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Kinematic analysis of shot release of intercollegiate athletes

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Abstract
The aim of the study was to assess the performance and to identify some of the most relevant kinematic parameters defining the completion result in Glide shot-put technique. Two shot-put men athletes were analyzed in this study from intercollegiate athletics championships. The video recording was made with two stationary digital cameras (DSR-PD 170 DVCAM digital video camera, Sony Company Japan Ltd). Using systematic video recording procedure Kinematic parameters such as, height of release, angle of release, velocity of release, two frames Release velocity before (two frames), trunk angle at release, horizontal release distance, projected distance, Angle between transverse axes of shoulder and hip, Angular Velocity of Shoulder and Angular Velocity of Pelvis. The result of the study indicates the possibility of increasing the horizontal length of the shot put, which would lead to greater distance. The significance of this research is to obtain useful information for coaches and athletes, which will contribute to the further improvement of techniques. It is necessary to conduct further and more detailed studies of phases preceding the release, on which performance of the release phase and achievement of the best possible results may depend.

Keywords: Shot-put, glide technique, angular velocity, transverse axes, trunk angle

Introduction
Glide shot-put technique is characterized by very complex movements performed at high speed in a confined space. Many factors determine the results in this track and field event, of which the most important are morphological characteristics, motor abilities and technique. The rules require that the shot must be spherical, and weigh 7.260kg for men and 4.000kg for women (IAAF Competition Rules 2014-2015) [1]. The distance thrown is determined by release velocity, angle of release, height of release and distance over which force is applied to the shot (Stepanek 1989; Palm, 1990; Bartonietz, 1994) [2-4]. The throwing technique requires great throwing explosive strength and the ability to perform the elements in the precise moment and in limited space. The goal of the athlete is to throw the shot away as far as possible, but according to the rules and regulations of the competition. Currently, most top male shot putters use the spin. However the glide remains popular, especially among Olympic and World Champions and women, since the technique leads to greater consistency compared to the rotational technique. Almost all throwers start by using the glide. It is worth noting that the world record by a male putter of 23.120 m (75 ft 10.236 in) by Randy Barnes was completed with the spin technique, while the second-best all-time put of 23.063 m (75 ft 7.992 in) by Ulf Timmermann was set with the glide technique. Measuring which technique can provide better result is difficult, as many of the best throws recorded with each technique have been completed by athletes under doping suspicions, or with a record of drug violations. The decision to glide or spin may need to be decided on an individual basis, determined by the thrower's size and power. Short throwers may benefit from the spin and taller throwers may benefit from the glide, but many throwers do not follow this guideline.
The purpose of this study was to identify some of the most relevant kinematic parameters of the glide shot-put technique performed during Kanniur Univeristy inter collegiate track & field meet in the year 2013, held at Kerala Armed Police Stadium, Dharmmashala, Kannur, Kerala.

Materials and methods
The first and second ranked athletes in the men shot put event from the athletic meet mentioned above were selected as the subjects for the study.

Two DSR-PD 170 DVCAM digital video camera (Sony Company Japan. Ltd) were used to record the control object and the performances. The cameras were placed around the shot put throwing circle spaced approximately 90^0 apart. Video data was gathered from the best attempt of each subject. Following collection of the performance data, a peak calibration spider was placed in the centre of the throwing circle and was used to calibrate and synchronize the field of view. The values of the variables were obtained using software for Quintic Biomechanics version 26, Quintic Consultancy Ltd. England. The Direct Liner Transformation (DLT) procedure (Abdel-Aziz & Karara, 1971) [5] was used to collect three – dimensional coordinates of 22 body landmarks and also the centre of the shot for each attempt.

Operational Terminology and Variables selected for the study

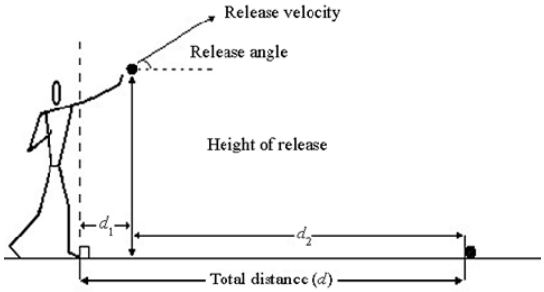

Fig 1: Graphical representation of release parameters contributing to the total distance of the throw. The total distance is equal to the sum of the horizontal distance relative to the toe board (d1) and the projected distance (d2).

Distance: Official distances selected for the study were (Total distance as shown in Fig. 1), Release Velocity: The magnitude of the shot velocity at the moment of release, Release Angle: The relative angle between the trajectory of the shot and the horizontal, Height of Release: The height of the centre of the shot above the surface of the ring at the moment of release, Horizontal Release Distance: The horizontal distance between the centre of the shot and the innermost edge of the toe board at the moment of release, Trunk Angle: The angle formed between the shoulder-hip line and the horizontal plane (Fig. 2), Shoulder Hip Separation (Angle between transverse axes of shoulder and hip): The orientation of the hips relative to the orientation of the shoulders. A neutral position (zero degrees of separation) occurs when the shoulders and hips are aligned with one another. A positive angle occurs when the throwing side shoulder is posterior to the throwing side hip. (Fig. 3).

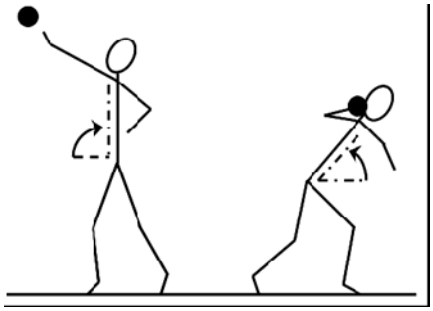

Fig 2: Definition of trunk angle. Trunk angle was defined as the angle formed between the shoulder - hip line and the horizontal plane. The dotted lines represent the shoulder-hip line and the horizontal plane formed by the ground.

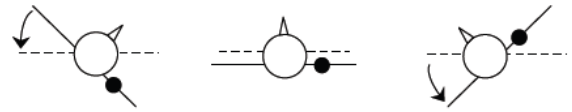

Fig 3: Shoulder-hip separation for right handed thrower. The dotted line represents the orientation of the hips and the solid line represents the orientation of the shoulders. The small black circle represents the shot. The angle between the line of the shoulder and the line of the hip represents the shoulder-hip separation. For left hander throwers, these angles are reversed.

Results & Discussion

The data collected has been analyzed and presented below in the Table 1

Table 1: Data of the Throws selected for Analysis

Kinematic Parameters	Name of the Athletes				
	Athlete I			Athlete II	
	Ist Best	IInd Best	IIIrd Best	Ist Best	IInd Best
Height of Release (m)	2.12	1.99	2.09	2.10	2.07
Angle of Release (^{0})	37.45	37.57	38.93	39.37	40.10
Velocity 2 Frames Before Release (m/s)	8.13	10.19	9.93	9.68	8.09
Velocity 1 Frames Before Release (m/s)	9.85	10.53	10.20	9.73	9.68
Velocity of Release (m/s)	10.04	10.58	10.24	10.38	9.19
Velocity1 Frames After Release (m/s)	10.13	10.56	10.36	10.47	8.78
Velocity 2 Frames After Release (m/s)	10.08	10.28	10.38	9.92	8.89
Trunk Angle of Release (^{0})	79.58	81.96	81.06	74.36	66.67
Horizontal Release Distance (m)	0.09	0.09	0.08	0.05	-0.07
Projected Distance (m)	10.77	10.51	10.42	10.62	10.09
Angle between transverse axes of shoulder & hip (^{0})	-22.02	-35.00	-41.25	-28.05	-45.05
Angular Velocity of Shoulder (^{0}/s)	886	863	858	780	761
Angular Velocity of Pelvic (^{0}/s)	621	457	544	553	524
Result (m)	10.86	10.60	10.50	10.67	10.02

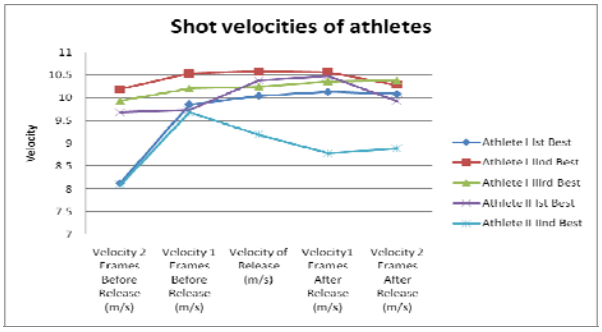

Fig 4: Comparative shot velocities 2 frames before release to 2 frames post release

Release Velocity: The shot velocity at release was 10.58 ms^{-1} in Athlete I and 9.19 ms^{-1} for Athlete II. Although this doesn't seem like a marked difference, Athlete I second best throw decreases his velocity. Without taking into account round 1, linear velocity at release would be 10.39 ms^{-1}, 1 ms^{-1} quicker than the Athlete II.

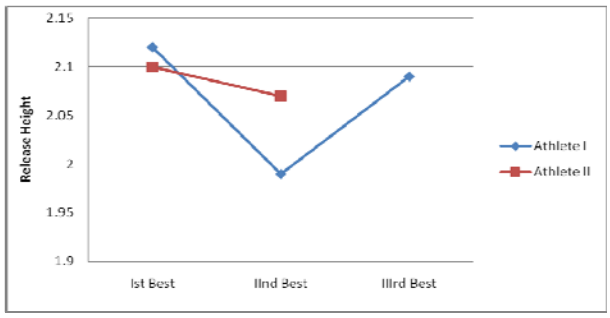

Fig 5: Comparison of the Height of Release

Release Height: From Fig. 5 it is evident that, vertical release height of Athlete I is higher than Athlete II. This difference in shot put release height could be due to individual technical difference. Hence the release height is an important factor for performance of the athletes in shot put.

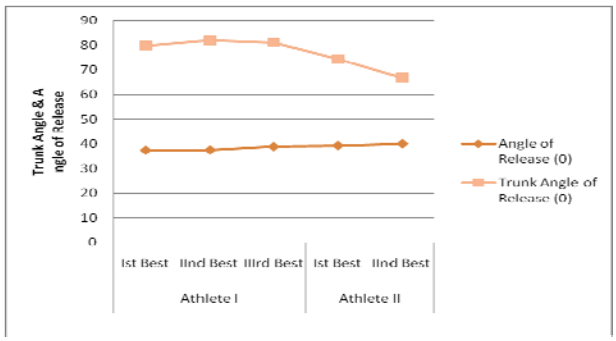

Fig 6: Comparison of the Angle of Release & Trunk angle

Release Angle: Angle of release is important in the shot event as the release speed of the shot decreases when thrown with a higher release angle. Analysis of the release angles showed athlete Athlete IIs release angle was 40.10º where as athlete Athlete I was 37.45º. According to current literature for elite shot-putters the optimum projection angle usually lies between 30° and 40°. Since the angle of Release of Athlete I is between 30^0-40^0, his performance is better than Athlete II.

Trunk Angle: The structure of the human body favours the production of putting force in the horizontal direction more than in the vertical direction. Considering just upper body strength, most athletes can lift more weight that increases the trunk angle. The Trunk Angle at shot release was 81.96^0 in Athlete I and 66.67^0 for Athlete II in the second best throws. Open chest throw increases trunk angle that increases the performance later.

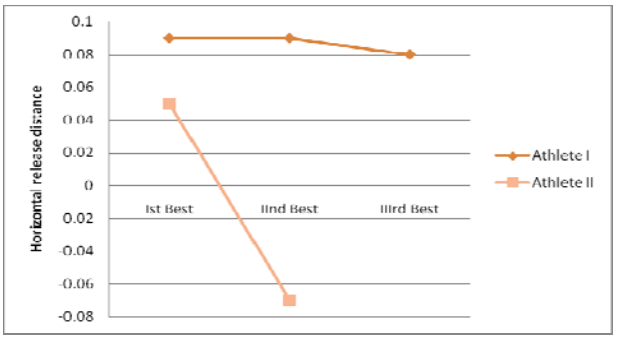

Fig 7: Comparison of the Horizontal Release Distance of Release during the Shot put of men athlete

Horizontal Release Distance: The horizontal release distance between the centre of the shot and the innermost edge of the toe board at the moment of release. Increase in horizontal release distance becomes a bonus to the athlete when he is doing the correct skill. The shot Horizontal release distance at shot release was 0.09 m in Athlete I and 0.05 m for Athlete II in their first best throws. When the second best throw was compared Athlete II throw was almost away from the innermost edge of the toe board that negative value, negatively influence the performance.

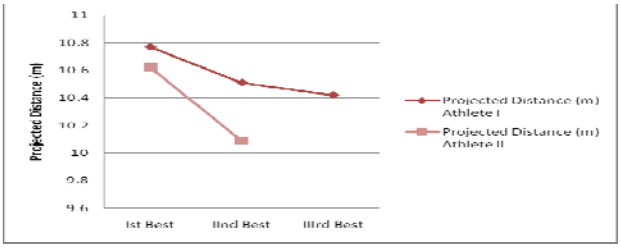

Fig 8: Comparison of the Projected Distance of men athlete on shot put

Projected Distance: When throwing with a high projection angle, the shot-putter must expend a greater effort during the delivery phase to overcome the weight of the shot, and so less effort is available to accelerate the shot (i.e. produce projection speed). The projected distance at shot release was 10.86 m in Athlete I and 10.62 m for Athlete II in the first best throws.
Total Distance: The total distance at shot release was 10.86 m in Athlete I and 10.67 m for Athlete II in the first best throws.

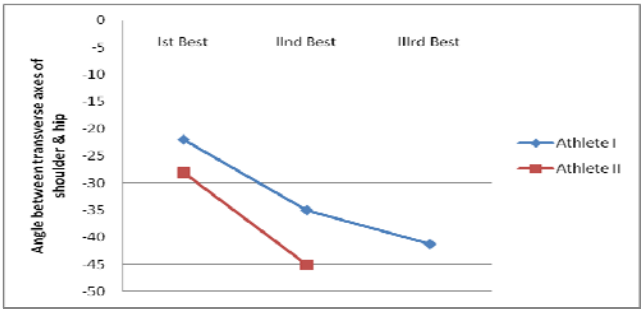

Fig 9: Comparison of the Angle between transverse axes of shoulder & hip (^{0})

Angle between transverse axes of shoulder & hip (^{0}): The degree of separation between hip, shot and shoulder was negative for the all best performers. This indicates that the performance was negatively influenced in transverse axes of shoulder & hip. Although in the case of Athlete I the angle was less negative comparatively.

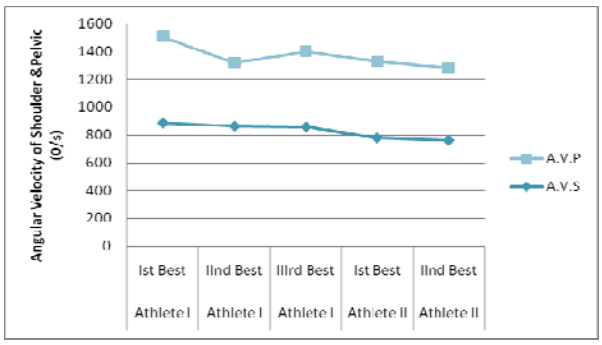

Fig 10: Comparing Angular Velocity of shoulder & Pelvis of the men athletes

Angular Velocity of shoulder & Pelvic: The angular velocity at the shoulder of Athlete II is 780°/s, whereas that of Athlete I was 886°/s which were the highest among those who participated in the Championships. These results demonstrate that high angular velocity in the upper body from the rotational technique can increase throwing speed. Thus, relatively shorter shot putters can use this technique to achieve long distances instead of attempting to increase throw height or projection angle.

Conclusions

The analysis has illustrated that Athlete I has a lower release angle and faster shot velocity at release. Although as stated earlier, that release height and release velocities are inversely proportional, this cannot be perceived as the only reason to the decrease in shot velocity and shot distance. Anatomical and physiological restrictions (height, power production) could also be a factor, as well as the athlete just could not perform well on that day. To be able to facilitate the athlete further, more throw sessions would be filmed, so that more data can be collected and accurate conclusions can be drawn.

For a throwing distance of 21m, a release velocity of 13.5 m/s^{-1} (Young, 2009) [6] is required. Release velocity is crucial in achieving results because the length of the throw is proportional to its square. The aim of coaches and scientists is to increase speeds over13 m/s^{-1} (Harasin, Milanović and Čoh, 2010) [7]. All athletes have their own specific optimum release angle because of individual differences in the rate of decrease in the force they could exert with increasing release angle. To achieve good performances, it is not necessary to throw at very close to the optimum release angle. Throwing with a high release speed is more important to performance than throwing at the optimum release angle.

References

1. IAAF Completion Rules Book, 2014. http://swissathletics.ch/files/ wettkaempfe /reglemente/IAAF_Competion_Rules_2014-2015.pdf. 11 August, 2015.
2. Stepanek J. *p*-Comparison of glide and the rotation technique in the shot-put. In: Tsarouchas L. (ed). Biomechanics in Sport In: Proceedings of the II^h International Symposium of the Society of Biomechanics in Sport, Hellenic Sports Hesearch Institute, Olympic Sports Centre of Athens, Greece, 1989, 135-146.
3. Palm V. *p*-Some biomechanical observations of the rotational shot-put. Modern Athlete and Coach, 1990; 3:15-18.
4. Bartonietz K. *p*-Rotational shot-put technique: Bio mechanic findings and recommendations for training. Track and Field Quarterly Review. 1994; 3:18-29.
5. Abdel-Aziz YI, Karara HM. *p*-Direct linear transformation from comparator coordinates in to object space coordinates in close-range photogrammetry. ASP Symposium on Close Range Photogrammetry. Falls Church, VA: American Society of Photogrammetry, 1971.
6. Young M. *p*-Development and application of an optimization model for elite level shot putting. (Doctoral dissertation) Retrieved from Graduate Faculty of the Louisiana State University, 2009.
7. Harasin D, Milanović D, Čoh M. *p*-3D kinematics of the swing arm in the second double-support phase of rotationalshot-put- elite vs sub-elite athletes. Kinesiology. 2010; 42(2):169-174.