KINEMATIC ANALYSIS OF THE POWER POSITION AND DELIVERY PHASE FOR THE O'BRIEN AND STANDING THROW SHOT PUT TECHNIQUES

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The purpose of the study was to examine the kinematic variables of the power position phase for the O'Brien and standing throw techniques used by competitive school athletes so as to gain insights into any technique differences amongst the kinematic variables of the power position between the two techniques and also study whether school athletes are able to capitalize on the biomechanical advantages of the O'Brien technique over the standing throw technique. Three female competitive school athletes were recruited for the study. Each subject performed 4 trials of the throws for each technique. Data was captured using the Peak camera systems operating at 50 Hz and 1/500 shutter speed. Maximal effort was stressed and only the best trial was taken for analysis for each technique per subject. The study showed that the athletes did not effectively capitalize on the biomechanical advantages of the O'Brien technique for maximizing their throw distance.

KEY WORDS: O'Brien technique, standing throw technique,kinetic link chain

INTRODUCTION: Shot-Put competitions have been held at the Summer Olympics since 1896 AD. Currently, there are two putting styles in use by shot put competitors, the glide and the spin. The first involves sidestepping to the front of the circle and releasing the shot-put (the glide, invented in 1876 in the United States). In 1951 Parry O'Brien of the United States invented a technique that involves the putter facing backwards, spinning 180 degrees across the circle, and then tossing the shot. The technique fetched O'Brien the gold at the 1952 Summer Olympics.

The O'Brien technique is considered biomechanically superior to the standing throw technique. The movement involved in the O'Brien technique is linear and it is easy to attain consistency in the technique over a relatively short period of time (Redding, 1988). The other advantage of the O'Brien technique is that the athlete is able to continue applying force over a greater distance with the glide (Redding, 1988 and Stimson, 1995) which is in line with the biomechanical principle of maximizing release velocity by increasing the momentum imparted to the shot. The glide increases the distance through which force can be exerted on the shot and also allows for an increase in the contribution of force from the muscles of the back (Redding, 1988 and Hay, 1993).

McCoy, Gregor, Whiting, Rich and Ward (1984) noted that the most important variable for maximizing the shot-put throw distance is the attainment of a stable power position. Jensen, Schultz and Bargerter (1984) found that the sequence of movements must be correctly timed and fully utilized in order to make its maximum contribution. In this respect, the O'Brien technique emphasizes a sequential and stable movement pattern that must be executed to maximize the effect of the momentum acquired through the kinetic link, and eventually transfer of the momentum to the shot put.

It is common for the coaches to use the standing throw as a progressive drill to the O'Brien technique and hence the purpose of the study was to determine the relevance of the standing throw technique as a drill to the O' Brien technique.

METHOD: The selected group of subjects comprised three female school athletes (N=3), age 15-16 years, who have been involved in national school level competitions for the past three years. These athletes could throw a 4 kg shot to a minimum qualifying distance of 7.5 m for 16-year old girls specified in the Singapore Schools Track and Field Championships. Participants underwent familiarization trials before the actual data collection and two warm

up throws for each technique was allowed, followed by a total of eight throws, comprising four standing and four throws using the O'Brien technique. Maximal effort was stressed and the throws were carried out in a randomized block manner. Only the best throw for each of the techniques for each athlete was considered for the purpose of the present study. Markers were placed at selected anatomical landmarks (acromion process, greater trochanter, lateral epicondyle and lateral malleolus). All subjects were marked using water-based skin paint at the specified anatomical landmarks.
Three Peak Motus cameras with fixed orientation genlocked together and operated at a nominal frequency of 50 Hz with a shutter speed of 1/500. Calibration was carried out using the Peak Performance Technologies' 3D control calibration frame.
In this study, only the delivery phase was analyzed, i.e. between the power position to the release of the shot, for both the standing throw and the O'Brien technique.

RESULTS AND DISCUSSION: In the present study, the athletes were able to put the shot to a larger distance with the standing throw technique as compared to the O'Brien technique. This shows that the athletes were not able to optimally capitalize on the advantages of the O'Brien technique.

Table 1: Comparison of best performances of the three athletes

Parameters	O' Brien	Standing Throw
Subject 1	7.50	7.53
Subject 2	8.38	8.45
Subject 3	7.94	8.39

Kreighbaum and Barthels, 1996, described the kinetic link of the shot-put throw as a combination of throwing and pushing action that is partly sequential and partly simultaneous. Sequential rotation of the massive segments like the leg, pelvis, trunk and shoulder-girdle should be followed by the simultaneous rotations of the less massive distal segments of the upper extremity. One of the inferences we could make from the data in the study to explain the performance of the athletes with the two techniques was that all the three athletes could not reap the advantages of a kinetic link between the upper and lower extremity of the body during the delivery phase to allow a transfer of momentum from a lower segment to a higher one. To maximize the benefit of the O'Brien glide technique the athletes should have progressively increased the velocity of all the segments to maximize the momentum transfer to the shot-put. However, as can be seen from the graphs in figure 1, the athletes increased the velocity of only the shoulder-joint during the delivery-phase. The velocities of the hip and knee joint either consistently decreased or remained almost constant during the delivery phase. This implies that momentum from the lower half of the body was not effectively generated and hence not channelled to the upper half of the body. For these subjects, the momentum for hurling the shot put was primarily generated from the shoulders and trunk.
Biomechanically the O'Brien technique has greater influence on the release parameters and impulse generation compared to the standing throw. However, since the three athletes could not hurl the shot further with the O'Brien technique, it suggests that the muscles forces were not coordinated during and after the power position of the O'Brien technique. It could be that the sequence of postural movement from the power position onwards is different for the two techniques.
Stability of dynamic movement is an important criterion for performance enhancement (Koh and Tan, 2005). Stability during throwing action is important in that it establishes a firm support base that eliminates sliding during the vigorous action of shot putting (Barlett, 2000). The other aspect that was looked at in this study was whether the athletes were able to acquire a stable position at the power position during the O'Brien technique to maximize the effectiveness of the throw. The assumption made in this study was that the kinematic configuration of the power position in the standing throw is the most stable and it is desired that the athletes acquire a similar kinematic power position for the O'Brien technique.
For this purpose the trunk and knee angle at the power position were analyzed. The angles were found to be different for the two throwing techniques indicating a postural difference for

the O'Brien technique amongst the athletes. The implication of this finding is that the stability was not established by the three athletes during the O'Brien technique.
Data on the trunk and knee angles of all three subjects based on the best throws are reported in the following table:

Table 2: Comparison of trunk and knee angles between the O'Brien and standing throw technique

Angles (º)	**Trunk: O'Brien**	**Trunk: Standing**	**Knee: O'Brien**	**Knee: Standing**
Subject 1	52.7	32.8	175.5	134.3
Subject 2	37.6	25.8	178.9	154.7
Subject 3	33.5	15.3	180.6	169.0

CONCLUSION: In shot-put the most proximal end of the kinetic link for the shot-putting action is the foot, followed by the shank, thigh, trunk, shoulders and arm. For the subjects, the results clearly indicate that the momentum for hurling the shot-put during the delivery-phase was primarily generated by the movement of the shoulders (and perhaps the trunk) and there was little if any, co-ordinated sequential generation and imparting of momentum from the limbs to the trunk. The generation of momentum only by the shoulder-trunk system could lead to additional stress on the erector-spinae, trapezius and deltoid muscles.
The difference reported for the kinematic configuration of the body at the power position could mean either of the following two things: a) the greater knee and trunk angles observed in the O'Brien technique could be a requirement for a stronger thrusting action rising out of the power position. This would further imply that the trunk and knee angles between the two techniques are indeed different and that coaches need to reconsider using the standing throw as a progressive drill to the O'Brien technique; b) the greater knee and trunk angles at the power position for the O'Brien technique could be due to an unstable kinematic configuration of the body and the coaches should focus on techniques that facilitates the attainment of a stable power position for the O'Brien technique with appropriate teaching drills. Further investigation is required.

(a) (b) (c)

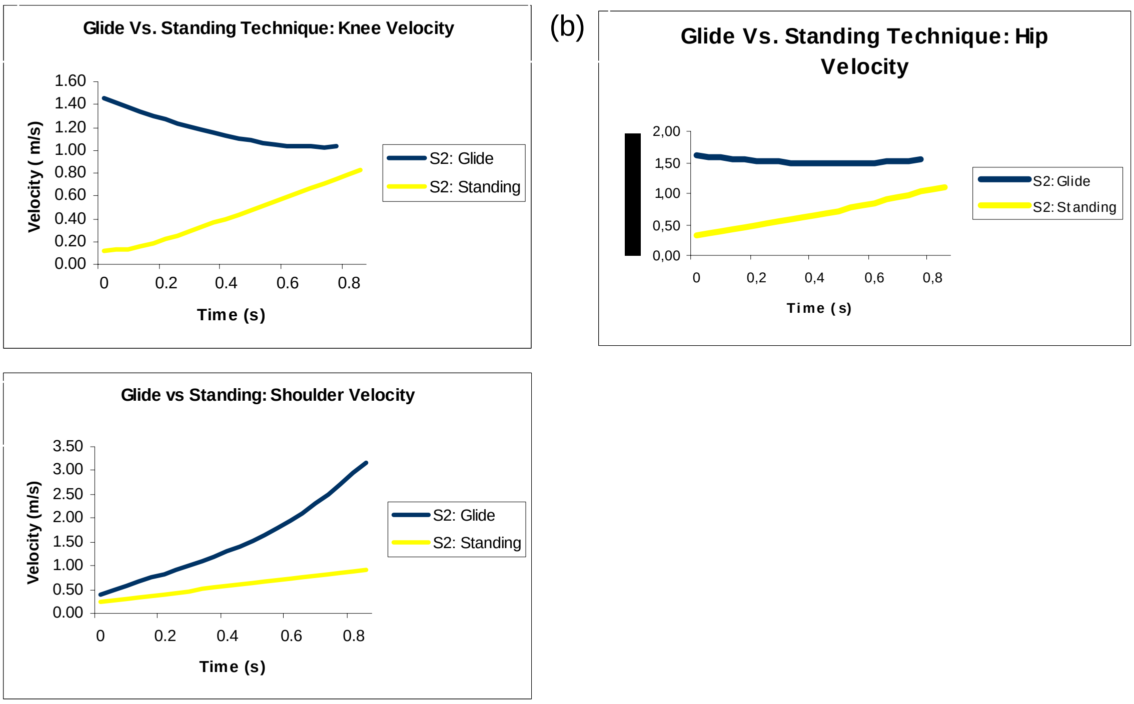

Figure 1: Representative graphs of the velocities of the a) hip, b) knee and c) shoulder during the delivery phase for one of the three subjects

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