A COMPARISON OF LOWER BODY ANGLES BETWEEN FREE HIGH PULLS AND A FIXED HIGH PULL APPARATUS

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INTRODUCTION: The majority of strength and conditioning programs for athletes are based on the Olympic lifting exercises. Olympic lifts generate explosive power through the lower body (Armstrong, 1993). There appears to be a relationship between resistance training exercises and bar path kinematics (Souza, Schimada, & Koontz, 2002). The resistance training program at the university used in this study had a piece of equipment called the Cormax ® Smith Machine Plus. The Cormax® Smith Machine Plus utilizes a barbell that is set in tracks which does not allow any horizontal bar movement. It also has a piston system that allows the athlete to throw and release the barbell. The pistons support the barbell and allows it to slowly drop back to the starting postion. The researchers were interested if the technique using this piece of equipment would be similar to the technique that is used with free weight high pulls. Therefore, the purpose of this study was to examine the lower body joint kinematics between the two methods of completing a high pull.

METHOD: Six senior football players at a Midwestern university agreed to volunteer for the study. The participants (mean age 22.2 $\pm$.75 years, mean height 182.5 $\pm$5.1cm, mean weight 107.2 $\pm$20.7kg) had an average of five years of Olympic training experience. The participants were randomly assigned to complete four days of the high pull exercise. There were two or three days between all testing sessions. Two of the days the participants completed the high pulls using the Cormax ® Smith Machine Plus and two of the days they completed the high pulls as normal with a free barbell. The testing was alternated so that half of the subjects used the Cormax ® Smith Machine Plus the first day and half used the normal technique the first day. The second day the participants used the other technique, the third day they used the same technique as the first day, and the fourth day they used the same technique as the second day. The participants completed 3 sets of 5 reps at 75% of their 1RM. Two minutes of rest was given between sets.
Markers were placed on each participant's right side at each of the following locations: greater trochanter of the femur, the center of the knee joint, and the lateral mallelous of the ankle. The participants were videotaped from the right side during the high pulls. Dartfish® was used to measure the hip, knee, and ankle angles at the end of the first pull and the end of the second pull (See Figures 1 and 2). Three separate univariate ANOVAs were used to test for significant differences between the angles at the hip, knee, and ankle angles. The Bonferroni method was used to protect against alpha level inflation, resulting in $p<.0083$. Coefficients of variation (CV) were calculated for the joint angle measurements. Eta squared values were used to examine effect size.

Figure 1. Position where angles were measured for the end of the first pull.

Figure 2. Position where angles were measured for the end of the second pull.

RESULTS: Significant differences were found at the ankle angle during the first pull and at the hip, knee and ankle angles during the second pull (See Table 1). Eta squared values for the end of the first pull were 0.23 (ankle), 0.006 (knee), and 0.0007 (hip). Eta squared values for the end of the second pull were found to be 0.03 for all three of the joints.

Table 1. ANOVA Results of the Angle Measurements

Pull		Cormax Mean(SD)	CV	Platform Mean(SD)	CV	F	p
Pull 1							
	Ankle	103.7(5.3)	4.0%	98.6(3.1)	2.6%	157.77	.0001*
	Knee	141.4(6.2)	1.0%	143.3(5.8)	0.9%	3.32	.0694
	Hip	102.6(9.8)	2.0%	101.7(7.2)	1.7%	0.47	.4950
Pull 2							
	Ankle	129.4(5.7)	1.0%	131.1(5.5)	1.4%	12.32	.0005
	Knee	162.3(6.8)	1.0%	163.8(6.5)	0.8%	16.03	.0001*
	Hip	169.7(5.2)	0.8%	169.6(6.9)	0.8%	17.69	.0001*

*p=<0.0001

DISCUSSION: The results of this study indicate that there are some significant differences in the lower body kinematics between the Cormax ® Smith Machine Plus and the normal free weight technique when completing high pulls. The ankle angle was found to be greater for the Cormax ® Smith Machine Plus at the end of the first pull indicating that the participants may have shifted their body back to allow the bar to clear their knees. The hip, knee, and ankle angles were found to be smaller at the end of the second pull indicating that the subjects could not reach as much extension in the lower body using the Cormax ® Smith Machine Plus. The angles were only measured at the end of the first and second pull; there could be other similarities or differences in joint angles during the rest of the motion.

CONCLUSION: The results of this study showed that there were some significant differences in lower body kinematics between the Cormax ® Smith Machine Plus and the normal free weight technique when using high pulls. Due to its design, the Cormax ® Smith Machine Plus has been reported to have some power output advantages due to the ability to throw and release the barbell. However, if the design results in significant differences in lower body kinematics from the platform high pulls, any possible power advantages may not be worth the changes in kinematics. The changes in kinematics when using the Cormax ® Smith Machine Plus could transfer to the platform high pulls and affect the athletes' ability to properly perform the platform high pulls technique. This issue warrants further study.

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