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COMPARISON OF KINEMATIC CHARACTERISTICS BETWEEN STANDING AND ROTATIONAL DISCUS THROWS

Oleg Nemtsev

Physical Training and Judo Institute of Adyghe State University, Maikop, Russia

The aim of this study was to describe the differences of kinematic characteristics of movements of the arm with a discus in delivery phase between standing and rotational discus throws. For this purpose, four male throwers performed three standing discus throws and three rotational throws. All trials were high-speed videotaped. The results of 3-D analysis indicated that discus descends lower and its release angle is less in standing throw.

KEY WORDS: discus, release angle, velocity.

INTRODUCTION: The technique of rotational discus throwing was many times in the focus of scientific studies (Bartlett, 1992; Atlmeyer et al., 1994; Ariell et al., 1997 and others). The results of such investigations gave an opportunity to state the optimal values of main characteristics in the technique of discus throwing, allowed to write grounded recommendations of teaching the technique of discus throwing and its improvement. However in teaching and improving the technique of discus throwing as well as in improving different aspects of physical training there were used not only the rotational discus throw but also standing throw. It allows the entry-level sportsmen to master the technique of one of the most important elements of discus throwing faster – the technique of movements in delivery phase in learning process and to focus on final movement in the improving process with sportsmen of higher qualification level. It's evident that it concerns the identity of techniques of movements in delivery phase in standing discus throw and in rotational throw.
Meanwhile the peculiarities of technique of standing and rotational discus throwing still remain the byways of learning. So there are only the data of high level qualification of sportsmen differences gained while discus throwing without discus (Nemtsev, 2006). At the same time data of presence or lack of differences in the technique of standing and rotational discus throwing could give the basis for evaluation of level of specialized standing throwing relatively to the full throw, become objective basis in decision making about usage of this training tool in any periods of sport career and training cycle.
Aforesaid stated the aim of the study was: to compare kinematic characteristics of movements of the arm with a discus in delivery phase between standing and rotational discus throwing.

METHOD: To elicit the peculiarities of the technique of standing and rotational discus throwing the 3-D video analysis was used. During the record there was used the system of motion analysis Qualisys including six cameras ProReflex with the frame frequency of 120 frames per second (Figure 1). The treatment of such cameras was made with the help of three-dimensional tracking Qualisys Track Manager (QTM) of 1.8.225 version. Data smoothing was done with the help of the filter Butterworth of the second order with 20 Hz frequency.
The following characteristics of marker movements fixed on the discus centre on the thrower hand were analyzed: minimal height over the sector in delivery phase (h_{min}), height over the sector in the release instant ($h_{release}$), release velocity ($v_{release}$), difference between height in release instant and minimal height in delivery phase ($h_{release} – h_{min}$), release angle, time from the release instant to the lowest position ($t_{release} – t\ h_{min}$), time of "velocity gain" ($t_{release} – t_0$, Figure 2).
Four discus throwers took part in the experiment (height 1.82±0.03 m, weight 85.3±13.40 kg, age 20.7±1.57 years old, discus throwing result 36.3±2.08 m).

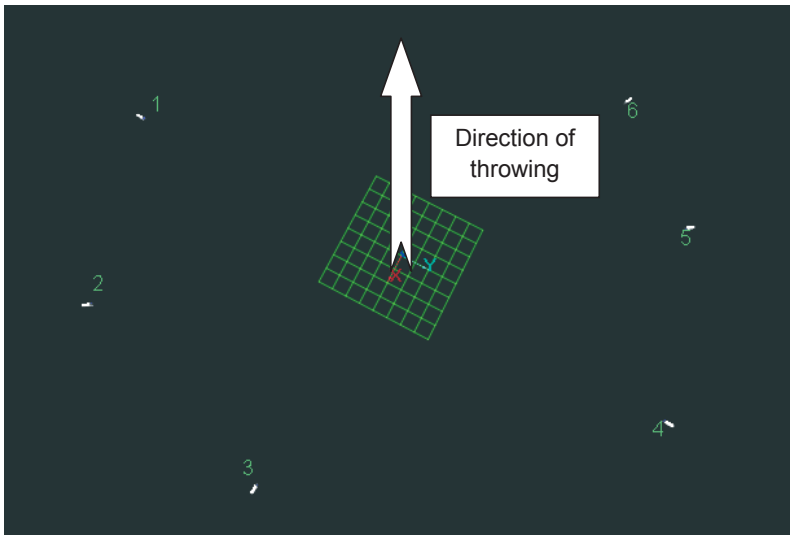

Figure 1: Placement of the cameras.

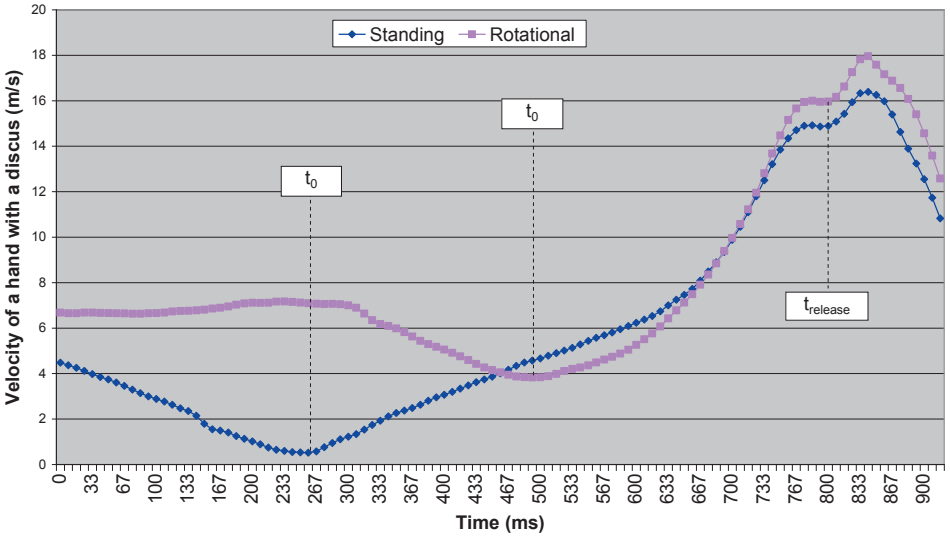

Figure 2: Method for the determination of the time of "velocity gain".

Every participant had three attempts standing and three attempts rotational discus throwing (2 kg discus). Kinematics characteristics of the best attempt (by distance of throw) in every style of discus throwing were taken into consideration.
Significance of differences between indices taken into consideration was determined with the help of a "repeated measures" t-test.

RESULTS: According to the analysis of data from Table 1 release velocity while standing discus throwing was lower than while rotational throwing. It allows considering that participants effectively used rotation for creating of discus velocity and taking the right position for movements of delivery phase. It was also stated that while standing discus throwing participants threw it with the lower angle dropping the discus lower than in rotational

throwing. Time of "velocity gain" was stated significantly higher while standing discus throwing than while rotational discus throwing.

Table 1
Kinematics data (Mean±S.D.) of the marker fixed on the discus thrower hand while standing and rotational discus throwing

Kinematics data	Standing	Rotational	t (p value)
$V_{release}$ (m/s)	14.6 ± 1.36	15.4 ± 1.07	-3.46 (<0.05)
Release angle (°)	35.2 ± 4.67	40.1 ± 4.46	-5.43 (<0.05)
$h_{release}$ (m)	1.48 ± 0.078	1.50 ± 0.096	-0.47 (>0.05)
h_{min} (m)	0.89 ± 0.083	0.81 ± 0.051	3.64 (<0.05)
$h_{release} - h_{min}$ (m)	0.59 ± 0.022	0.69 ± 0.137	-2.33 (>0.05)
$t_{release} - t\ h_{min}$ (s)	0.127 ± 0.022	0.119 ± 0.008	0.93 (>0.05)
$t_{release} - t_0$ (s)	0.452 ± 0.097	0.254 ± 0.037	4.43 (<0.05)

Two of the participants had higher height of the marker fixed on their hands in the release instant in standing discus throwing and the two others – lower than in rotational discus throwing. This stipulated the absence of significant differences of this index and also the difference between height hand in release instant and minimal height in delivery phase while standing and rotational discus throwing in the whole group. No significant differences of movement time from the lowest position to the release instant were found out.
It should be also pointed out that qualitative difference in the change of velocity of the discus thrower hand in the delivery phase while standing and rotational discus throwing. So if while rotational discus throwing the velocity began to gain strongly after the long stabilization period (Figure 3) or some reduction (Figure 2) and also from non-zero value, the velocity gain while standing discus throwing was made after the full stop of the discus.

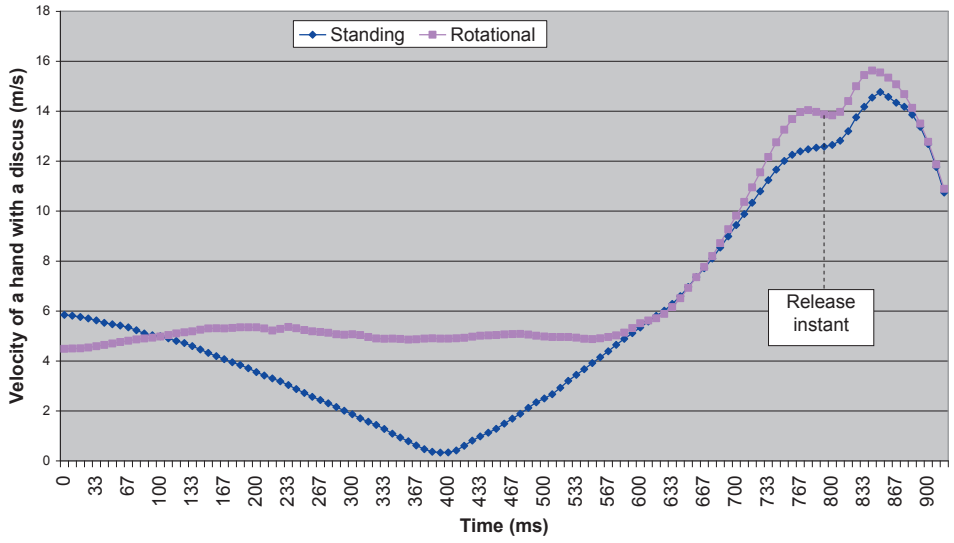

Figure 3: Velocity of hand with discus while standing and rotational throwing.

DISCUSSION: Differences of release angle as one of the characteristics stating the range of discus and also the minimal height of the marker fixed on the discus thrower hand in the delivery phase as one of important indices of the discus throwing technique allow speaking about great differences in technique of standing and rotational discus throwing.
Data of great differences of the lowest discus height in the delivery phase while standing and rotational discus throwing prove the study results when two highly qualified discus throwers simulated discus throwing (Nemtsev, 2006). Meanwhile it was stated that highly qualified discus throwers (unlike in the real study) also showed significant differences of height discus in release instant (in the moment of marker fixed on the discus thrower hand was reaching the maximal velocity) while standing and rotational discus throwing.

CONCLUSION: The study results give the reasons to believe that there are great differences in the technique of the delivery phase while standing and rotational discus throwing.
The peculiarities of techniques of standing and rotational discus throwing contributes to byway of learning and thus be useful as a training tool.
The following studies in this direction may be pointed at the study of kinematics peculiarities of standing and rotational discus throwing made by highly qualified discus throwers with more stable technique.

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