A PILOT STUDY TO MEASURE FORCE DEVELOPMENT DURING A SIMULATED MALTESE CROSS FOR GYMNASTICS STILL RINGS

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The purpose of this study was to develop a measurement procedure for the Maltese cross performed on still rings. Sixteen elite/international gymnasts participated. Two small force platforms (FPs) interfaced to a portable data logger (100 Hz sampling rate) were placed under the gymnasts' hands in a simulated Maltese position (i.e., prone). Gymnasts attempted to rise a few centimeters to a Maltese position while vertical ground reaction forces were recorded bilaterally. Results indicated that the FPs had sufficient fidelity to differentiate gymnasts' abilities to perform a Maltese. This method may serve to gauge the preparedness of male gymnasts performing this important skill.

KEY WORDS: still rings, strength development, test

INTRODUCTION: The Maltese cross is currently a valuable skill in men's gymnastics. The Maltese cross is performed on the still rings and consists of supporting and holding the body by the hands and arms while the body is kept in a straight and horizontal position. During the still rings finals of the 2003 World Championships all eight of the finalists used a Maltese in their routines (Inside Gymnastics, 2003). In spite of the skill's popularity and value, gymnastics lacks simple metrics to determine the progress of athletes toward this skill due to the unique nature of the apparatus and the unique body position involved. In terms of coaching tactics, the ability to determine feasibility and progress toward difficult skills could aid coaches in monitoring developmental progress (Sands, 1984). The purpose of this study was to determine if a pair of small force platforms could be used to differentiate between gymnasts who could perform a Maltese from those who could not.

METHOD:

Data Collection: Subjects. Sixteen male gymnasts from the United States Senior National Team (N=12) and the Japanese Senior National Team (N=4) agreed to participate (Table 1). Data were collected at a joint training camp held at the U.S. Olympic Training Center in Colorado Springs, CO, USA over three days in January 2006. Athletes were assigned to three test groups with one group testing each day. This approach was used at the coaches' request to prevent major intrusions to training. Instrumentation. Data were collected from two small force platforms (FPs) (PASCO Inc., Roseville, CA, USA, 4.5x35x35 cm). These were interfaced to a small data logger (GLX, PASCO, Inc., Roseville, CA, USA). Data were sampled at 100 Hz and stored in the data logger for later download to a laptop computer. The FPs were calibrated and validated using methods described earlier (Major, Sands, McNeal, Paine, & Kipp, 1998). Procedures. Athletes were queried regarding their perceived ability to perform a Maltese on the still rings (Table 1, Stated Maltese Ability (SMA)). Athletes assumed a prone lying position on the floor with arms at their sides and palms downward placed in the center of the force platforms. On a countdown from the investigator, the athletes pressed downward against the force platforms and attempted to raise their bodies completely off the floor a few centimeters. The athletes attempted to hold their maximum force or elevated body position for two or more seconds. A completed Maltese was one in which the entire body, except for the hands, was lifted off the floor (Table 1, Tested Maltese Ability (TMA)). Two trials were conducted with approximately three minutes rest between trials. Peak force was defined as the greatest force achieved during the period of maximal effort. Mean force was defined as a one second average of the force data generated by both arms during a relatively stable portion of the maximal effort (Figure 1).

Table 1. Descriptive Information

Variable	**Mean**	**SD**
Age(yr)	22.9	2.3
Height(cm)	164.9	6.0
Mass(kg)	63.9	7.6
Analysis Groups	Able	Unable
Stated Maltese Ability	12	4
Tested Maltese Ability	9	7

Data Analysis: Data were analyzed to determine stability via absolute and relative technical errors of measurement (TEM_{abs} and TEM_{rel}, respectively) (Hopkins, 2000). The mean of the two trials was used for further data analyses. The two force-time records (one from each arm/FP) were summed and characterized by a peak value and a mean value. These values were then compared to body weight by simple subtraction. Athletes were grouped for analyses based on two criteria: 1) Stated Maltese Ability (SMA), and 2) Tested Maltese Ability (TMA). Descriptive statistics, unmatched t-tests, and the Wilcoxon Signed-Ranks Test (Field, 2000) were used to characterize these data. The potential for the intrusion of fatigue on test results was assessed by a Oneway ANOVA (test days). Statistical significance was set at $P < 0.01$ to allow for increased Type I Error due to multiple comparisons (Sokal & James Rohlf, 1969).

RESULTS: Trials data showed high reliability and no statistical differences between trials for both the mean summed arm forces (TEM_{abs} = 20.7(N), TEM_{rel} = 3.4%, intraclass correlation = 0.99, t_{paired} = 0.006 P = 0.97) and the peak summed arm forces (TEM_{abs} = 16.5(N), TEM_{rel} = 2.6%, intraclass correlation = 0.99, t_{paired} = 0.009 P = 0.57). An example of the force-time data is shown in Figure 1.
The discrepancy between those athletes who said they could do a Maltese (SMA) and those who were actually successful in the test (TMA) was not statistically significant (Wilcoxon SRT, Z = -0.63, P = 0.527). Testing the summed force performances for fatigue effects based on day of testing were also not statistically significant (all P > 0.05). However, given the pilot nature of this investigation, the discrepancy between the athletes' stated and actual abilities remained of interest and separate group analyses were performed.

<u>Stated Maltese Ability.</u> Mean summed force and peak summed force absolute value comparisons (Table 2) showed no statistical differences. However, when comparing the mean and peak force sums relative to body weight the results were statistically significant (Table 2).

Table 2. Stated Maltese Ability

Variable	Group	N	Mean	SD	Sig.
Mean Force Sum (N)	Unable	4	477.6	80.0	P > 0.05
	Able	12	563.7	94.3	
Peak Force Sum (N)	Unable	4	505.6	71.1	P > 0.05
	Able	12	603.0	97.6	
Mean Force Sum (N) - Body Weight (N)	Unable	4	-182.1	57.1	P = 0.001
	Able	12	-52.1	52.6	
Peak Force Sum (N) - Body Weight (N)	Unable	4	-154.1	48.9	P = 0.001
	Able	12	-12.8	54.8	

Tested Maltese Ability. Mean and peak summed force absolute value comparisons (Table 3) showed a similar pattern as that observed in the SMA groups analysis above. The absolute values of mean force and peak force were not statistically different. Comparisons of the differences between mean and peak forces and body weight showed statistical differences in both cases.

Table 3. Tested Maltese Ability

Variable	Group	N	Mean	SD	Sig.
Mean Force Sum (N)	Unable	7	498.5	65.4	P > 0.05
	Able	9	576.1	106.0	
Peak Force Sum (N)	Unable	7	532.1	61.9	P > 0.05
	Able	9	614.8	110.9	
Mean Force Sum (N) - Body Weight (N)	Unable	7	-148.8	64.6	P = 0.001
	Able	9	-34.7	42.7	
Peak Force Sum (N) - Body Weight (N)	Unable	7	-115.2	65.8	P < 0.001
	Able	9	4.0	47.6	

DISCUSSION: The results of this pilot study showed that a relatively simple testing method could result in reliable data while differentiating between those gymnasts who could perform the Maltese from those who could not. As an aside, the force-time curves also demonstrated arm force symmetry (Figure 1). The goal of this study was to demonstrate a simple physical relationship that when a gymnast is able to produce more force than his body weight, then his body will rise from the floor. In spite of this apparent simplicity, coaches and athletes are too often without such measuring tools to gauge athlete development. The testing method described here may serve coaches and athletes by providing relevant and detailed feedback of status and progress.

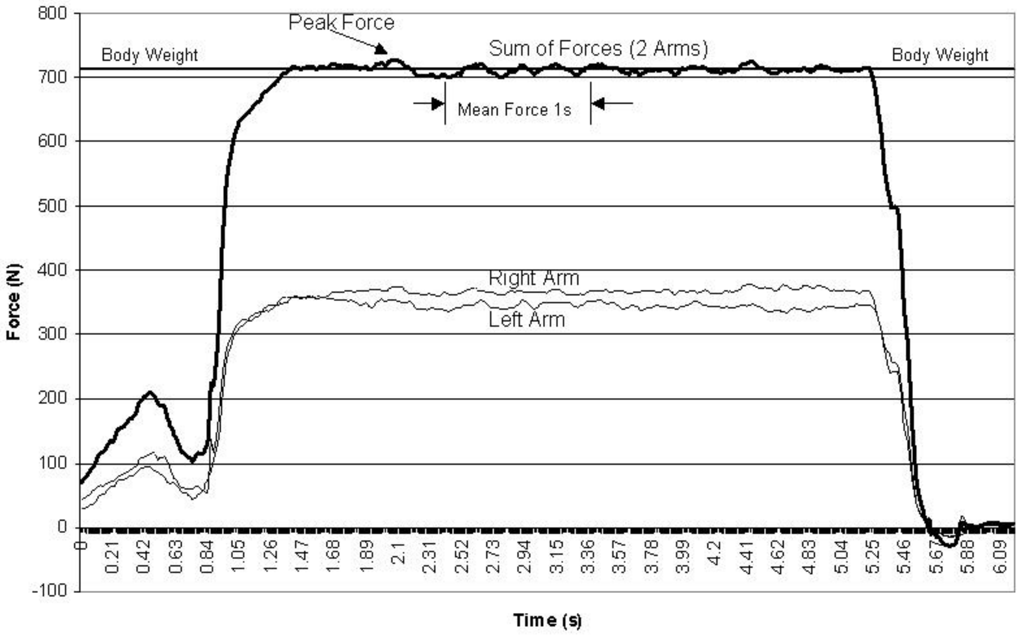

Figure 1. Example force-time curves for an athlete who can do a Maltese. Note that the sum of the two arm forces is approximately body weight.

CONCLUSION: The strength testing approach described here was developed to ascertain the status and progress of elite male gymnasts. The initial results indicate that the method has sufficient fidelity to differentiate between athletes who can and cannot perform the Maltese. Future work will continue these efforts and address other important strength skills in men's gymnastics as well as developmental progress.

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