Isokinetic Muscle Strength and Performance Testing – Thomas Young

The purpose of this project was to learn about the relationships and applications of isokinetic strength testing. A secondary purpose was to become familiar the biodex dynamometer along with sports performance tests specific to jumping.

The equipment used for this project was the following: Biodex Isokinetic dynamometer (System 4 Pro, Biodex Medical Systems, Shirley, New York)), Biodex Advantage software (version 4.59), masking tape, and a tape measure. The participant was a graduate student athlete for the university who performed her own warm up by jogging in two circles around the biomechanics lab. For the first trial, the participant was first instructed to perform an isokinetic strength test at 60 deg/s with her dominate leg. A practice trial was conducted first for the subject to become familiar with the machine. Once this was achieved, the participant performed three maximum knee extensions and flexions with verbal encouragement to get the highest value possible. A two-minute rest period was granted. For the second trial, the participant performed another isokinetic strength test, but at 180 deg/s. Again, a practice trial was performed to allow the subject to become familiar with the system. Once this was achieved, the participant performed three maximum knee extensions and flexions with verbal encouragement to get the highest value possible lab. Once these tests were completed, they were repeated on the nondominated leg. After using the biodex, the subject completed two sports specific jump tests. The first test was called a single leg vertical jump test in which the subject was asked to jump as high as possible with only one leg (without a running start). A familiarization trial was completed prior to data collection. The participant then completed three single leg jumps with her dominate leg with a brief break in-between each trial. The same protocol was repeated with her nondominated leg. The second sports specific test was called single leg hop. This involved the subject completing jumping as far as possible and landing on one leg. After a practice trial, the subject felt uncomfortable performing any more due to a fear of injury, so the test was modified to a double leg jump. This could also be called a broad jump. The subject performed three trials on each side of the measuring tape to signify the dominate and the nondominate leg. A brief break was allowed between each trial. The lab was cleaned after data collection and data processing was completed with excel in the biomechanics computer lab. There were many equations used in the analysis of the biodex data. The biodex gave the user the following output variables: time (milliseconds), torque(N-m), position (deg), position (ana), and velocity (deg/sec). Time was converted from milliseconds to seconds. The velocity that came from the biodex was converted from degrees per second (deg/sec) to radians per second (rad/sec). Power, in watts, was calculated as torque (N-m) multiplied by velocity (rad/sec). The integral was calculated as the sum of power from the previous frame window to the current frame window and then divided by 2 and then multiplied by 0.01. The last frame number used to end data collection was when the calculated velocity, power, and integral were all nonzero values. If one of these values was zero, the frame number was skipped for the above calculations.

Tables 1, 2, and 3 are attached at the end of the report to satisfy page length requirements.

As a preface, a modified jump was used during the single leg jump trials (now a broad jump). The participant was worried about potential injury if she landed on only one leg. Data processing was also only completed for the dominate leg (right) only. Additionally, there is an excel spreadsheet containing 4 graphs for each condition which plotted the following: frame number vs torque (N-m), time vs power (W), time vs position (deg), and time vs velocity (deg/sec). The torque curve looks similar to a sinusoidal cure. The power curve looks like an inverted quadradic repeating about every 75 seconds with a max vertex around positive 200 for condition 1 and positive 500 for condition 2. The position curve alternates between being negative linear and positive linear about every 75 seconds with slopes alternating between negative and positive 60 for both conditions 1 and 2. The velocity curve shows vertical asymptotes at about every 75 seconds and has a horizontal line (slope 0) connecting these asymptotes at both positive and negative 60 for condition 1 along with positive and negative 180 for condition 2.

Table 1 shows condition 1 (60 deg/s) and condition 2 (180 deg/s) for the following metrics pertaining to extension: peak torque, peak power, work, angle of peak torque, and torque rate. All the averages are higher for condition 1 compared to condition 2 except for peak power and torque rate. This makes sense as the subject should have found it easier to go through the range of motion for condition 1 compared to condition 2 and should result in a lower wattage for the first condition. Condition 2 can be deemed more strenuous than condition 1 as the range of motion is larger plus the participant has already completed three maximum knee flexions and extensions for condition 1. However, the total work performed during condition 1 was 511.5 J while the total work performed in condition 2 was 441.4 J.

Table 2 shows condition 1 (60 deg/s) and condition 2 (180 deg/s) for the following metrics pertaining to flexion: peak torque, peak power, work, angle of peak torque, and torque rate. All the averages are lower for condition 1 compared to condition 2 except for peak torque and work. The peak torque metric makes sense as there was an issue with the biodex confirming the participant brought her knee all the way back. This could potentially cause bias as the system was manually stopped by the researchers stopping the trial manually instead of the biodex doing this automatically. It also makes sense to have higher metric values of flexion for condition 2 as the participant must bring her leg through a farther range of motion compared to condition 1. However, the total work performed during condition 1 was 476.1 J while the total work performed in condition 2 was 391.2 J.

Table 3 shows the averages of the 3 trials for each of the sports specific conditions tested. The single leg hop test showed interesting results between the dominate and nondominate leg. Prior to testing, it was believed the dominate leg would illicit a higher vertical jump value, but this is not the case. The nondominate leg showed about a 1.5-inch higher average jump height compared to the dominate leg. This was not expected, but perhaps could be due to fatigue from the previous testing involving the biodex. Another potential reason could be the left leg is slightly longer than the right leg. This could give the left leg a slight advantage for achieving a higher jump height compared to the contralateral leg. The double leg hop (broad jump) went as expected. The participant was able to achieve a 5.8-inch difference in favor of the dominate leg.

However, this testing is not the most accurate as it was not a true single leg hop as described prior to testing. This test was modified to prevent a possible injury of a college athlete.

Table 1: Extension metrics read as average ± standard deviation.

Table 1: Extension				
	Right side 60		Right side 180	
	Mean	STD	Mean	STD
PK Torque (N-m)	180.567	36.639	141.600	25.727
PK Power Watt (W)	192.677	38.942	399.432	80.610
Work (J)	170.501	35.018	147.141	30.829
Angle of PK TQ (Deg)	63.000	3.606	59.000	1.000
Torque Rate (Nm/s)	401.929	119.140	699.119	144.013

Table 2: Flexion metrics read as average ± standard deviation.

Table 2: Flexion				
	Right side 60		Right side 180	
	Mean	STD	Mean	STD
PK Torque (N-m)	-1.267	0.896	-2.000	0.794
PK Power Watt (W)	168.405	39.850	345.352	8.556
Work (J)	155.685	31.668	130.384	0.824
Angle of PK TQ (Deg)	31.000	2.000	42.667	2.887
Torque Rate (Nm/s)	0.448	0.281	2.279	2.255

Table 3: Jump trials read as the averages of inches and meters.

Table 3: Jump Trials (Mean)				
	Dominate Leg		Nondominate Leg	
	inches	meters	inches	meters
Single Leg Jump	101.333	2.574	102.833	2.612
Double Leg Hop	82.833	2.104	77.000	1.956