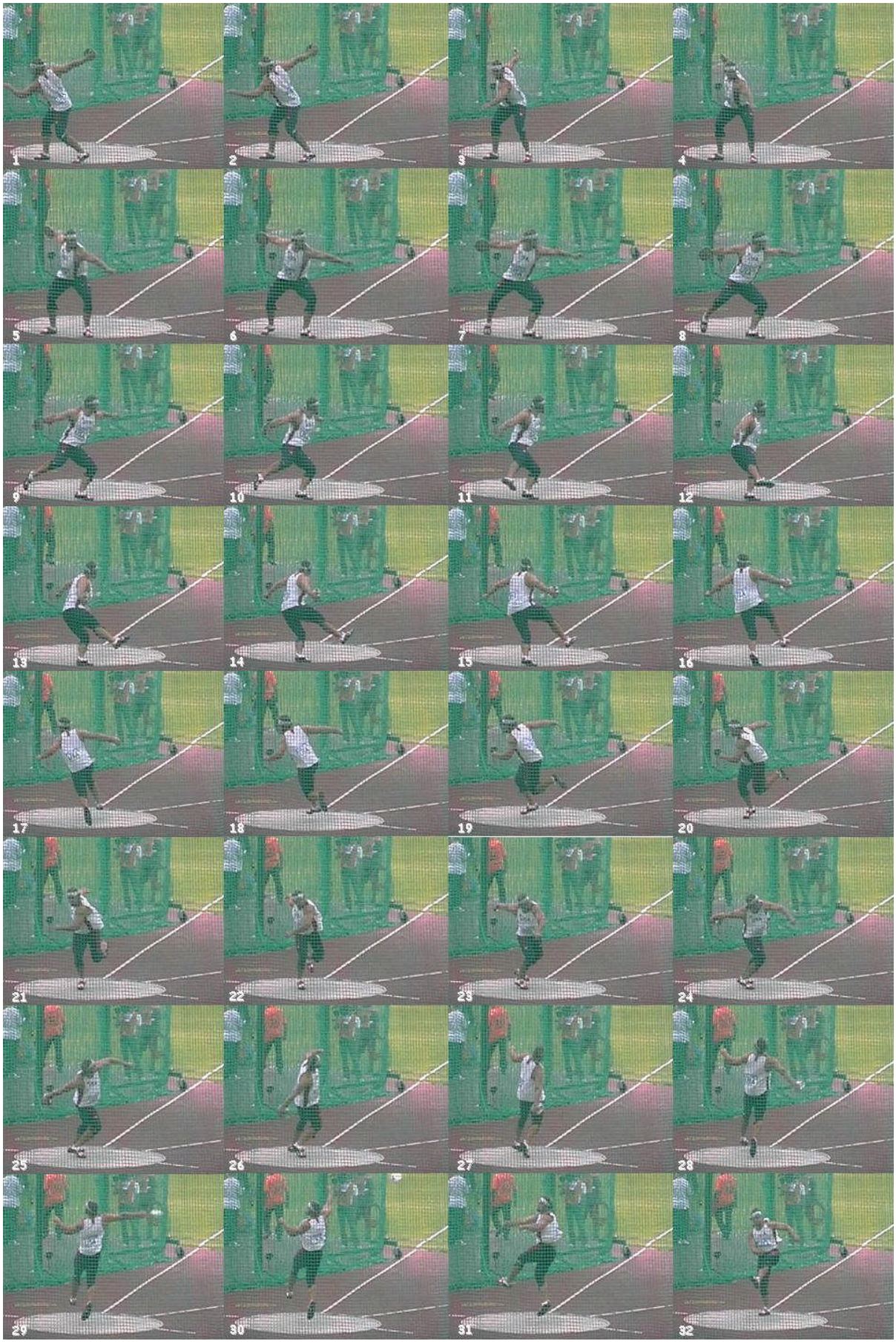

Figure 2. Ian Waltz (USA, bronze medal; 62.12m, 3rd attempt). Frame 1-7: Preparation; 8-16: Entry; 17-19: Airborne; 20-23: Transition; 24-29: Delivery; 30-32: Recovery.