Predictive Values For Grip and Torque Strengths Using Isometric Strength Testing Unit (ISTU®) Hand Attachments

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ABSTRACT

Normative data for determining maximum grip and torque strength for upper extremities is offered using newly developed hand attachments which can be adapted to most isometric strength testing units.

KEY WORDS: ISTU®, GRIP, STRENGTH, WRIST, TORQUE

The measurements of maximum hand grip strength in ergonomic or clinical settings has been a useful means of assessing physical characteristics, progress in rehabilitation and degree of disability in upper extremity injuries. However, reliable normative data on the hand has not been available.

Ergometrics, Inc. developed the ISTU hand attachments in response to this need. Of particular concern was testing for grip and torque strength. (Fig.1 and Fig. 2)

The hand devices were engineered and designed to operate as attachments to the main ISTU testing platform. The same recording instrumentation could then be used to test for strength and reproducibility. The protocols which were developed called for grip testing to be done with the upper and lower arm at right angles and the middle finger knuckle pointing at the strain gauge. All other positions would be tested at shoulder height with the arm fully extended.

The hand attachments were sent to four clinics for the purposes of gathering test data. Each clinic was asked to test 25 male and 25 female subjects resulting in a total sample size of 100 males and 100 females (See Exhibit A for data collection sheet). This data was then analyzed using the same population parameters as the Biomechanical Model. These parameters are as follows:

A. Age — 18 to 55
B. Male Height — 66' to 74"

C. Female Height — 61' to 68"
D. Male Weight — 126 lbs. to 216 lbs.
E. Female Weight — 104 lbs. to 198 lbs.

The test results were corrected by one standard deviation for actual grip strength. Males were between 88 lbs. and 132 lbs. while females fell between 47 lbs. and 81 lbs. Based on these parameters the population size was reduced to 42 males and 51 females. The data was sorted in numeric order using actual arm lift values. The data was then analyzed looking for correlations between strength, age and anthropometric data. A direct correlation was found between the arm lift and power grip. (Exhibit B)

The Biomechanical Model predicts arm lift strength based on height, weight, gender and body position. If there is a direct correlation between arm lift strength and grip strength, then logic dictates that grip strength and wrist torque can also be predicted using the Biomechanical Model. Hence, grip strength could be estimated as a percentage of the predicted arm lift taken from the Biomechanical Model. The percentage used to predict the grip strength was based on:

1. A comparison of the predicted arm lift mean with the actual grip strength mean of the tested population.
2. A percentage that would allow 75% of the tested population to fall within or above the predicted values.

Grip strength was predicted for each subject and compared to their actual grip strength. These results were also compared to the predicted results of the Jamar hand study which is based on age classifications. Fifty percent of the male and female tested population fell below what was considered normal strength according to the Jamar Study, while the predictions based on the Biomechanical Model resulted in only 25 percent falling below predicted values.

Based on this information wrist torques were predicted using the Biomechanical Model. The percentages used to predict wrist torque took two factors into consideration:

1. A comparison of the predicted grip strength mean with the actual wrist torque mean of the tested population.
2. A percentage that would allow 75% of the tested population to fall within or above the predicted values.

The percentage selected for predicted grip strength was 129% of the predicted arm lift. The wrist torque values were then based on a percentage of the predicted grip strength. These percentages were as follows:

	MALE	FEMALE
Flexion	45%	54%
Extension	50%	59%
Pronation	90%	76%
Supination	50%	50%
Ulnar Deviation	125%	128%

This data is now incorporated in Ergometrics' Biomechanical Model computer software. The format calculates predicted strength values for grip strength and wrist torques. The

model also adjusts the predicted values down 5% for the nondominant hand. The format summarizes the differences between actual test results and the predicted test results. This data is then summarized to determine a percentage of strength impairment for either the right side or left side upper extremities.

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Figure 1. The ISTU® Hand Attachments

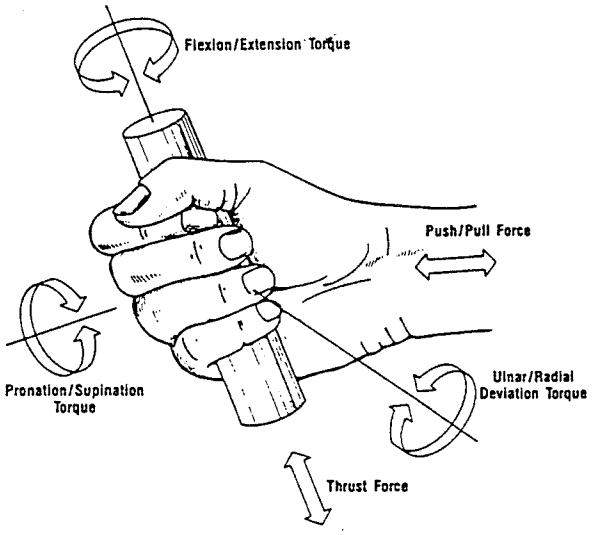
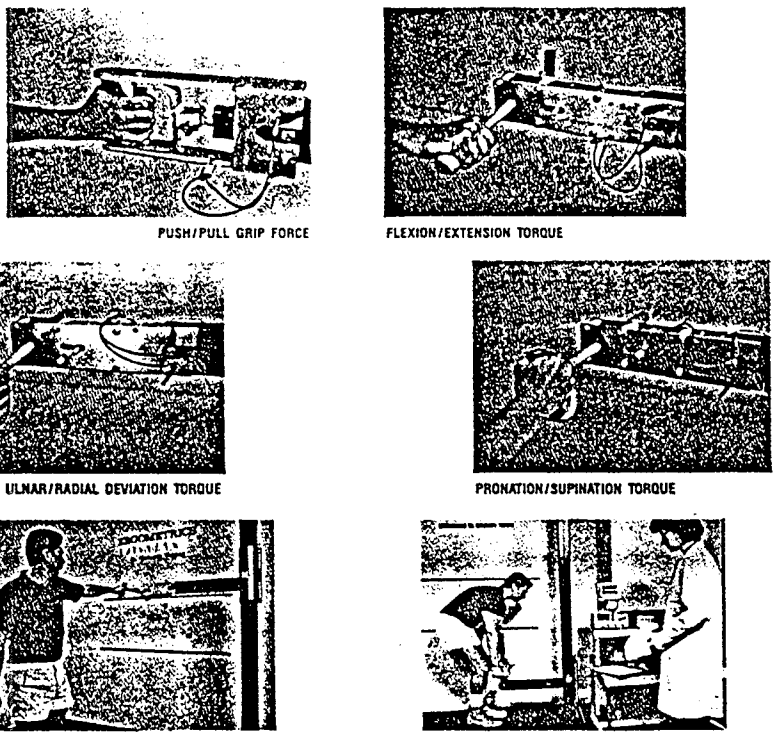


Figure 2. The ISTU® Hand Attachments



ISTU™ hand tools measure the isometric strength of the hand in pounds and inch pounds (right vs. left) applying the principles of psychophysics that allow for accurate and reproducible measurements.

Exhibit A
ISTU® Hand Attachments

1. Name:
2. Gender (circle one): Male Female
3. Age:
4. Occupation:
5. Height:
6. Weight:
7. Measurement of tip of middle finger to first wrist line:
8. Diameter of hand around palm:
9. Diameter of wrist:
10. Hand dominance (circle one): Right Left

Arm lift

	Right	Left
Power grip* (Elbow right angle)	____	____
Wrist torque flexion* (Device shoulder high)	____	____
Wrist torque extension (Device shoulder high)	____	____
Pronation (Device shoulder high)	____	____
Supination (Device shoulder high)	____	____
Ulnar deviation (Device shoulder high)	____	____

Prior to actual testing do an arm lift to make sure the subject understands how the ISTU® operates and also as a means of verifying testing data. Please allow the subject enough trials to be considered trained on how to use the ISTU®. Look for reproducibility in testing during trials.

Exhibit B
Ergometrics, Inc. Biomechanical Model

Hand Calculation

Subject: Joe Johnson
Age: 36 Sex: M Dominant Arm: R

	Subject Limit	Expected Limit	Difference	%
Arm Lift:	100	100	0	0
Power Grip R:	129	129	0	0
L:	123	123	0	0
Flexion R:	55	58	-3	-5
L:	55	55	0	0
Extension R:	50	64	-14	-22
L:	50	61	-11	-18
Pronation R:	100	116	-16	-14
L:	100	110	-10	-9
Supination R:	60	64	-4	-7
L:	60	61	-1	-2
Ulnar Deviation R:	135	161	-26	-16
L:	135	153	-18	-12

Right upper extremity = 11
Left upper extremity = 7

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