

# A 3D KINEMATIC ANALYSIS OF SHOT PUT TECHNIQUES USED BY ELITE MALE TRANS-FEMORAL AMPUTEE ATHLETES

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## INTRODUCTION

Shot putting techniques used by elite, nonamputee (NA) throwers have previously been investigated [c.f., 1,2,3]. Moreover, trans-femoral (TF) amputee athletes most likely adapt their throwing technique due to the loss of musculature and motions about the knee and hip joints. At present, there are no documented reports about TF amputee shot put that will enable us to understand the techniques used and, hence, help improve performance while minimizing injury risk. The aim of the study was to determine the shot put techniques used by elite, male TF during international competition.

## METHODS

The putting techniques of five athletes competing in the final of the mens F42 shot put competition at the 2008 Paralympic Games were analysed. All athletes (mean  $\pm$  SD: age  $37 \pm 2$  yrs) used a trans-femoral prosthesis with a locked or absent knee component.

During data collection, digital signals of all TF throw performances from two digital cameras (Basler A602fc, Germany:) were directly input into computers (100 Hz). For each athlete, the longest official distance thrown was analysed using EHuman<sup>®</sup> software. The athlete, shot and throwing circle were manually digitized, reconstructed (DLT) and filtered (4<sup>th</sup>-order, low-pass Butterworth filter, optimal cut-off frequencies). Several variables of the shot at release were calculated: resultant release velocity ( $VEL_R$ ), angle of release to the horizontal ( $ANG_R$ ), height of release ( $HT_R$ ), and horizontal position at release relative to the front of the throwing circle ( $POS_{horiz}$ ).

## RESULTS AND DISCUSSION

One athlete performed a standing throw, all others used the glide technique. Of the release variables, although interrelated [4],  $VEL_R$  is the most important determinant of throw distance [1], and the variable whose magnitude varies the most amongst NA throwers of different skill levels [1].

Compared to NA throwers (low to high skilled: throw distance = 15.81 – 21.67 m;  $VEL_R$  = 11.8 -13.43  $m \cdot s^{-1}$ ) [1],

the TF throw distances (Table 1) are closer to the minimum NA values, mostly due to lower release velocities. Similar to prior research [1],  $VEL_R$  was highly correlated with throw distance ( $r_{pearson} = 0.851, p = 0.034$ ).

$ANG_R$  values were around the lowest values (27°) previously reported [4], and generally lower than those displayed by the highest skilled NA throwers [1,2,5].  $HT_R$  values were similar to values of comparable NA throwers [1,2].  $POS_{horiz}$  was not related to throw distance and was highly variable amongst the TF throwers. Two TF athletes (rank #2 and #4 official throw distance) released the shot from -0.27 m and -0.33 m behind the front of the circle, respectively, while one TF athlete (rank #1 official throw distance) released at a similar position to the elite NA throwers [1].

## CONCLUSIONS

This study provides a first description of the shot put techniques of elite male TF amputee athletes. The TF athletes exhibited release variables lower than those of high skilled NA athletes, though a positive relationship between release velocity and distance thrown still exists. Future work will analyse the technique of TF athletes in closer detail to provide information that may lead to improved performance.

## ACKNOWLEDGEMENTS

This study was funded by CIF, Stockholm; approved and supported by the International Paralympic Committee. Thanks to Judith Visser and Peter Raffalt for help with data collection.

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**Table 1:** Means ( $\pm$  SD) and ranges of the shot put release variables for the five TF amputee athletes.

	$VEL_R$ (m/s)	$ANG_R$ (deg)	$HT_R$ (m)	$POS_{horiz}$ (m)	Throw Distance (m)
<b>Mean (<math>\pm</math> SD)</b>	10.47 ( $\pm$ 0.83)	31 ( $\pm$ 2)	2.01 ( $\pm$ 0.20)	-0.06 ( $\pm$ 0.23)	12.69 ( $\pm$ 1.38)
<b>Range</b>	9.67 – 11.63	27 – 32	1.88 – 2.36	-0.33 – 0.19	11.47 – 14.43