

ISOKINETIC STRENGTH AND MUSCLE ACTIVATION (sEMG)

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ISOKINETIC STRENGTH and MUSCLE ACTIVATION (sEMG)

1. Background and rationale

In MOST we will assess concentric isokinetic strength of the knee extensor (quadriceps) and knee flexor (hamstring) muscles. Concentric refers to contraction of the muscle as it shortens and eccentric to contractions of the muscle as it lengthens. Standing up from a chair requires concentric contractions of the knee extensors and eccentric contractions of the hamstrings. Sitting down slowly requires eccentric contraction of the knee extensors and concentric contraction of the hamstring respectively. Both types of contractions are important to function. However, in MOST only concentric contraction will be tested because eccentric motions produced by active dynamometers are not considered to be like those seen during functional activities. Short and rapid eccentric motions are normally produced during daily and sporting activities; isokinetically, this is not seen as the isokinetic movements are usually long and through full range of motion.*

A Cybex 350 isokinetic dynamometer will be used to evaluate the concentric strength of the knee extensors and flexors. Isokinetic dynamometers test muscle performance as the participant applies force against a continuously moving mechanical arm. This is in contrast to isometric tests, which require application of force against an immovable mechanical arm or lever. The Cybex is capable of testing a variety of muscle groups while the mechanical arm is moving at a wide range of speeds. However, studies have found that muscle performance at one speed is highly correlated with performance at other speeds. We will test the performance of the right and left knee extensors and flexors at 60° per second.

We will simultaneously measure muscle co-activation during isokinetic strength testing using measure of muscle surface electromyography (sEMG). This test will enable measurement of co-activation during a challenging task (done at maximal effort), while capturing the period of maximal co-activation, ~10° to 40° from full extension. Using the following methods, we will measure muscle activity over both the medial and lateral quadriceps and hamstrings.

2. Equipment and supplies

2.1 Isokinetic testing

- Cybex 350 Isokinetic Test and Exercise System and HUMAC 2008 Windows Software
- Johnson anti-shear attachment
- Certified weights (two 2.5 lb, two 5 lb, one 10 lb, and two 25 lb) that have a hole in the center and fit on the T-bar for calibration
- Step stool with a handrail

* Chan, K M and Maffulli, N (1996) Principles and practice of isokinetics in sports medicine and rehabilitation. Williams & Wilkins, Hong Kong

2.2 Muscle sEMG

- Delsys Bagnoli 4-channel muscle surface electromyography (sEMG) system, including filter/amplifier unit, National Instruments USB DAQ card, 4-channel portable EMG pack, and five Delsys 2.1 surface electrodes (sensors)
- EMGDAQ, a custom Labview software application for data collection/analysis interface (4-channel EMG)
- Dell laptop (Vostro™ 1710) with Windows Vista
- Supplies: four each - Delsys 2-slot medical-grade, double-sided adhesives per limb (eight per participant), one each - 2" round reference pad (one per participant) (Dermatode, American Imex)
- ~ 1 cm wide Medical grade tape x ~ 32" per participant (e.g., Micropore or Transpore skin tape), alcohol swabs (~ two per participant)

2.3 Service and maintenance

The Cybex 350 is a low maintenance machine. There are three areas which should be lubricated every two months with a dab of lithium grease (one on each seat back and one on each pedestal clamp). It is recommended that every three months the steel shaft of the dynamometer be wiped with a rubbing alcohol pad.

The sEMG equipment requires minimal maintenance. The sensor wires should not be wound tight as that can cause internal damage. The sensors should be stored carefully in their packages between use. The silver bars should be gently wiped with isopropyl alcohol between participants. A new ground electrode should be used for each new participant.

Repair of the Cybex dynamometer is covered under the Computer Sports Medicine, Inc. (CSMI) one-year warranty and extended service contract (48 hours after call in to CSMI).

Rob and Rich Potash: Computer Sports Medicine, Inc.

101 Tosca Drive

Stoughton, MA 02072-1505

Phone: 781-297-2034, Ext. 106

Fax: 781-297-2039

Problems with the Delsys equipment will be addressed by Delsys. Initial contact can be made to:

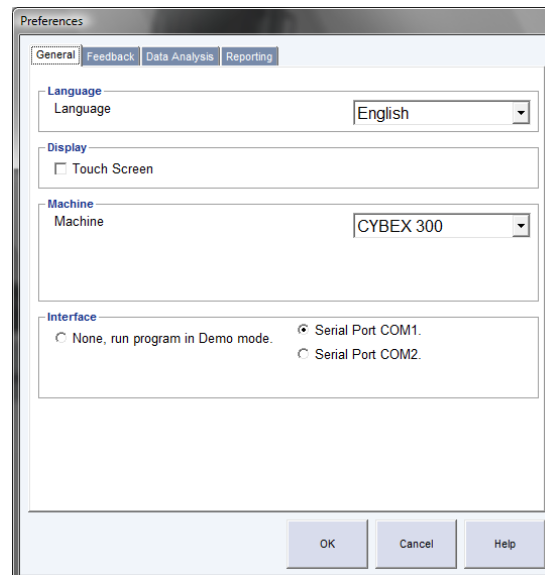
Devi Bheemappa
Manager, Sales and Marketing
Delsys Inc.
Phone: 617 236 0599 xt.231
Fax: 617 236 0549
devi@delsys.com

Any computer problems are covered by Dell's next day service.

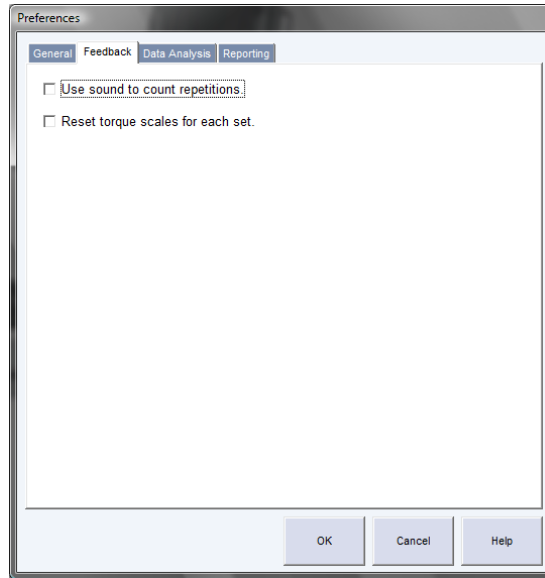
2.4 Preferences set during installation of Isokinetic Testing software

Preferences will be set by head technician or clinic coordinator using the file preference on the pull down window.

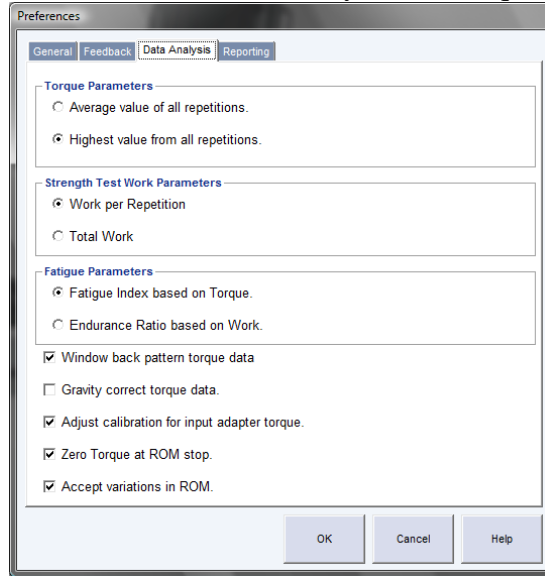
Tab 1 General



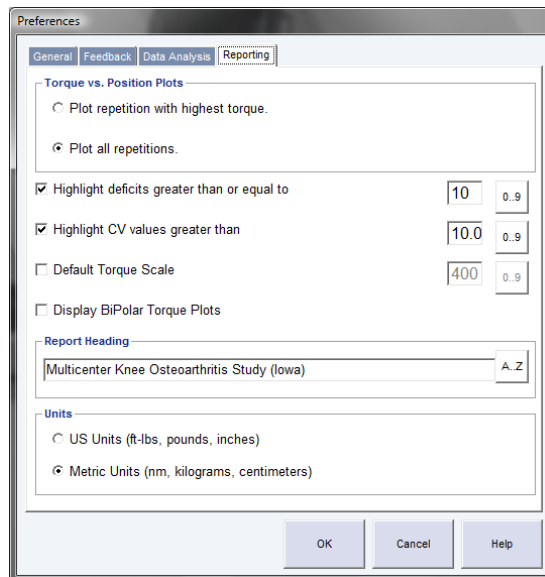
Tab 2 Feedback – be sure there is no check mark next to "use sound to count repetitions."



Tab 3 Data Analysis - check "Highest value from all repetitions," "Work per repetition," "Window back pattern torque data," "Adjust calibration for input adapter torque," "Zero torque at ROM stop," and "Accept variations in ROM." Make sure that the "Gravity correct torque data" is NOT checked.



Tab 4 Reporting - check "Plot all repetitions," "Highlight deficits greater than or equal to 10," "Highlight CV values greater than 10.0," and "Metric Units (nm, kilograms, centimeters)." Enter the customized report heading in the appropriate box (e.g., "Multicenter Knee Osteoarthritis Study").



When the machine is turned on each day, preference settings should be checked. Notify the study coordinator if the preferences have been changed.

2.5 Calibration

See Appendix 1 for step by step dynamometer calibration instructions. Each clinic has certified weights for calibration. These procedures should be followed once a week. A reading of 178 to 182 ft-lbs is acceptable. High or low values may indicate bouncing of weights during calibration while the arm is moving. If out of range, repeat calibration once, making sure weights fall smoothly, followed by verification. If the calibration and verification range is still not correct, call CSMI (781-297-2034).

The EMG does not require calibration as each muscle signal will be normalized to its own maximum during the maximum testing protocol.

3. Safety issues and exclusions

Both the quadriceps test using the Cybex and the surface electromyography (sEMG) are generally safe and well tolerated. However, injury during strength testing may occur in participants with knee joint pathology or if the machine is operated incorrectly.

Participants should not be tested on the dynamometer if they have any of the following conditions (see data collection form for specific questions corresponding to each exclusion):

Participant exclusions:

- Blood pressure, defined as >199 / 109 mm Hg
- History of cerebral aneurysm
- Cerebral bleeding within the past six months
- Back surgery within the previous three-month period
- Myocardial infarction in previous six-week period
- Cataract surgery within the previous six-week period
- Untreated inguinal hernia
- Participant develops chest pain or dizziness while at the clinic or during test
- Thigh strap cannot be tightened because thigh is too large

Side-specific exclusions – test can be performed on unaffected side:

- Joint replacement surgery (hip/knee) within the previous three-month period.
- Extreme knee pain that would make it uncomfortable to test that leg and would invalidate the examination result.
- Extreme pain in other lower extremity joints that would be aggravated by testing.
- Amputation, prosthetic device, cast or brace.

Stopping rules:

- If the participant develops chest pain or dizziness during the test, do not complete the test.
- Participant says they cannot continue with test due to knee or back pain. Test other side if possible.

sEMG exclusions:

- Pacemaker or other implanted cardiac device, infusion pump or stimulator
- Allergy to adhesive or allergy to silver
- Skin irritation, rash or wound in the area of sensor placement

4. Participant preparation

Ideally, this test should be performed after a short period of warm-up exercise. The 20-meter walk and chair stand tests are well suited to this purpose and should be performed just before the isokinetic strength test.

Ask the participant to remove their shoes. Participants should be wearing shorts or other loose fitting clothing that allows access to the anterior and posterior thigh muscles for sEMG sensor application. The sEMG reference pad will be placed on the lateral malleolus of the ankle. Socks may be worn if desired, but should allow for access to this lateral bony prominence.

Prior to seating the participant on the Cybex chair, clean and apply the four sEMG sensors to the left thigh (see section 5.2.4 for details). (Note that during some study years testing is performed on one leg only with the right leg preferred, with the exception that participants who had knee replacements will be eligible for testing in both legs.) Once applied, seat participant so that you can test their left leg first (unless contraindicated or not required). To test the left leg, seat the participant on the right-hand chair (your left as you face the two Cybex chairs). Ensure that the sEMG wires will not get in the path of the moving dynamometer arm, and secure the portable sEMG connector box to the waist strap.

See picture below.



5. Detailed measurement procedures

5.1 Record keeping

The Cybex 350 dynamometer has an automatic positioning feature that stores and recalls a participant's exact positioning and testing protocol from one examination to the next. It is important for longitudinal evaluations that the methods of strength testing and the participant positioning be consistent throughout the study.

In addition, participant identifiers and test data are entered into the HUMAC database via the keyboard (see Section 5.2.2, below). It is important to complete all of the required fields to allow the participant to be positively identified in the data sent to the Coordinating Center for analysis.

The custom sEMG interface (EMGDAQ) on the Dell Laptop computer will be used to store and analyze the muscle activity signals. It is important to enter the test location, test limb, and MOST ID

number to ensure the file names can be accurately identified in the data files sent to the Coordinating Center for analysis.

Data are also recorded on a data collection form as a backup to the computer storage of participant positioning and for a tracking record of isokinetic dynamometry testing performed on each participant. Additionally, sEMG parameters must be recorded on the data collection form.

The following dynamometer and strength parameters are recorded:

- Chair back angle: 85° (default)
- Chair seat fore/aft position
- Chair back translation
- Dynamometer tilt: 0° (default)
- Dynamometer height
- Knee/hip adapter
- Inner tube
- Outer tube
- Whether test was performed and reason if not
- Number of trials completed
- Highest four torques (flexion and extension)

The following sEMG parameters are recorded:

- Check that channel number and applied muscle locations are correct
 - Lateral hamstring (channel 1)
 - Medial hamstring (channel 2)
 - Lateral quadriceps (channel 3)
 - Medial quadriceps (channel 4)
- Channel gain settings
- Whether sEMG amplifier signaled high noise or signal clipping with an audible beep

Important: A two page printout of the MOST report should also be printed immediately after the testing session and kept in the participant's record in case of computer failure (see Appendix 3).

5.2 Administration

5.2.1 Determine contraindications

Use the questions and other criterion on the data collection form to determine if the participant is eligible for the test.

5.2.2 Getting started:

5.2.2.1 Preparing sEMG sensors

Apply the double-sided sEMG adhesive (lift up on the green tag) to each of four sEMG sensors with the green tags directed away from the sensor wires. Carefully align the holes with the silver bars. Press firmly to ensure good contact between the adhesive and the plastic sensor.



Delsys sEMG 2.1 sensors and the double-sided adhesives



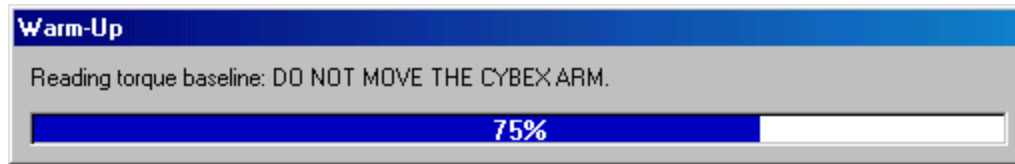
sEMG reference pad.

Attach the 2" round disposable pad to the small reference wire.

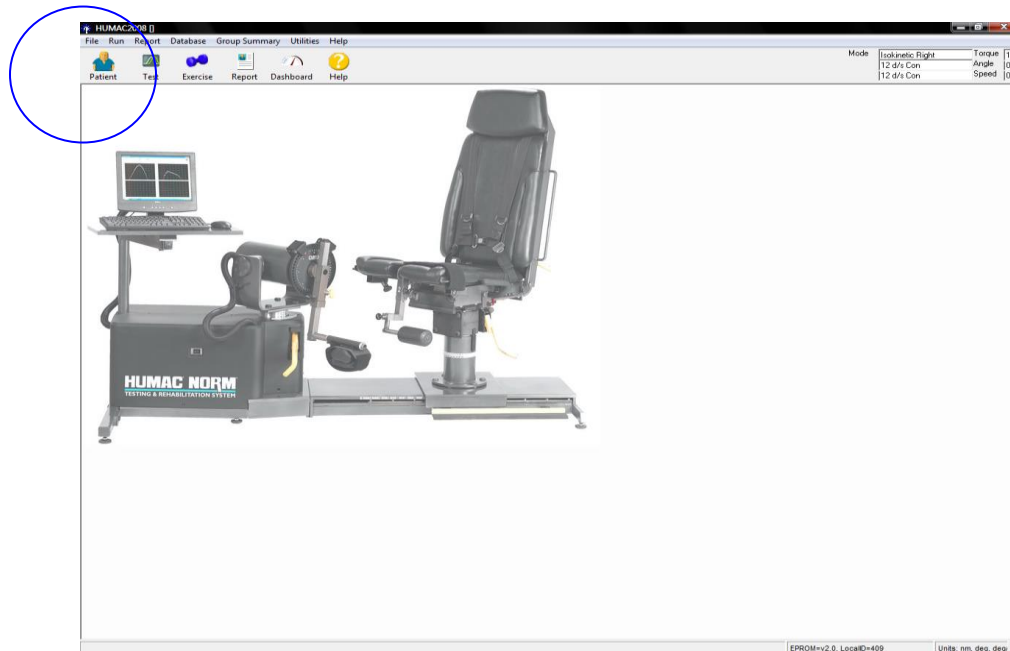
Set aside until you are ready to apply to the participant. Be careful not to damage the wires by getting them tangled or wrapping them too tightly.

5.2.2.2 HUMAC computer screen

Before opening the HUMAC program, make sure the dynamometer is turned on. The switch is behind the dynamometer. Double click on the HUMAC icon on your computer screen. When you begin, the HUMAC computer screen will look like this:



and then like this:



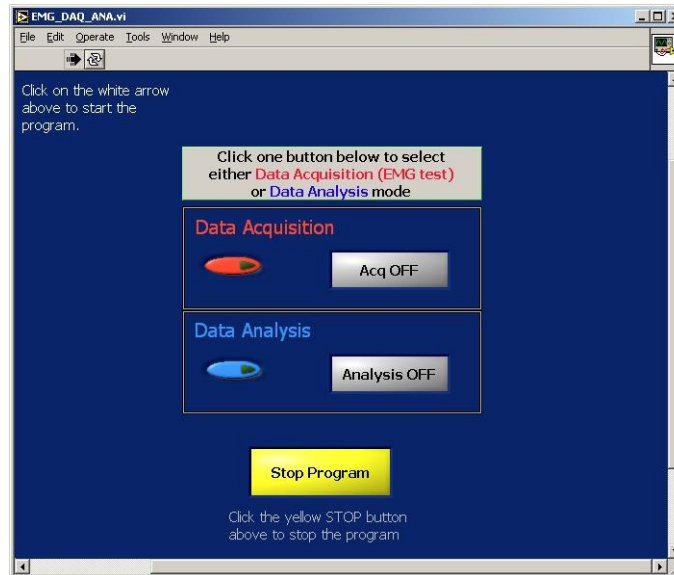
Click on "Patient" on upper left part of window.

5.2.2.3 EMGDAQ computer screen

Open the sEMG data acquisition software icon (EMGDAQ) on the laptop screen. You should see an interface with two options to continue:

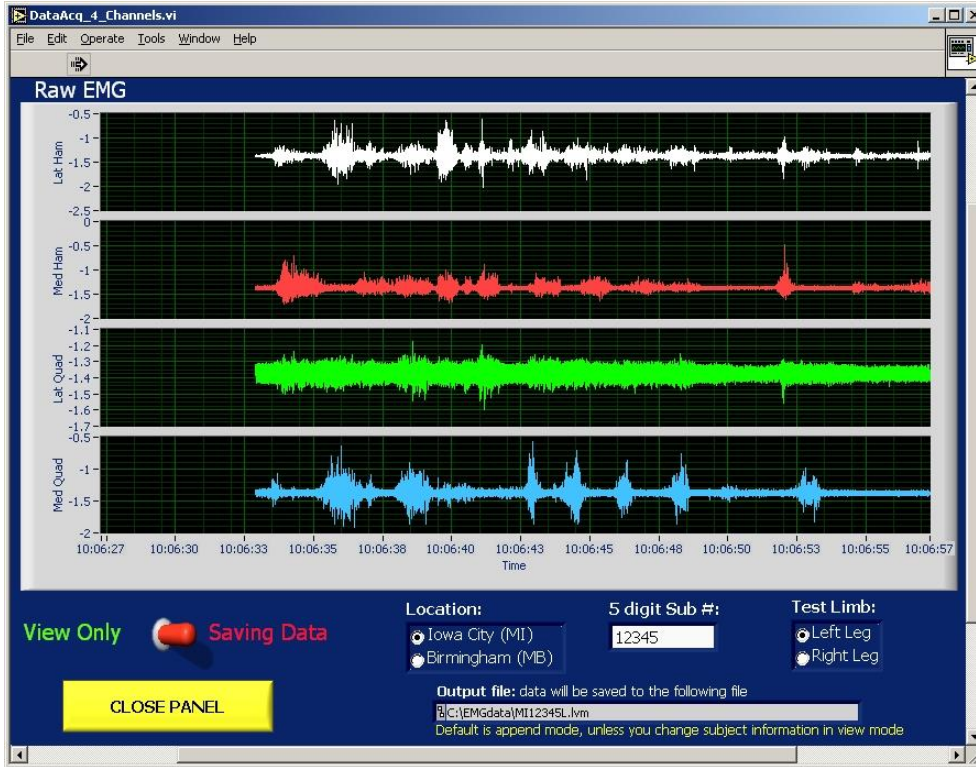
- Data Acquisition (used to collect sEMG data during testing) and
- Data Analysis (used by the Coordinating Center for later post-processing)

Click on the red Data Acquisition button (see below).



Note: the program should open in “run” mode, meaning you can begin to use the program immediately. This is indicated by a black arrow above the white text in the left upper corner. To stop the program from this screen, click on the yellow Stop Program button. If you click the yellow Stop Program button, the arrow becomes white. To restart, you will need to click on the white arrow.

Important: Enter the participant information on the Data Acquisition screen (see below) including test location, test limb and five digit MOST ID number. This information is used to create the filename to store the sEMG test results.



Note: the name and location of the saved output file is provided in the bottom grey rectangle.

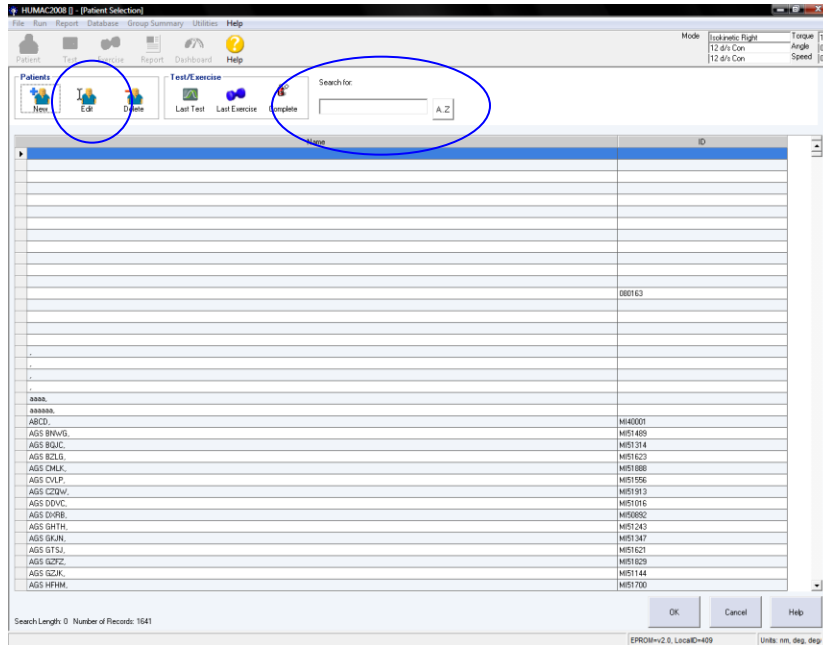
5.2.2.4 Delsys Amplifier Channel Settings

On the main Delsys amplifier unit, turn the gain on each sEMG channel to 1k. (The exception to this is that during some years the gain for all women should be turned to 10k. During these times, indicate that the gain was set to 10k on the data collection form. Be sure to return the gain to 1k for men). With this exception, 1k is the standard gain setting (see Section 5.2.4.d testing sEMG signals).



5.2.3 Isokinetic Test parameters

a. The next screen will include a list of participants who have had tests. You may search for participant in the search field (“Search for”) using the participant’s acroscopic. Then click on the correct participant from the list displayed.



b. Choose "Edit" at right side of screen.

c. Review information on screen:

Make sure that the following information shows up on the screen. Be sure to update the MOST staff ID number.

Last, First, MI

Participant’s acroscopic should be in the Last name field (leave the First and MI fields blank)

ID

MOST seven-digit ID#

Birth date

Do not record

Height:

Do not record

Weight:

Enter current body weight in kgs recorded from the scale (see page 33 of Clinic Visit Workbook)

Sex:

Male or Female

Preferred Side:

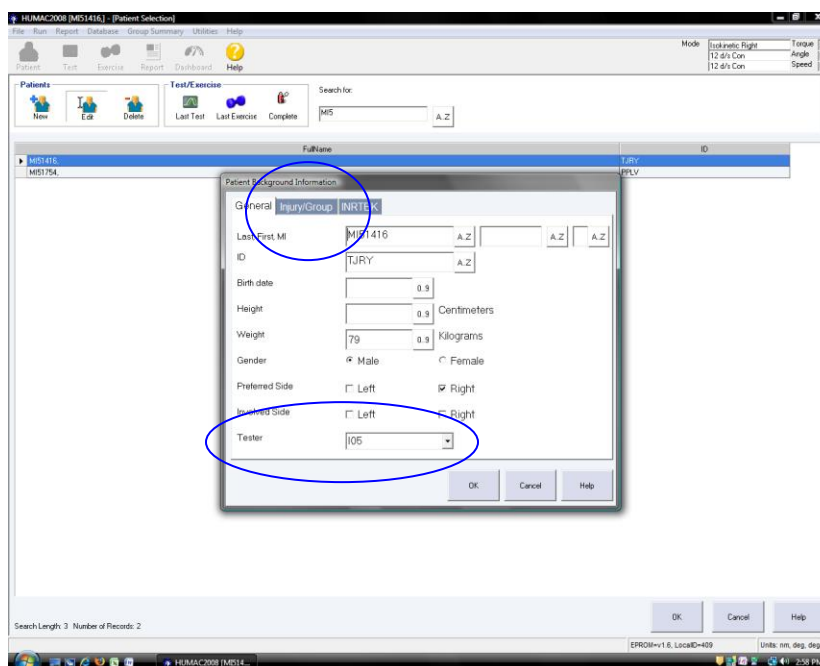
Right or Left (Ask, “Which foot do you or did you prefer to kick a ball with?” whichever foot they kick with is their preferred side. If they don’t know, leave this blank).

Involved Side:

Do not record

Tester

Enter MOST staff ID from the list

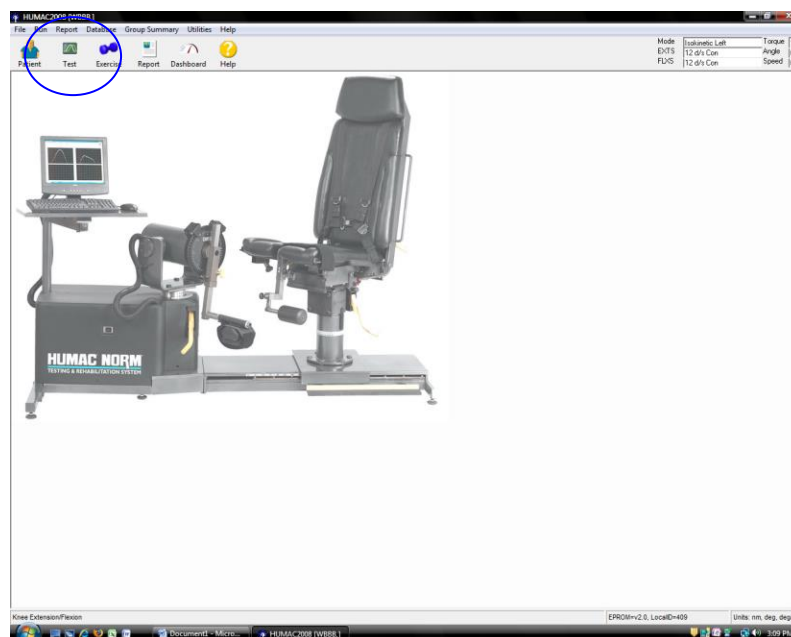


Click on the Injury/Group tab. Add site, year, and week under grp 1 (e.g., MI2009w1) to identify participant as being testing during each week for weekly download and back-up.

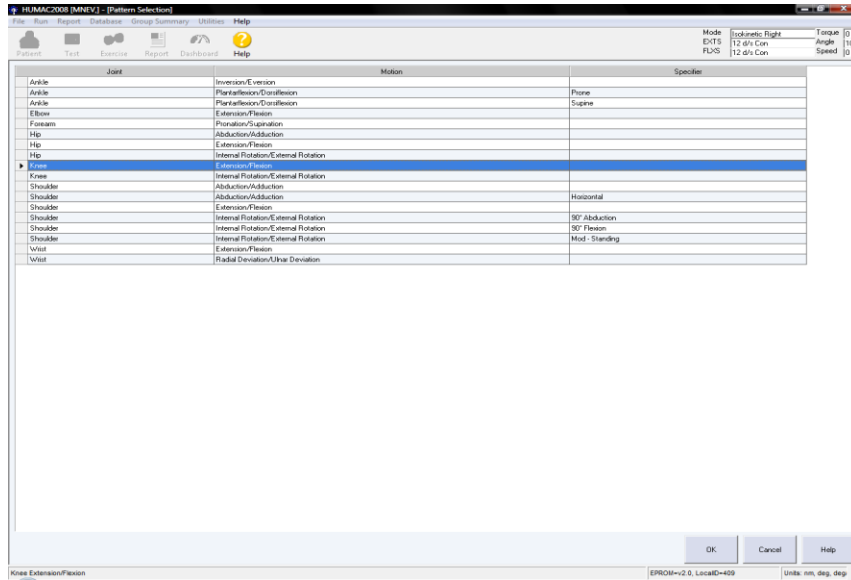
When finished, click “OK.”

d. You will then be at the main screen, which will look like this:

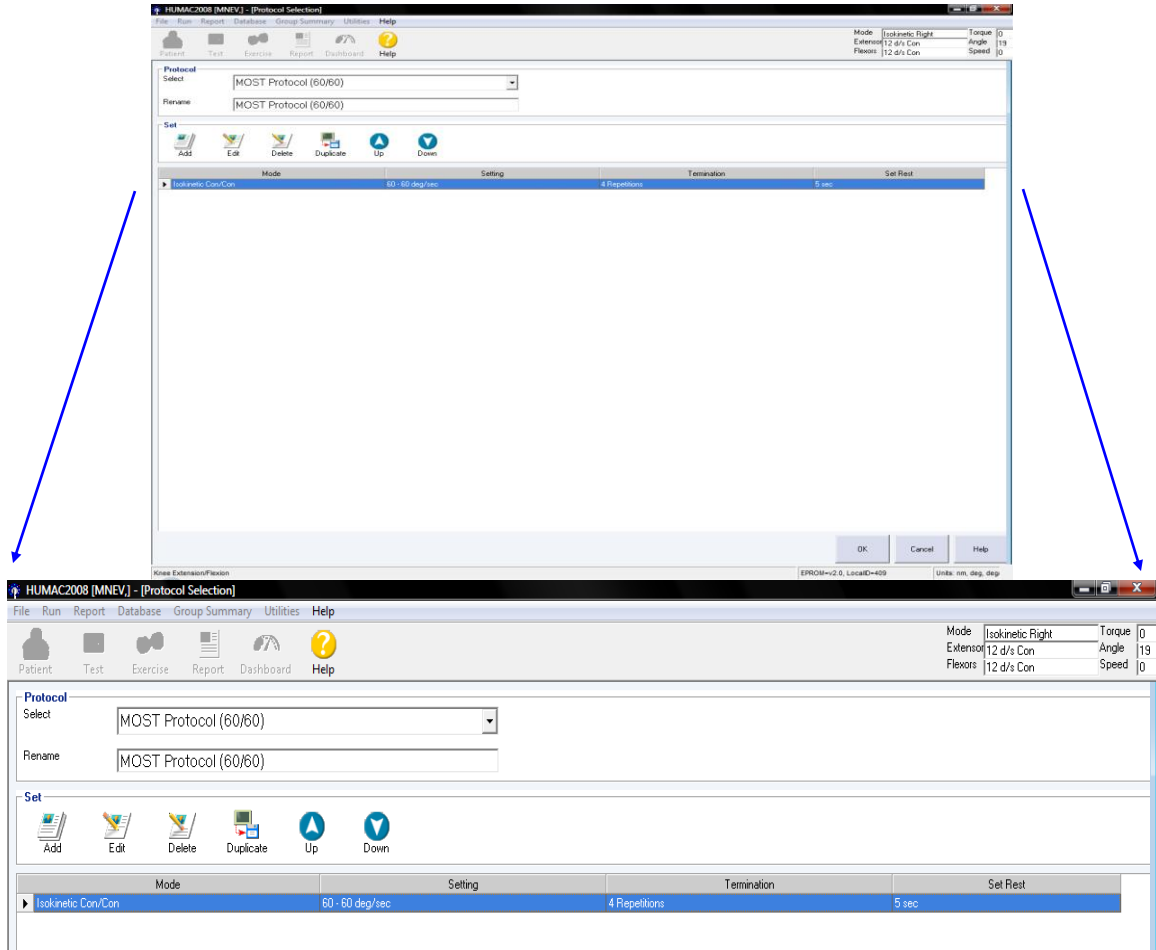
Click on “Test.”



- e. The next screen that will appear allows you to choose which test to do: Highlight **Knee Extension/ Flexion** and click “OK.”



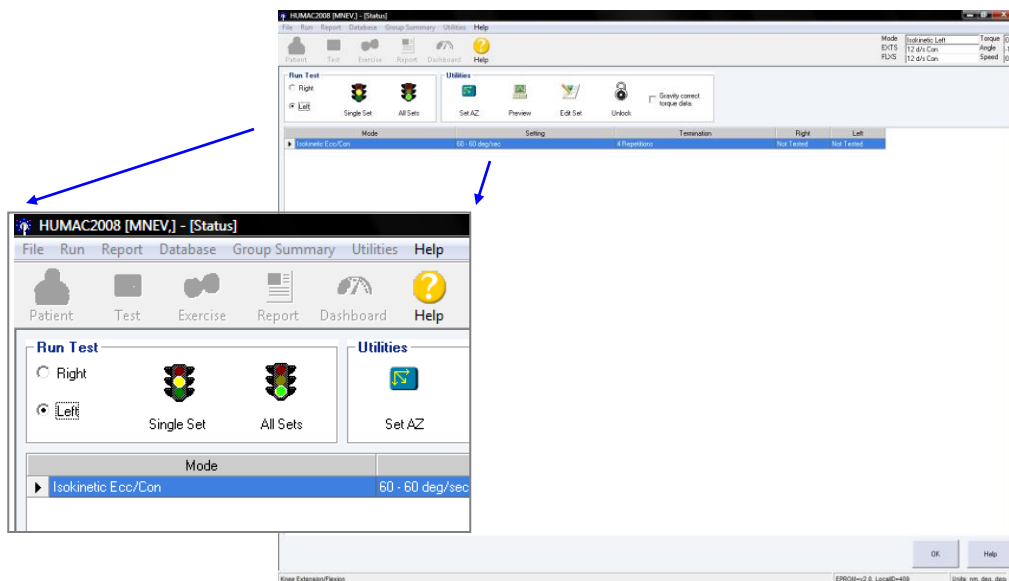
f. The next screen that will appear is for selecting the Speed Protocol:



Choose the protocol (see example above: choose MOST Protocol (60/60)).

The screen will display the preset protocol (see inset: Isokinetic Con/Con; 60 – 60 deg/sec; 4 Repetitions, 5 sec). Click “OK.”

g. The next screen that will come up will be the “Test Status” screen.



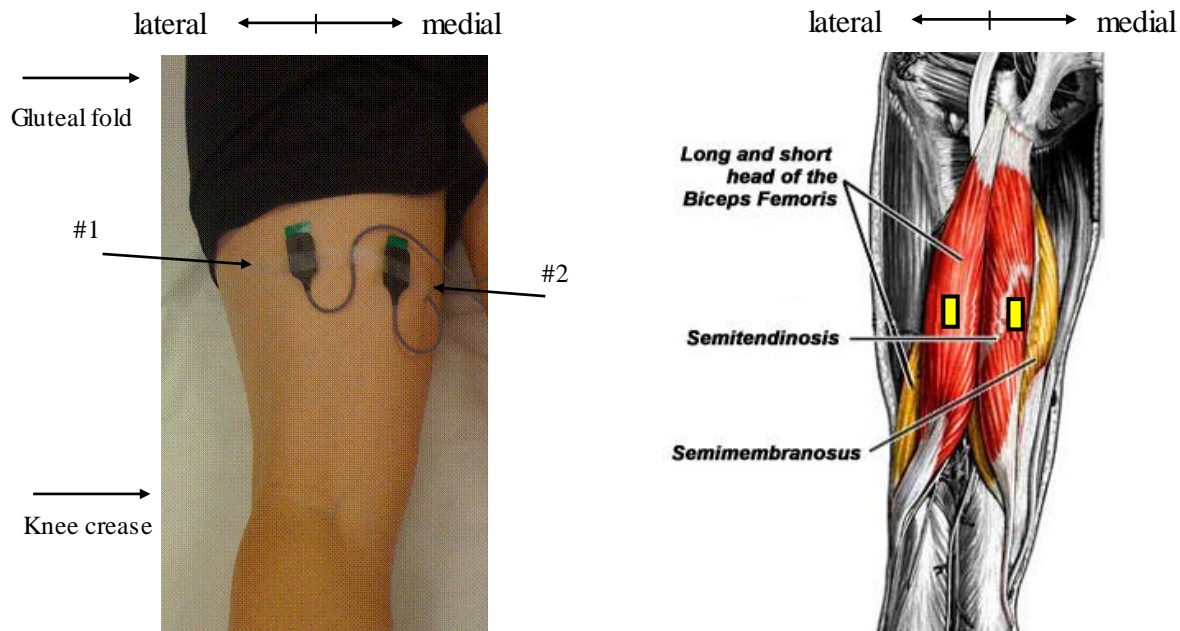
Click in the bubble that corresponds to the side being tested. Then choose “**Single Set**” by clicking on the yellow “stop light.”

5.2.4 Applying the sEMG sensors

EMG sensor placement will follow the SENIAM recommendations for Surface ElectroMyoGraphy for the Non-Invasive Assessment of Muscles (<http://www.seniam.org>), avoiding known innervation zones.

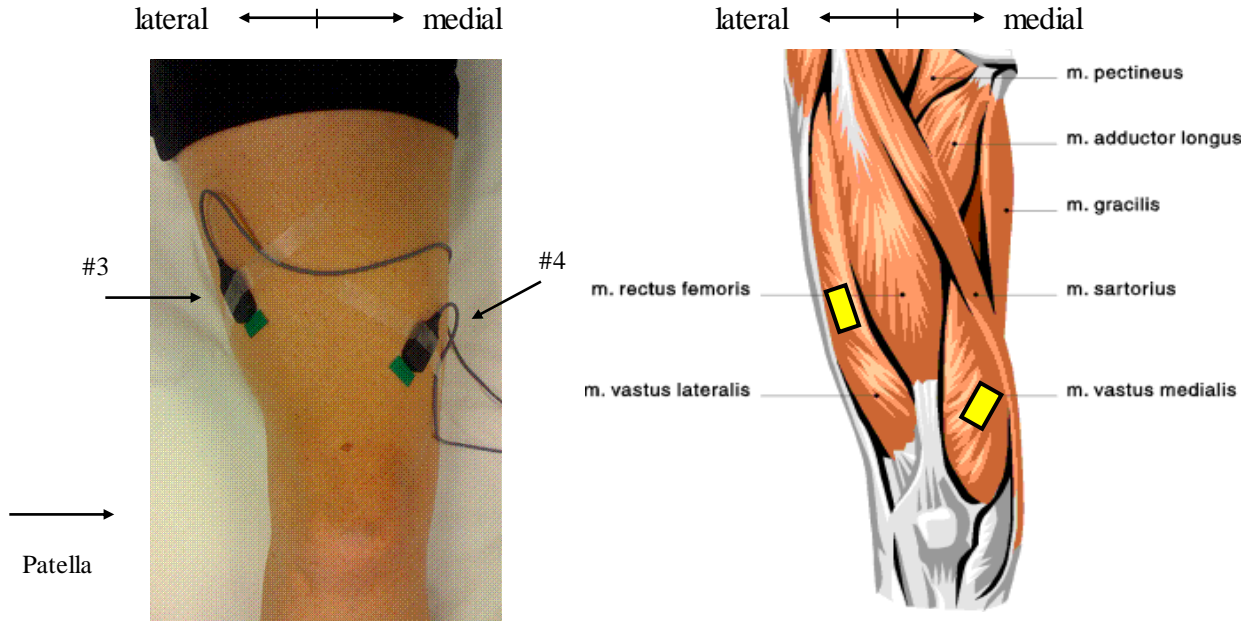
Script: “We will be applying these sensors (*examiner shows participant a sEMG sensor*) to the skin on the front and back of your thigh to monitor the muscle activity while you perform the strength test. They cannot stimulate or shock you, but only measure your muscle activation, similar to having an electrocardiogram (EKG). We will attach the sensors with double-sided tape. They shouldn’t bother you during the test, however if it hurts to sit on them, please let me know. One additional disposable pad will be placed on your ankle as a reference, it also cannot stimulate or shock you.”

a. First vigorously clean the skin with rubbing alcohol pads in the region of the expected electrode placement. After the skin is dry (no longer wet/shiny appearance) apply the surface sEMG electrodes as indicated below to the leg to be tested (1st left) while participant is standing. Apply in the order (1 through 4) listed: 1st lateral posterior thigh (biceps femoris), 2nd medial posterior thigh (semitendinosus and semimembranosus), 3rd lateral anterior thigh (vastus lateralis), and 4th medial anterior thigh (vastus medialis).



Sensor #1: Lateral Hamstring. Apply the sensor mid-way on the posterior thigh – approximately centered medial to lateral and proximal to distal, directed vertically. The biceps femoris runs from the ischial tuberosity proximally to the lateral tibial plateau distally at the knee. Be careful not to place this sensor too far laterally as it will pick up signals from the quadriceps muscles from the front of the thigh more easily.

Sensor #2: Medial Hamstring. Apply the sensor mid-way on the posterior thigh – approximately centered proximal to distal and between sensor #1 and the most medial aspect of the thigh, directed vertically. The semitendinosus and semimembranosus muscles run from the ischial tuberosity proximally to the medial tibial plateau distally at the knee.



Sensor #3: Lateral Quadriceps. On the lateral anterior thigh, apply the sensor approximately 1/3 of the distance between the lateral femoral condyle and the anterior superior iliac spine (ASIS). The sensor should be placed at an angle of approximately 30° to the line of the femur, centered on the lateral thigh approximately mid-way between the line of the femur and the iliotibial band (IT band) on the lateral thigh. The vastus lateralis runs from the proximal femur to the lateral patella distally at the knee.

Sensor #4: Medial Quadriceps. On the anterior medial thigh, apply the sensor approximately 1/4 of the distance between the medial patella and the anterior hip. The sensor should be placed at an angle of approximately 30° to the line of the femur (creating a “V” with respect to the lateral sEMG sensor (#3)). The sensor should be approximately centered on the medial thigh between the line of the femur and the medial mid-line of the thigh. The vastus medialis runs from the proximal femur to the medial patella distally at the knee.

b. Place the disposable gel reference pad on the lateral malleolus of the ankle of the same limb.



c. As you apply each sensor, attach the corresponding wire to the appropriate connector on the portable sEMG pack.



d. Test sEMG signals by asking the participant to bend and straighten their knee or perform small standing knee bends. Watch the EMGDAQ screen to visualize bursts of activity in each of the four sensor channels.

If a sensor is not used, indicate “Not placed” on the data collection form OR if the gain of a sensor is set > 1K, please write in “10k” in the “Comments” section of the data collection form. (For those years where the gain is set for 10k for women, the 10k setting must also be noted on the data collection form.)

sEMG Signal Quality Checklist:

- **Adhesives firmly attached to sEMG sensors (rub with your fingers to ensure good attachment)**
- **Vigorously scrub skin in region of the sensors with 70% rubbing alcohol.**
- **Firmly attach all sensors and reference pads to skin with adhesives and tape.**
- **Check that sEMG placement is as directed; for example, check that the lateral hamstring sensor is placed relatively close to the thigh midline as it can pick up quadriceps activity too easily if placed laterally.**
- **Keep sEMG wires as far from electrical sources of noise (the Cybex, outlets, etc.) as possible.**
- **Encourage participants to apply their best efforts to the strength testing.**
- **Remind participants to FULLY relax after completing the strength test before stopping the sEMG data collection.**
- **Remember to stop data collection.**

Troubleshooting:

No apparent signal: If nothing appears to happen, check that the sEMG device is turned on and the gains are set to at least 1K on each channel. Note that the screen is set to “autoscale” so if you recently turned on the system or had the reference pad unattached, it may be merely autoscaling to a large burst of noise. Wait approximately 10 seconds and ask participant to repeat some knee activity (e.g., kicking their lower limb forward and back).

If only select channels appear to remain unchanged, check that those sensors are well attached. If for any reason a sensor is removed (e.g., loose, incorrect placement, etc.), remove the double-sided tape and replace with a new adhesive. Once the tape has touched skin it will not provide a good connection a second time. If a participant has particularly hairy skin, you may not be able to get a good connection between the sensors and the skin. We are not shaving for this study; the connection may improve once they are sitting on the sensors (for the posterior thigh sensors) or when strapped in for the testing (anterior thigh sensors). You may choose to proceed despite a non-ideal signal quality; if this is the case enter the reason the signal was not ideal in legible writing in the “Comment” section of the data collection form.

Very small signals: If during the signal checking or warm-up contractions, the signals are there but very small (< 0.5 v), you may consider increasing the gain to 10k. This may be necessary for individuals who have higher skin resistance, are older, or weaker. For females, the standard for a particular test visit (e.g., a portion of the 60 month follow-up visit) may be to set the gain to 10k. On the data collection form, indicate gains other than 1k (e.g., “10K”), and explain reasons if not due to standard protocol for that visit (e.g. “small signals”).

Signals appear “squared off” or “maxed out”: If the gain is set too high, or the reference pad or one of the sensors is not attached, the sEMG signals can exceed the level the laptop is able to read in (e.g., 5v). In this case, the signals will appear to have a squared-off and flat shape rather than the more typical activation spikes that should occur during muscle activity. If this occurs check 1) that all sensors

and reference pads are firmly attached, and 2) consider reducing the gain to 1k if set higher for that individual. Gain settings can be adjusted for each muscle channel individually if necessary, as they are each standardized by their own maximum value. However, try NOT to change the gain during the 4 test contractions when possible, but between the practice and test contractions.

5.2.5 Positioning the participant on the Cybex

The settings that were entered for the baseline exam should be used for the follow-up exam unless the participant has experienced some significant change in body size or anatomy that results in those settings now being inaccurate. These settings are on the MOST Data from Prior Visits Report.

Important! After the settings have been set and the participant is sitting in the chair, if you think that the chair seat should be set differently, or any other setting just doesn't seem right, see if you think that the participant can do the measurement without discomfort as it is, even though the setup doesn't look perfect to you. It is preferable that the baseline settings are used. However, if any setting has to be adjusted for participant safety or comfort, or is obviously so far wrong that it is most likely that the setting was incorrectly recorded at the previous visit, make the adjustment and record the new setting on the data collection form. Even if you use the exact settings that were used at baseline, you should still record the settings on the data collection form.

5.2.5.1 Johnson anti-shear accessory fitting

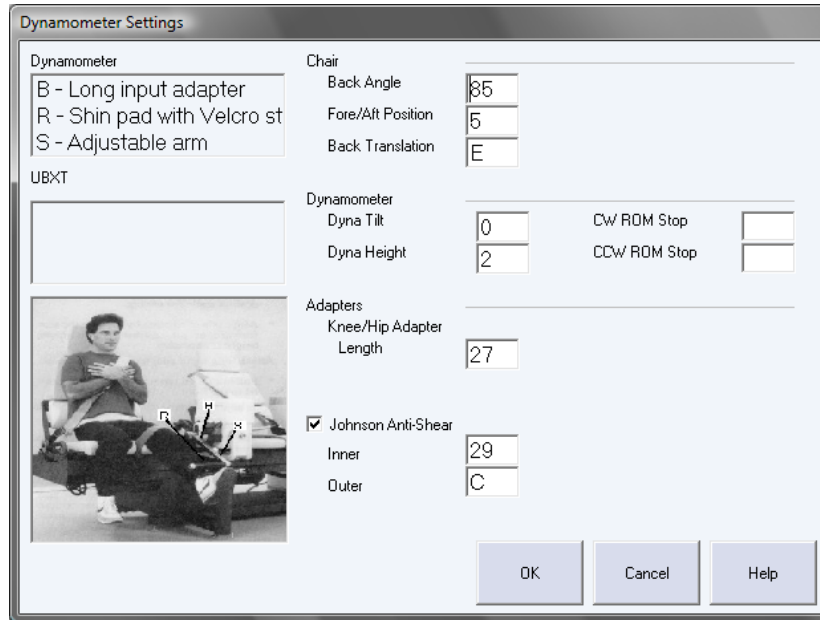
Position the participant in the chair and set the dynamometer settings. To adjust the Johnson anti-shear accessory, place the lower pad of the anti-shear device above the ankle and place the upper pad just below the knee. These settings correspond to the inner tube (range 27 to 41) and outer tube (range A to K) settings of the Johnson anti-shear accessory (see Appendix 2 for instructions).

5.2.5.2 Setup parameters to be entered on computer

After Pressing Single Set Button the following two screens will appear:

- Dynamometer Settings
- Set Anatomical Zero

The Dynamometer Settings screen will allow entry of the dynamometer settings as the participant is positioned on the Cybex chair.

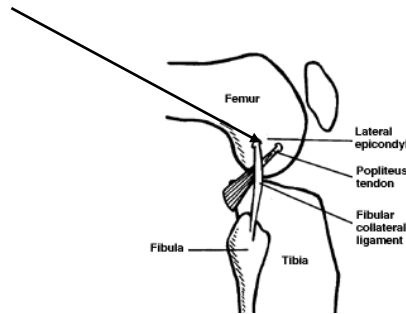


This screen requires entry of the:

FIXED PARAMETERS	VARIABLE PARAMETERS
<p><u>Chair:</u> Back angle 85°</p> <p><u>Dynamometer:</u> Dyna Tilt 0</p> <p>CW ROM Stop leave blank</p> <p>CCW ROM Stop leave blank</p>	<p><u>Chair:</u> Chair Seat Fore/Aft Position (range 0-8)</p> <p>Back Translation (range is A-P).</p> <p><u>Dynamometer:</u> Dyna Height (range 0-10)</p> <p><u>Adapters:</u> Knee/Hip Adapter Length (range 15-38) Johnson Anti-Shear (check box) Inner (range 27-41) Outer (range A-K)</p>

Script: “To begin, the device will be adjusted to fit your body (*examiner adjusts seating and strap*). This strap will be tight, as it should be for testing, however if it hurts please let me know.”

- Check that the seat angle is set to 85°
- Ask participant to sit up straight with hips square and backs of knees touching front of seat. Make sure that their shoes are removed.
- Adjust seat back (back translation) to participant.
- Ask participant to move heel back to the cushion under the seat.
- Adjust the fore/aft chair position so that the participant's knee axis corresponds to the dynamometer axis. The axis of the dynamometer should line-up with the lateral epicondyle. (Lateral epicondyle)



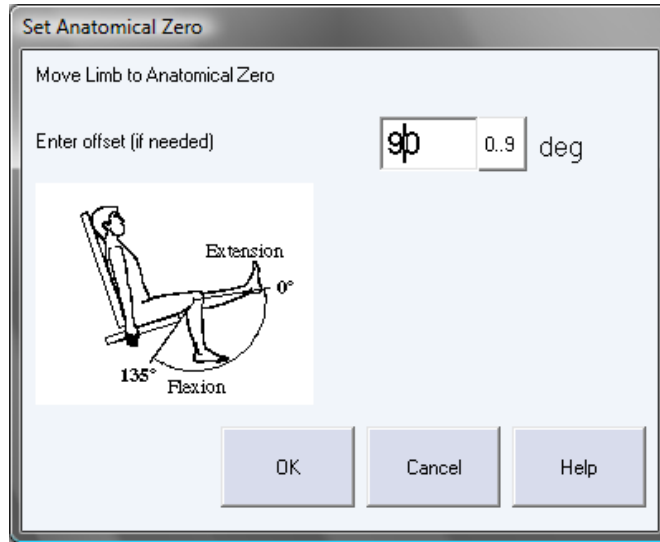
Lateral epicondyle(outside) of knee

- Adjust dynamometer height by loosening the large handle underneath the dynamometer; push the dynamometer up or down to center the dynamometer axis along the participant's knee axis. Tighten the handle. Record the dynamometer height.
- Have the participant place the nontesting leg behind the contra limb stabilizer.
- Use Johnson Anti-Shear accessory to position and stabilize participant's knee (see Appendix 2 for instructions). Note: the knee/hip adapter length setting (figure 21 in Appendix 2), the inner tube setting, and the outer tube setting (figures 14 and 15 in Appendix 2) should be recorded.
- Be sure all positioning parameters are recorded on screen.
- Tighten ankle strap. Fasten thigh strap as far above the knee as possible, if not able to fasten, participant is not tested on that side. Fasten shoulder belt snugly. If participant is uncomfortable, a small pillow can be placed between the shoulder belt and the chest.
- Click "OK" on the patient set up screen.

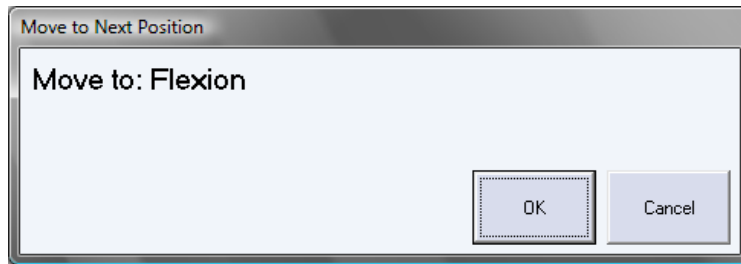
5.2.6 Set anatomical zero with participant's leg in full flexion

Position participant in full flexion

The participant's leg should be flexed to about 90 degrees. When the "Set Anatomical Zero" screen comes up, enter "90" and click "OK."



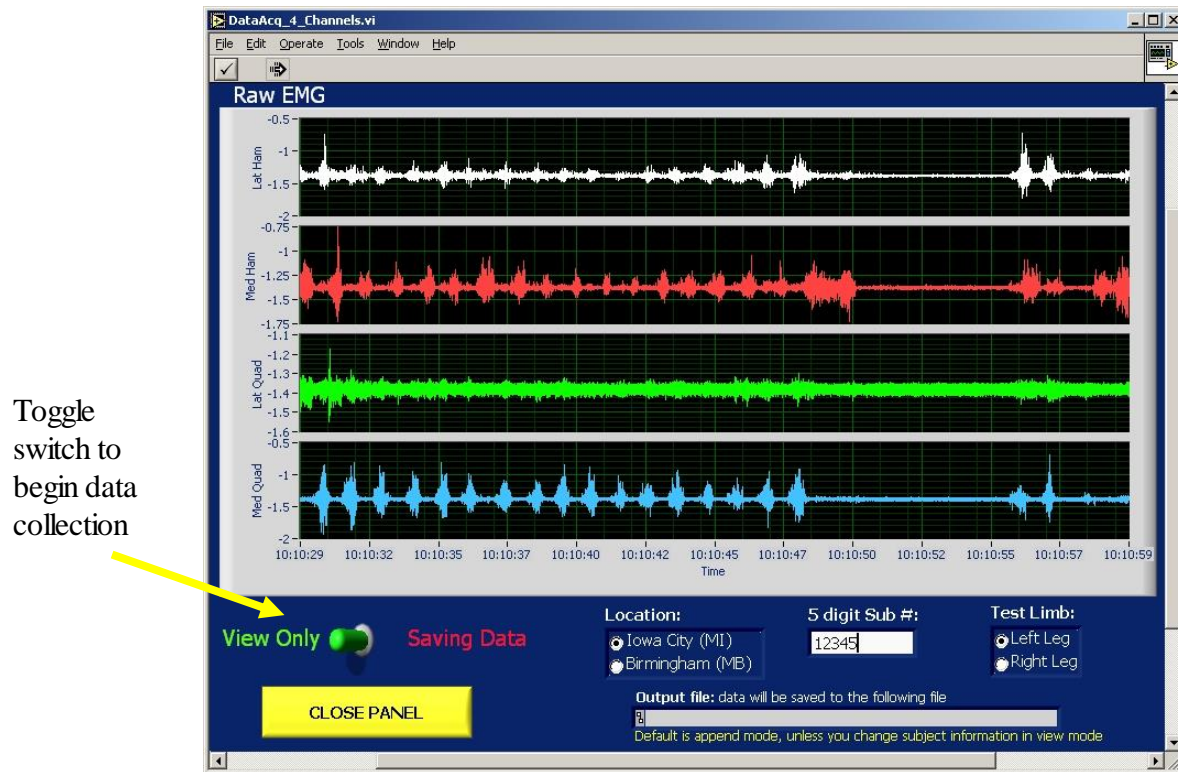
The next screen to appear is below:



5.2.7 Explanation, demonstration and practice trials

The participant should now be ready to begin testing. The examiner has chosen one speed, knee extension/flexion conc/conc at 60 degrees per second (see section 5.2.3.e).

Just prior to starting the Cybex testing protocol (including the practice trials), toggle the red “Saving Data” switch to begin collecting the sEMG data (see arrow below).



Explain the test procedure to the participant and have them perform the practice trial on the first side to be tested. Have the participant push and pull the resistance arm at 50% effort for the three practice trials. Encourage them with each push and pull.

Script: “During this test you will start with your leg bent at a right angle and then kick up, pushing as hard and fast as you can, and then pull your leg back down, again as hard and fast as you can. You will continue to push up and pull down as hard as you can, repeating this several times all in one smooth motion. (*Examiner demonstrates leg motion. To get the machine to start recording pull all the way back first and then push out; demonstrate.*) First you’ll do three repetitions, at 50% effort for practice so you get the feel of it. There will be 5 seconds of rest and then you will do four repetitions for the actual test, pushing as far as you comfortably can. You need to push and pull as hard and fast as you can.”

“Hold onto the handles firmly with both hands during testing. Do not hold your breath during the test. I’ll tell you when to begin and end the test. If you experience any pain, tell me and we will adjust or stop the machine.”

“Do you have any questions?”

IMPORTANT: *Examiner toggles sEMG switch on laptop just prior to starting test.*

“OK. Now let’s do three practice pushes and pulls. Ready, begin. Push. Pull. Push. Pull. Push. Pull. Great. Good effort.”

If the participant complains of pain during the practice, ask: “Does it hurt enough that you want to stop?”

If the participant complains of pain during the practice trials, determine how severe the pain is and whether testing should continue. If necessary, discontinue testing that leg and go on to test the other leg. If pain or discomfort is due to sEMG sensors, you may determine whether adding the foam cut-out would be helpful. If not, you may need to remove the problematic sensor(s). If a sensor is removed, turn the gain on the corresponding sEMG amplifier channel to 0.

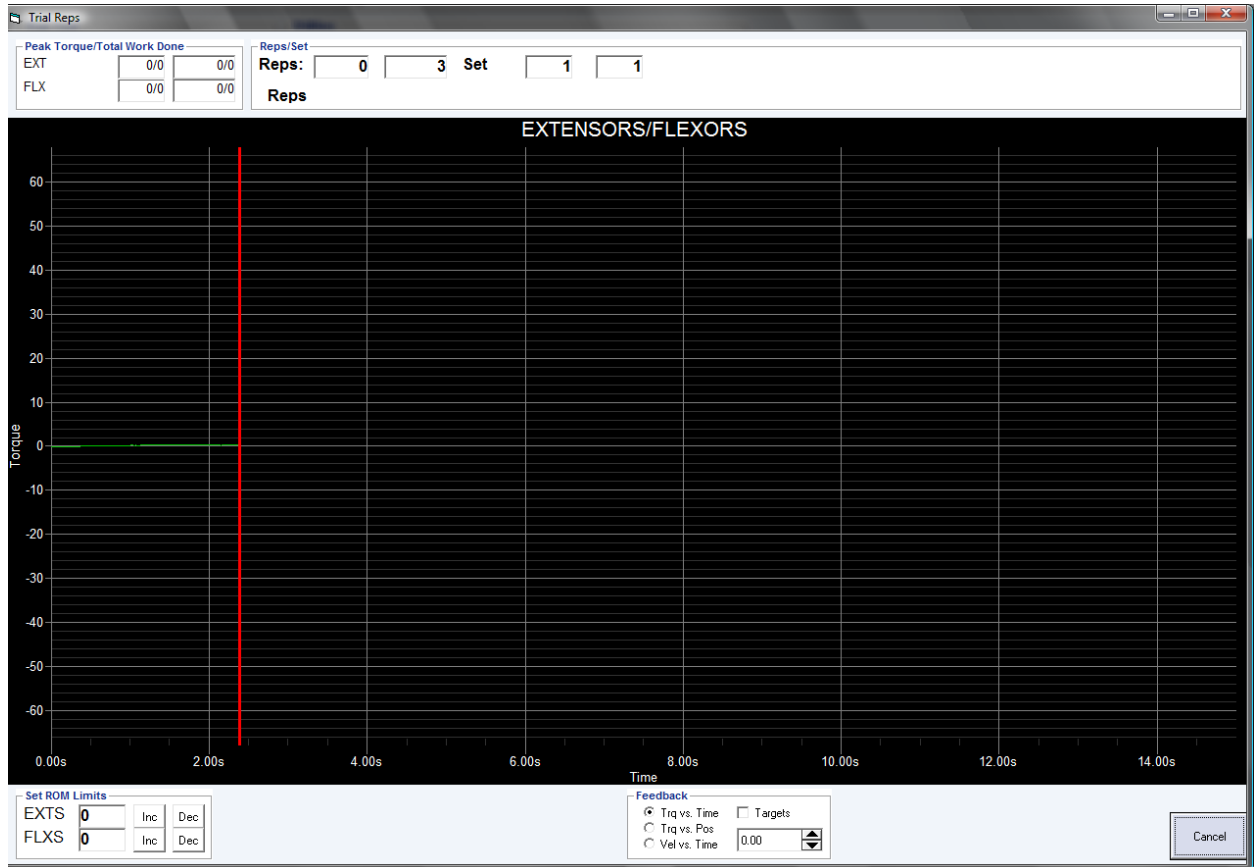
5.2.8 Isokinetic test at 60° per second

Once the participant has practiced and is comfortable with the testing procedure, tell them they are now ready for the actual testing. Encourage the participant to ‘push, pull, push, pull, push, pull’ as hard as they can on all four contractions. That concludes one set.

Script: “OK. Now we’re ready for the actual test. This time you will do four repetitions. Remember that it is important for you to push and pull as hard as you can on each repetition.

“Are you ready for the four pushes and pulls? Begin. Push.....Pull! PushPull!
Push.....Pull! PushPull! Great! Good effort! After you rest a moment we’ll test the other side.”

The testing screen will look like this:



After the test, ask the participant to completely relax for 3 to 5 seconds:

Script

“Please completely relax.”

After 3 to 5 seconds, toggle the EMGDAQ switch to stop data collection on the laptop.

Record on the data collection form whether the participant completed at least 90% of the expected range of motion (81 to 90 degrees) for all tests, based on your observation. That is, while you observed the participant performing the test, did they appear to use > 80 degrees range of motion (ROM), or did they appear to change direction early for some or all of the repetitions?

Script

“During this test did you experience any pain in your joints or muscles?”

Record participant’s answer on the data collection form.

Script

If “Yes” ask:

“Where was the pain located?”

Record location on the data collection form. Indicate if pain reported in either knee. If yes, ask participant to rate the pain.

Script

If the participant reported pain in either knee, ask:

“Did this pain prevent you from pushing or pulling as hard as you can?”

Record the participant’s answer on the data collection form.

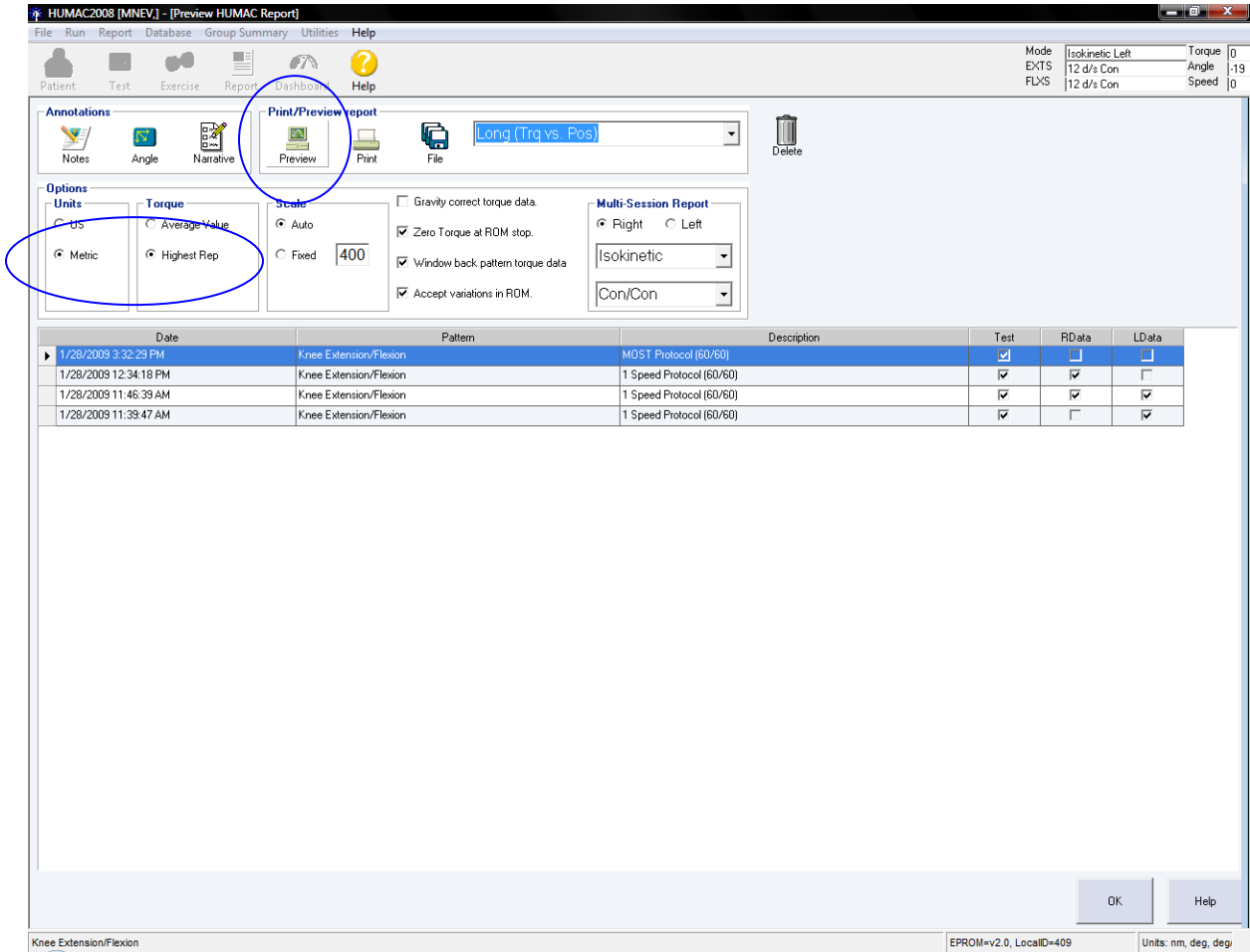
Unfasten straps, including Delsys sEMG portable pack from the waist strap, and carefully assist participant in rising from the Cybex seat without catching sensor wires on equipment. Remove sEMG sensors and reapply new double-sided tapes to the sensors. Reposition sEMG sensors on right limb using the same procedure outlined above. Remove reference pad from left ankle and apply similarly to the right ankle (re-using the pad).

Reposition the participant on the Cybex to test the other leg using the same procedure.

Click on Right Leg on the EMGDAQ laptop interface and on the Cybex computer interface. Just prior to starting the test, toggle the EMGDAQ switch to start sEMG data collection for the right leg. Continue with the strength protocol: three practice trials at 50% effort and four test trials at 100% effort.

When completed, complete the test in the same manner as described for the left leg.

Click on “OK” and return to Preview Humac Report.



Highlight the test that was just performed. Click on “Metric” units and “Highest Rep” for torque.

Record the four maximum Peak Torques (repetition 0, 1, 2 and 3) for both extension and flexion of both the left and right side on the data collection form.

5.2.9 Results print out, data transfer, data backup

a. Print final isokinetic strength results

Print the MOST report, go to the Humac Preview Report screen and highlight *MOST on the pull down report menu. Click on the “Preview” button. Print the two page report using the arrow button in the upper left hand corner to move from one report page to the other. Place the report in the participant’s study record (see Appendix 3 to view a sample of the complete report).

There are no sEMG results to print.

b. Back-up

Operators will back-up isokinetic and sEMG data weekly (see Appendix 6 Cybex and sEMG Back-up Procedures). Once per week, the contents of the database will be uploaded to the Coordinating Center using a Secure Data Gateway (see Secure Data Gateway operations manual).

c. Data Transfer

Follow instructions in Secure Data Gateway operations manual.

6. Alert values/Reporting to participants

There are no alert values. When the testing is completed, thank the participant.

7. Quality assurance**7.1 Training and certification**

At baseline, the Cybex vendor, CSMI, provided on-site training at both field centers, covering basic machine operation and the fundamentals of testing, as well as study-specific procedures for the isokinetic testing. On-site training at both field centers for the sEMG operations will be provided by a “master” examiner. Operators will be retrained and recertified midway through each examination cycle. Operators should practice on volunteers until reliable measurements are achieved. It is especially useful to practice on volunteers who are not knowledgeable about what to expect.

The examiner requires no special qualifications or experience to perform this assessment.

Training should include:

- Attend the training session
- Observe measurement by experienced examiner
- Read Cybex and Delsys manufacturer’s user’s guide and MOST operations manual with goal of understanding
 - the proper use of Cybex and Delsys equipment
 - the proper operation of the HUMAC and EMGDAQ software
 - the proper calibration and adjustment of equipment
 - exclusions and safety considerations
 - detailed testing procedures
- Practice on colleagues and “naive” volunteers


7.2 Certification requirements

- Complete training requirements
- Recite exclusion criteria
- Demonstrate calibration and adjustment of Cybex
- Demonstrate appropriate application of sEMG sensors and reference pad
- Perform test on two volunteers under the observation of clinic QC officer or designated Cybex and sEMG expert(s)


7.3 Quality assurance checklist

- Know frequency of calibration and verification
- Exclusion questions asked from data collection form
- Blood pressure form checked to determine if testing contraindicated
- Recite two stopping rules
- Participant information correctly entered on computer screen
- Correct test pattern and protocol entered on computer screen
- Identify warm-up exercises
- Locates femoral lateral epicondyle
- Cleans sEMG locations for medial and lateral quadriceps and hamstring muscles
- Applies sEMG sensors and reference pad correctly
- Participant positioning correctly determined
- Positioning parameters correctly entered on screen
- Correct placement of Johnson anti-shear device
- Correct instructions given while demonstrating procedure
- Correct instructions given for three practice trials
- sEMG data collection is begun starting with three practice trials
- Correct instructions given for four test trials
- Standard level of encouragement (motivation and feedback) offered to participant
- Key points from script stated and clearly delivered
- Correctly uses EMGDAQ software interface for sEMG data collection
- Results for extension and flexion correctly recorded on data form
- Records whether sEMG test was done and if not, why not
- Two page MOST report printed and placed in participant's file
- Reviews form for completeness
- Form correctly filled out

8. Data collection form



Isokinetic Strength - sEMG



Visit	MOST ID #	Acrostic	Staff ID#
<input type="radio"/> 60-month <input type="radio"/> 84-month	<input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/>	<input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/>	<input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/>

Exclusion criteria

- Is the participant's blood pressure greater than 199 mm Hg (systolic) or greater than 109 mm Hg (diastolic)?

(Examiner Note: Refer to Blood Pressure form, Clinic Visit Workbook, page 32.)

Yes No Don't know/Refused

↓

Do NOT test. STOP. Go to next exam.

- Script: "First I need to ask you a few questions to see if you should do this test."

Has a doctor ever told you that you had an aneurysm in the brain?

Yes No Don't know/Refused

↓

Do NOT test. STOP. Go to next exam.

- Has a doctor told you that you had a cerebral hemorrhage (bleeding in the brain) in the last six months?

Yes No Don't know/Refused

↓

Do NOT test. STOP. Go to next exam.

- Have you had either of your knees replaced in the past 3 months?

Yes No Don't know/Refused

↓

Which knee was replaced?

Right Left Both knees

Do NOT test Right leg. If no other exclusions test left leg.

Do NOT test Left leg. If no other exclusions test right leg.

Do NOT test. STOP. Go to next test.

- Have you had either of your hips replaced in the past 3 months?

Yes No Don't know/Refused

↓

Which hip was replaced?


Right Left Both hips


Do NOT test Right leg. If no other exclusions test left leg.

Do NOT test Left leg. If no other exclusions test right leg.

Do NOT test. STOP. Go to next test.


♦Page 39♦




 51250

Isokinetic Strength - sEMG

Visit	MOST ID #	Acrostic
<input type="radio"/> 60-month <input type="radio"/> 84-month	<input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/>	<input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/> <input style="width: 20px; height: 20px;" type="text"/>


MOST

6. Within the past 3 months, have you had back surgery?
 Yes No Don't know/Refused

↓
 Do NOT test. STOP. Go to next exam.

7. Within the past 6 weeks, have you had a heart attack?
 Yes No Don't know/Refused

↓
 Do NOT test. STOP. Go to next exam.

8. Within the past 6 weeks, have you had cataract surgery?
 Yes No Don't know/Refused

↓
 Do NOT test. STOP. Go to next exam.

9. Do you have a hernia in your groin that has not been operated on?
 Yes No Don't know/Refused

↓
 Do NOT test. STOP. Go to next exam.

10. Do you have a pacemaker or other implanted device, infusion pump or stimulator?
 Yes No Don't know/Refused

↓
 Do NOT administer sEMG test.

11. Do you have an allergy to adhesive or allergy to silver?
 Yes No Don't know/Refused

↓
 Do NOT administer sEMG test.

Examiner Note: Do not ask this question.

12. Does participant have a skin irritation or wound in the area that the electrodes will be placed?
 Yes No Don't know/Refused

Which thigh has a skin irritation?

Right
 ↓
 If no other exclusions administer sEMG test on left thigh.

Left
 ↓
 If no other exclusions administer sEMG test on right thigh.

Both thighs
 ↓
 Do NOT administer sEMG test.



Isokinetic Strength - sEMG

Visit	MOST ID #	Acrostic
<input type="radio"/> 60-month <input type="radio"/> 84-month	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>



15. Was the sEMG test performed on the left leg?

Yes No

a. Was the entire set completed?

Yes No

How many sEMG sets were completed?

b. Did sEMG amplifier signal high noise or signal clipping with an audible beep?

Yes No

c. Why wasn't the test done?
(*Examiner Note: Mark all that apply.*)

Participant refused

Stopped test due to participant discomfort

Equipment problems

Other (*Please specify:* _____)

_____)

16. During this test, did you experience any pain in your joints or muscles?

Yes No Refused or unable to answer

a. Where was the pain located? (*Examiner Note: Mark all that apply.*)

Back

Left side

Buttock

Hip

Thigh

Knee

Leg

Ankle

Foot

Other (*Please specify:* _____)

Right side

Buttock

Hip

Thigh

Knee

Leg

Ankle

Foot

Other (*Please specify:* _____)

b. Did participant report pain in either knee?

Yes No

Examiner Note: REQUIRED: Show Card #27 and ask participant to ...

i. Please rate the knee pain that you had by pointing to the number on this card.

0 1 2 3 4 5 6 7 8 9 10

c. Did this pain prevent you from pushing or pulling as hard as you can?

Yes No Don't know





Isokinetic Strength - sEMG



Visit	MOST ID #	Acrostic
<input type="radio"/> 60-month <input type="radio"/> 84-month	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>

19. Was the sEMG test performed on the right leg?

Yes

No

a. Was the entire set completed?
 Yes No

How many sEMG sets were completed?

b. Did sEMG amplifier signal high noise or signal clipping with an audible beep?
 Yes No

c. Why wasn't the test done?
(Examiner Note: Mark all that apply.)

Participant refused

Stopped test due to participant discomfort

Equipment problems

Other *(Please specify: _____)*

20. During this test, did you experience any pain in your joints or muscles?

Yes

No

Refused or unable to answer

a. Where was the pain located? *(Examiner Note: Mark all that apply.)*

Back

Left side

Buttock

Hip

Thigh

Knee

Leg

Ankle

Foot

Other *(Please specify: _____)*

Right side

Buttock

Hip

Thigh

Knee

Leg

Ankle

Foot

Other *(Please specify: _____)*

b. Did participant report pain in either knee?

Yes

No

Examiner Note: REQUIRED: Show Card #27 and ask participant to . . .

i. Please rate the knee pain that you had by pointing to the number on this card.

0 1 2 3 4 5 6 7 8 9 10

c. Did this pain prevent you from pushing or pulling as hard as you can?

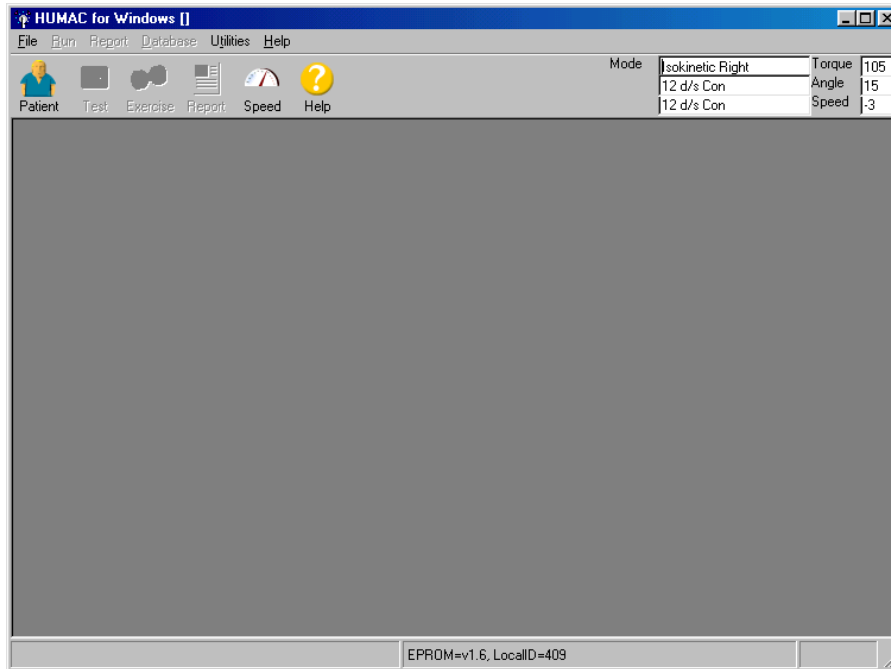
Yes

No

Don't know

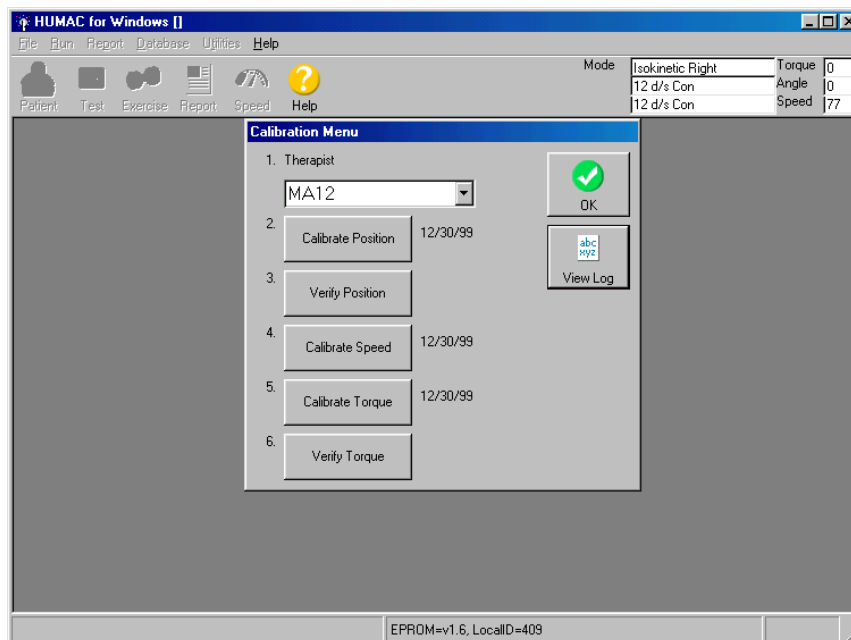
Appendix 1 Cybex Calibration Procedure

To begin the HUMAC calibration procedure, see menu at top of screen:



Pull down "Calibration" from the Utilities menu.

Type in the Staff ID# in the space labeled "Therapist." You'll have to edit the Therapist list.



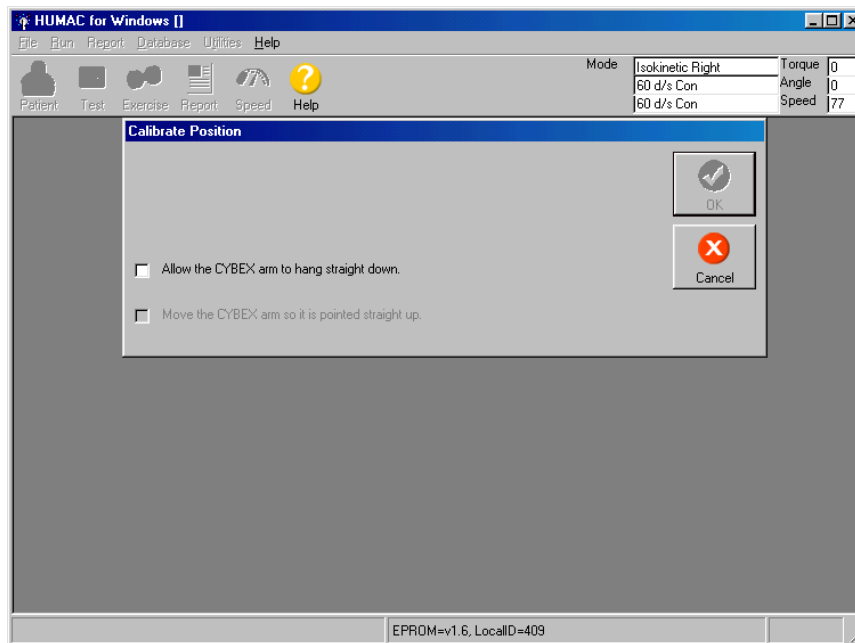
The HUMAC Calibration menu allows you to calibrate and verify the CYBEX Position, Speed, and Torque.

- Position calibration
- Position verification
- Speed calibration
- Torque calibration
- Torque verification

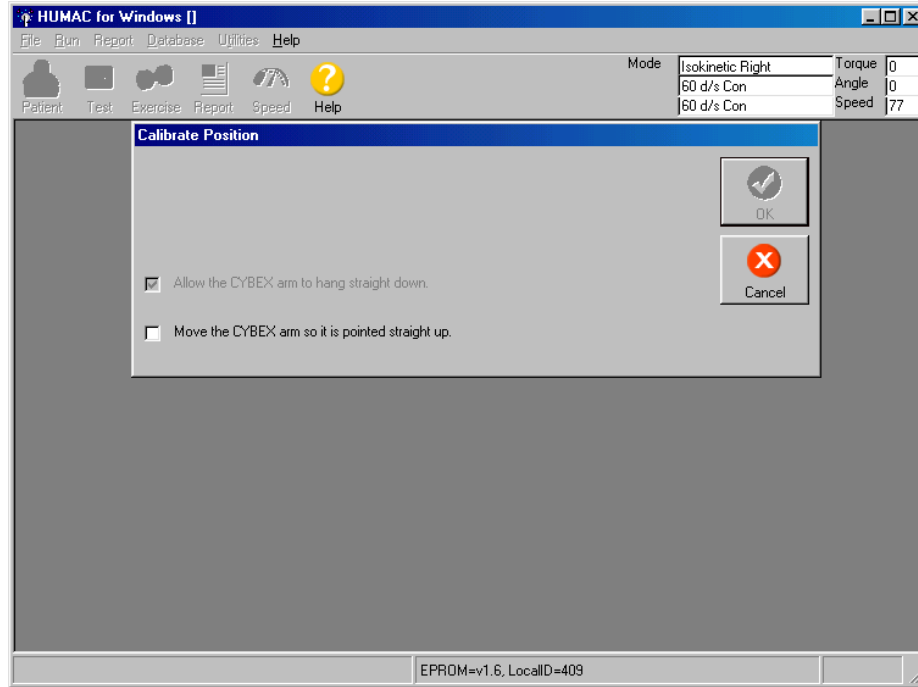
Position Calibration

The Position Channel Calibration procedure assures the HUMAC correctly converts the signal from the CYBEX position transducer to the correct degree values for the reports.

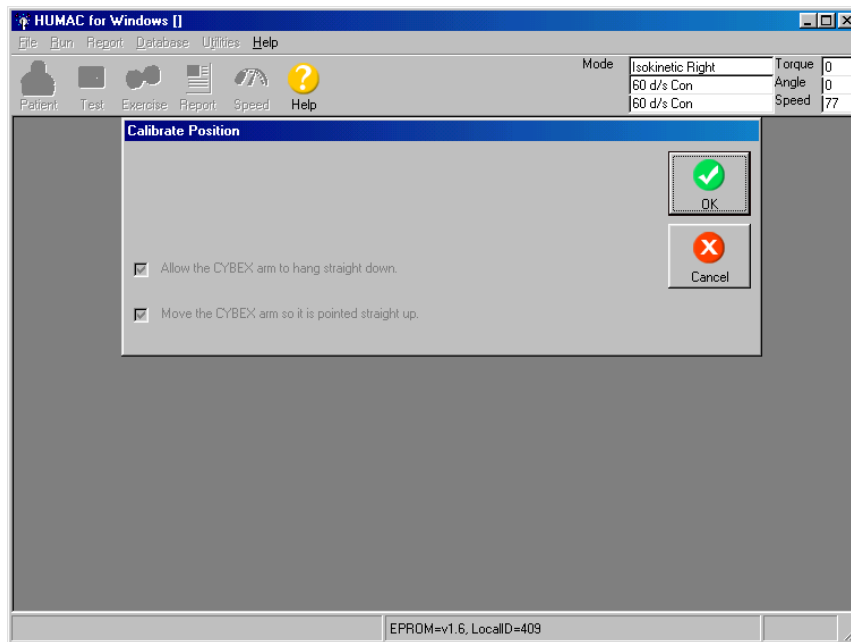
To calibrate position, click on item #2: Calibrate Position



Follow the instructions: "Allow the CYBEX arm to hang straight down." and click.

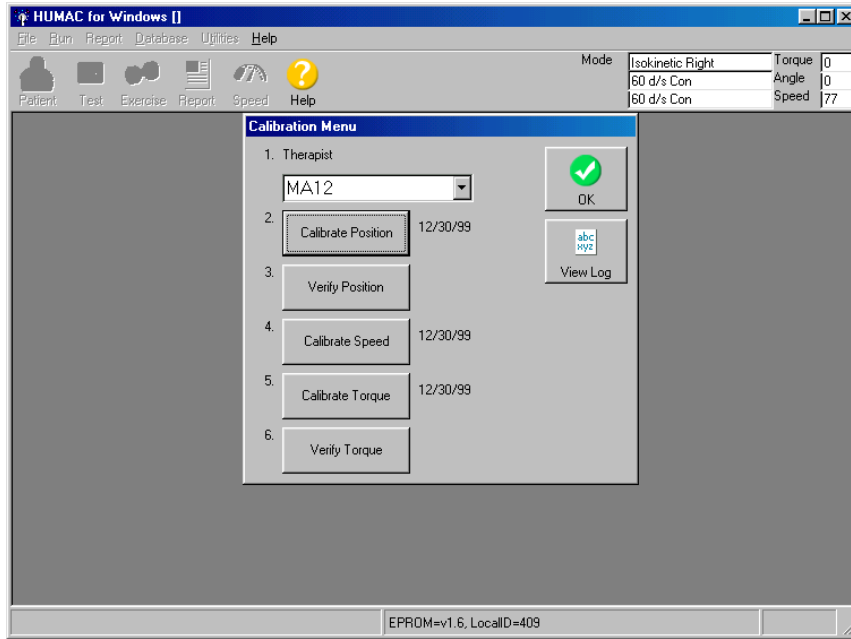


Move the CYBEX arm so it is pointed straight up – click



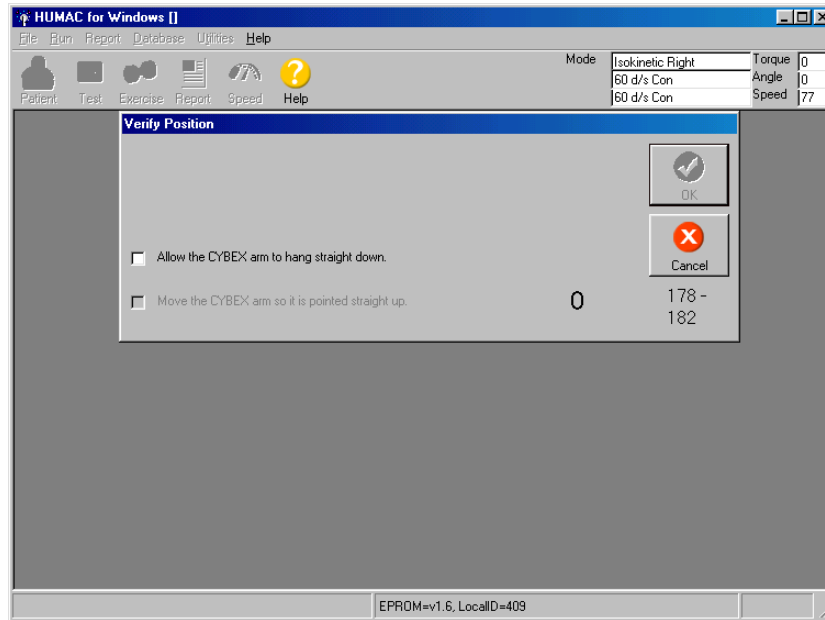
Then click "OK."

You will then be back at the original screen. You are now ready to Verify Position. Click on Verify Position.

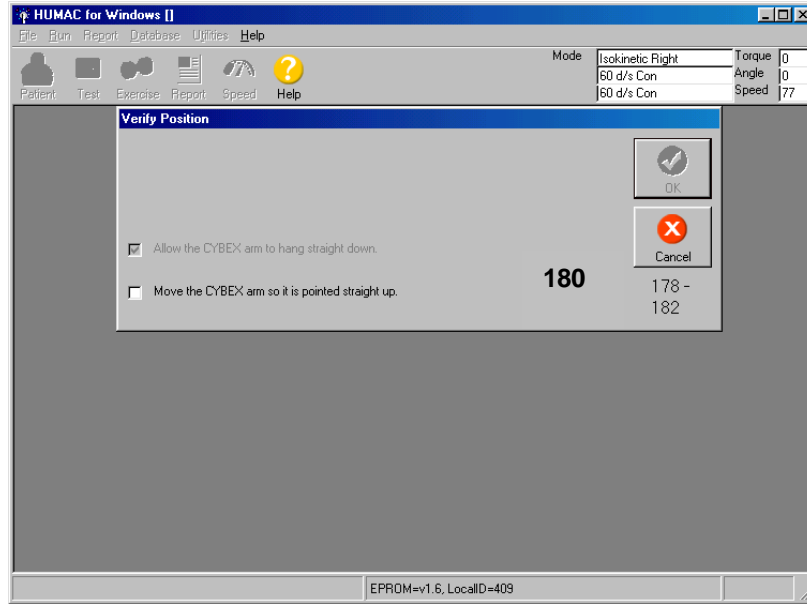


Position Verification

The Position Channel Verification checks the calibration results.



Follow instructions on the screen. Allow the CYBEX arm to hang straight down – then click.

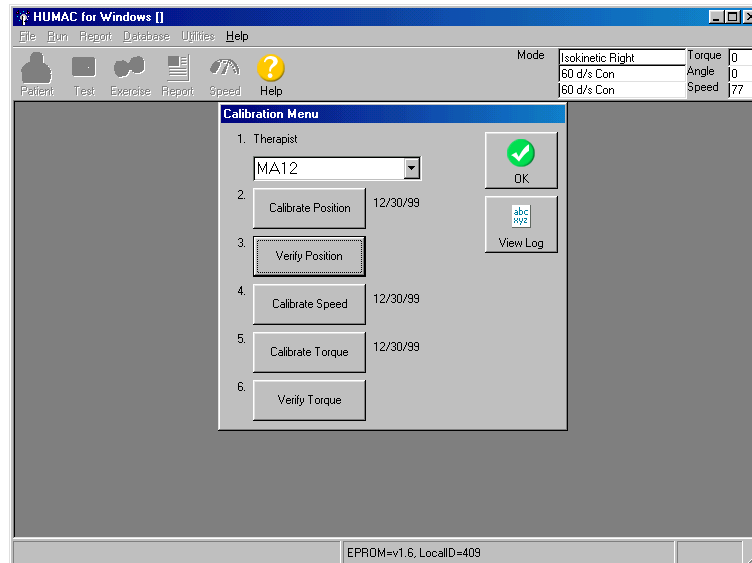


Move the CYBEX arm so it is pointed straight up – then click.

When the arm is pointed straight up, the position value displayed on the right of the screen should be 180 degrees.

Click OK or hit spacebar.

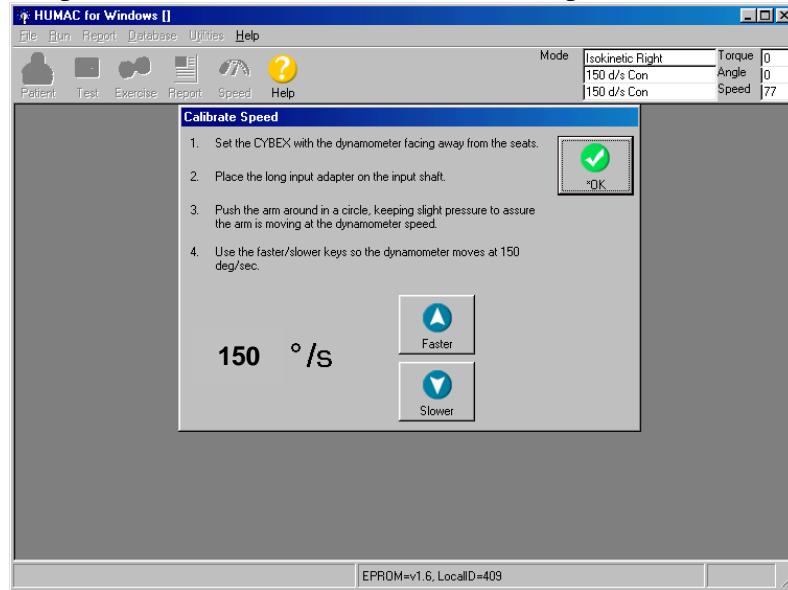
Again, you'll be at the main screen.



Choose Calibrate Speed

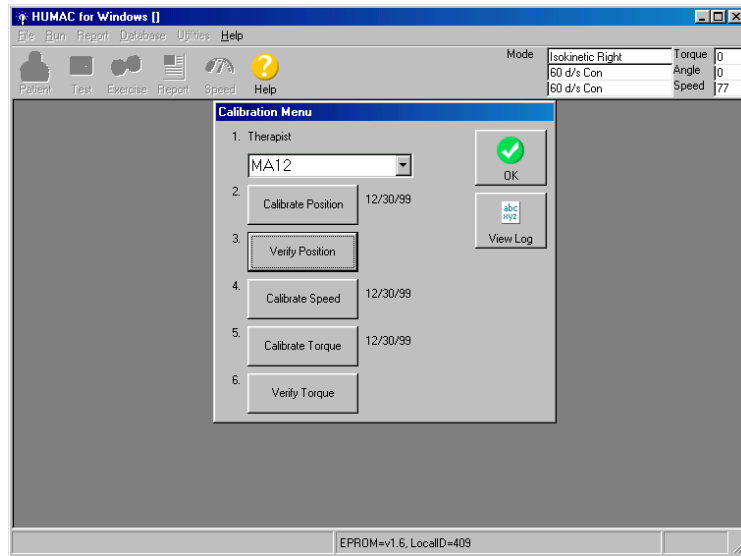
Speed Calibration

The Speed Calibration procedure assures the HUMAC sets the speed of the CYBEX accurately.



Follow the instructions on the screen. Click on Faster or Slower to get to the correct speed, which is 150 deg/sec. Click OK or hit spacebar.

Again, you'll be at the main screen:



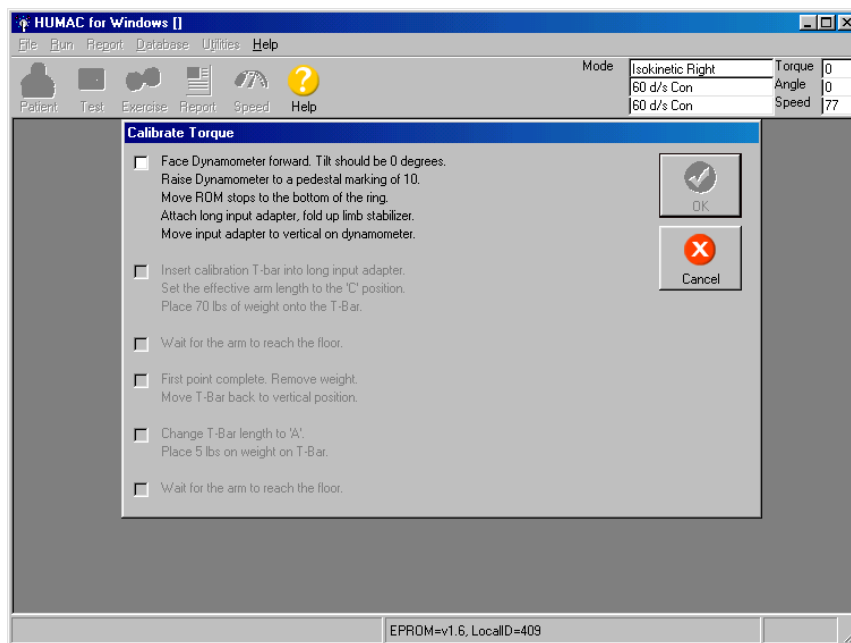
1. Position the dynamometer with the shaft facing away from the CYBEX and the ROM blocks removed so you can rotate the arm in a full circle.
2. Place the long input adapter on the CYBEX.
3. The HUMAC will send a command to set the CYBEX speed to 150 deg/sec. Push the arm around a circle being sure to keep pressure against the arm so it is moving at the set speed.

- Use the Faster and Slower keys to adjust the HUMAC speed command so the displayed speed is 150 deg/sec as you push the arm.

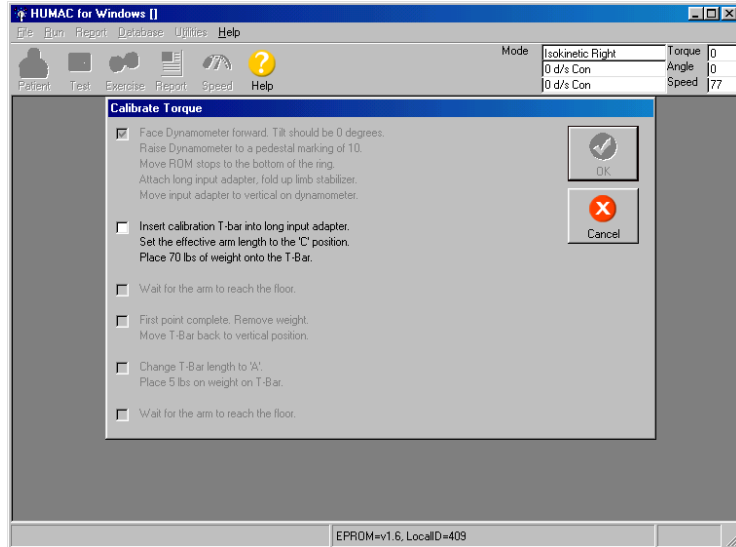
Choose Calibrate Torque

The Torque Channel Calibration procedure assures the HUMAC correctly converts the voltage from the CYBEX torque transducer to the correct Newton-meter values for the reports.

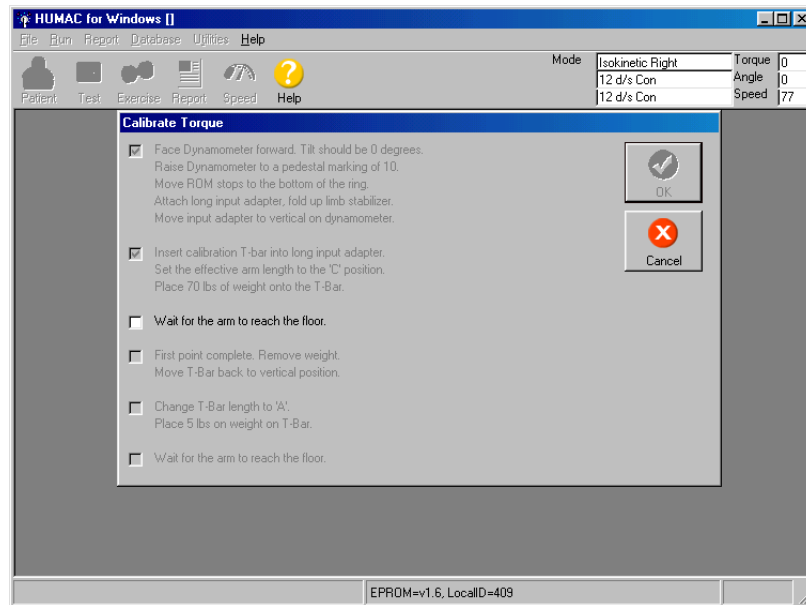
- Setup the Dynamometer with the shaft facing away from the CYBEX and the input adapter pointed straight up. When you check this box, the HUMAC will set the speed to 0 deg/sec to hold the adapter in the vertical position.



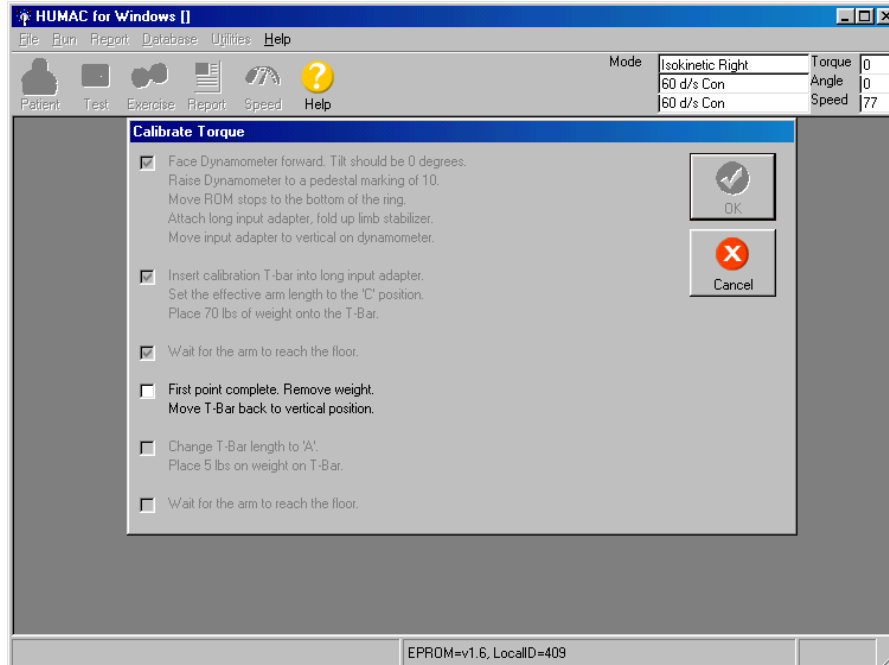
- Insert the calibration bar into the adapter at the **C setting** and place 70 pounds to the bar. When you check this box, the HUMAC will set the CYBEX speed to 12 deg/sec and the weight will begin to fall. Place about 20 lbs of resistance on the bar to prevent bouncing through the first third of descent.



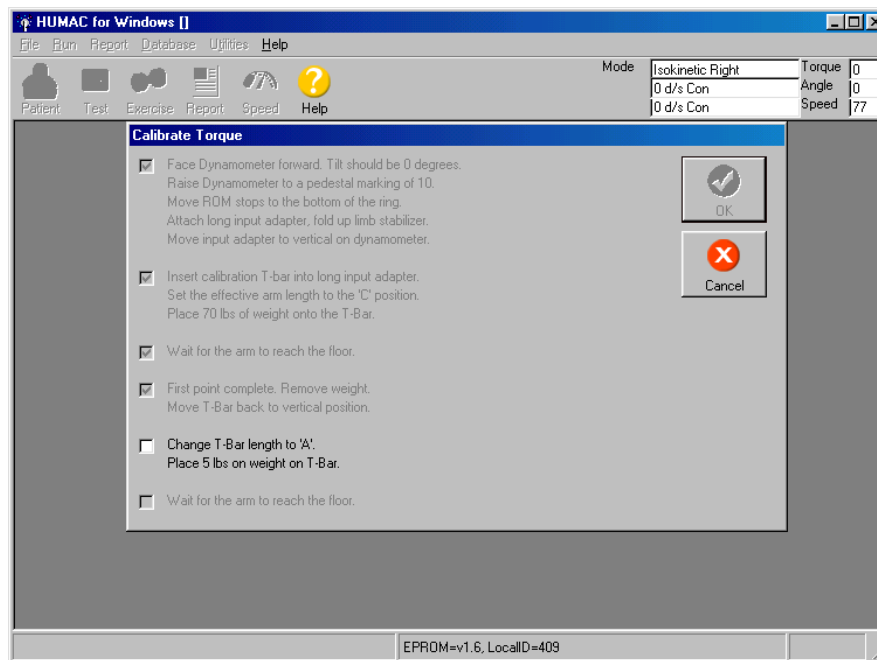
3. The weight should be falling smoothly. After the weight reaches the floor and stops falling, check this box. The HUMAC will set the speed back to 60 deg/sec.



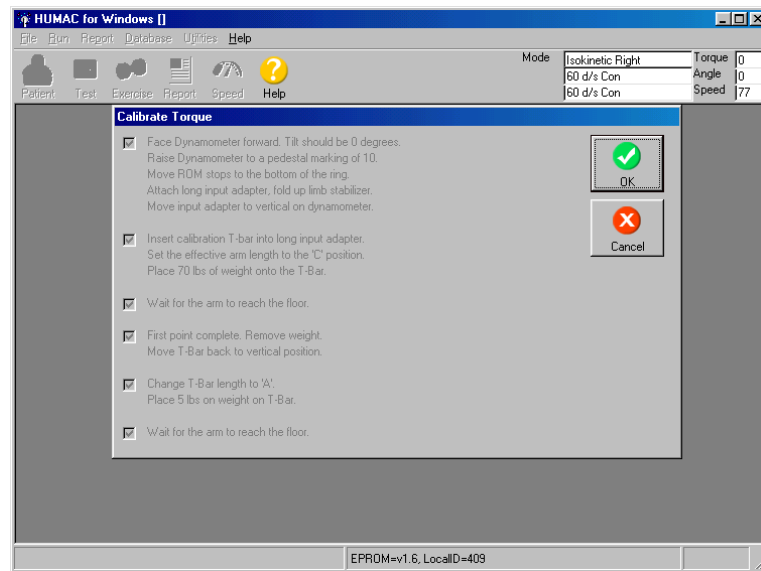
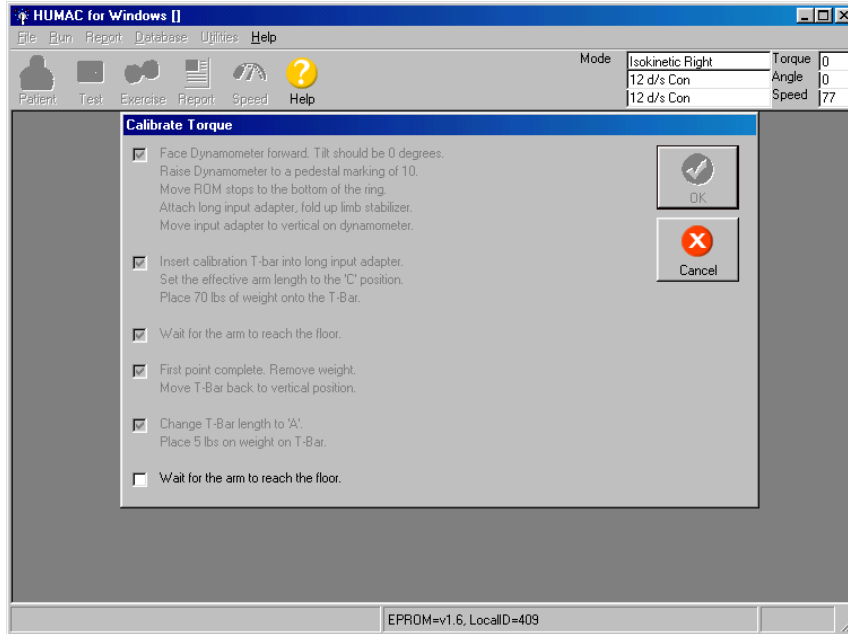
4. Return the T-Bar to the vertical position. After you check this box the HUMAC will set the speed to 0 deg/sec to hold the adapter in the vertical position.



5. Insert the calibration bar into the adapter at the **A setting** and place 5 pounds to the bar. When you check this box, the HUMAC will set the CYBEX speed to 12 deg/sec and the weight will begin to fall.

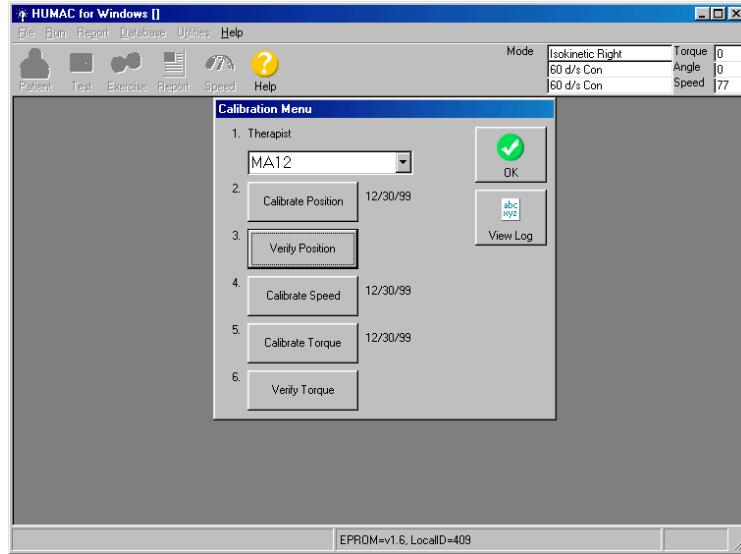


6. The weight should be falling smoothly. After the weight reaches the floor and stops falling, check this box. The HUMAC will set the speed back to 60 deg/sec.



Click OK or hit spacebar.

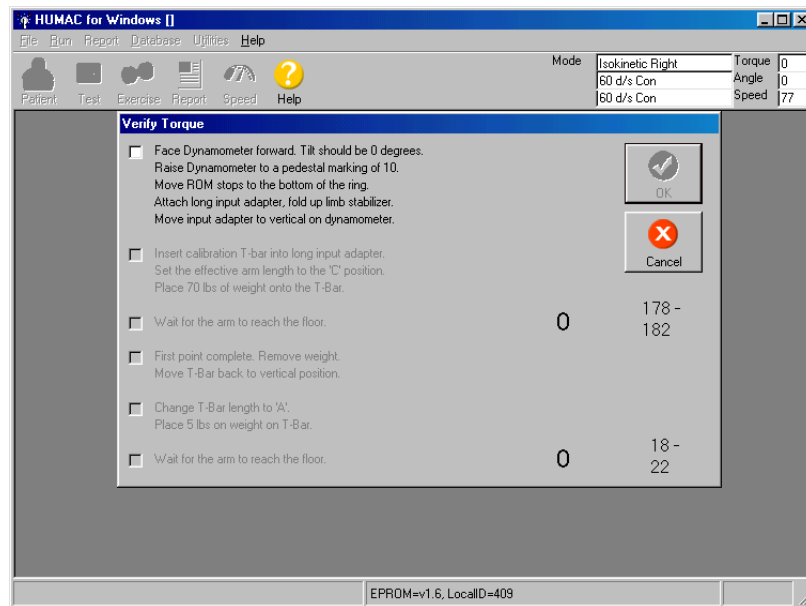
You'll be back at the original screen:



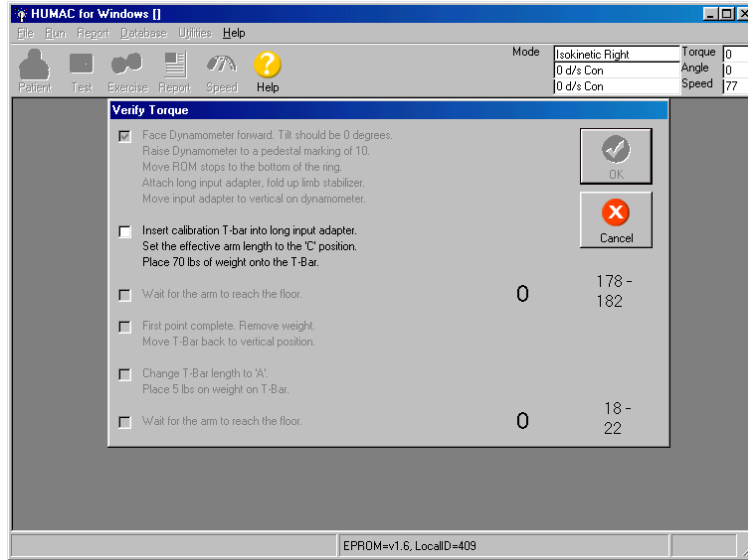
Choose Verify Torque

The Torque Channel Verification procedure checks the calibration results.

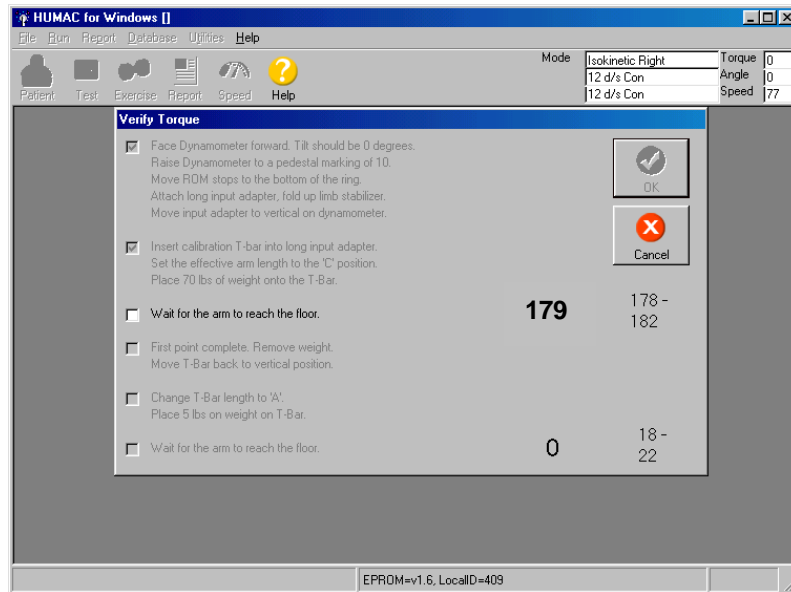
1. Setup the Dynamometer with the shaft facing away from the CYBEX and the input adapter pointed straight up. When you check this box, the HUMAC will set the speed to 0 deg/sec to hold the adapter in the vertical position.



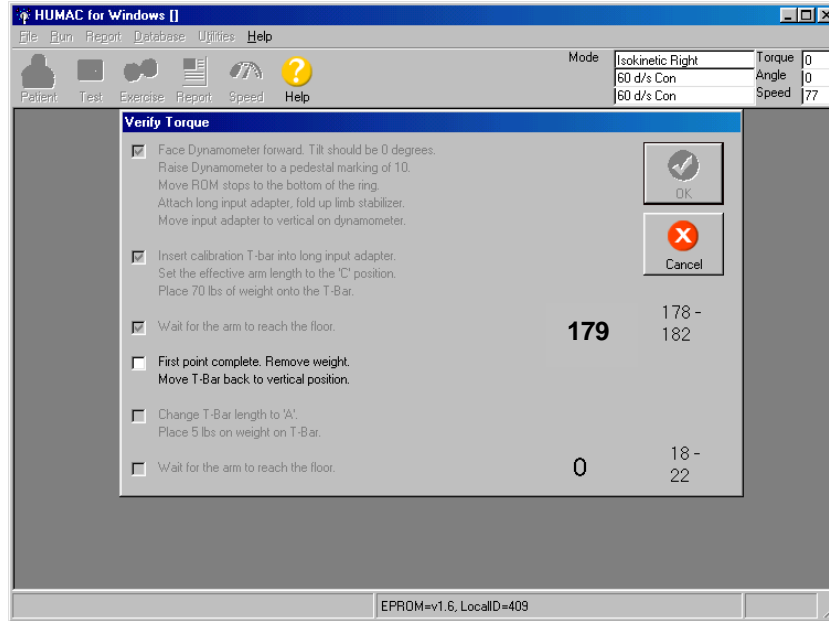
2. Insert the calibration bar into the adapter at the **C setting** and place 70 pounds to the bar. When you check this box, the HUMAC will set the CYBEX speed to 12 deg/sec and the weight will begin to fall.



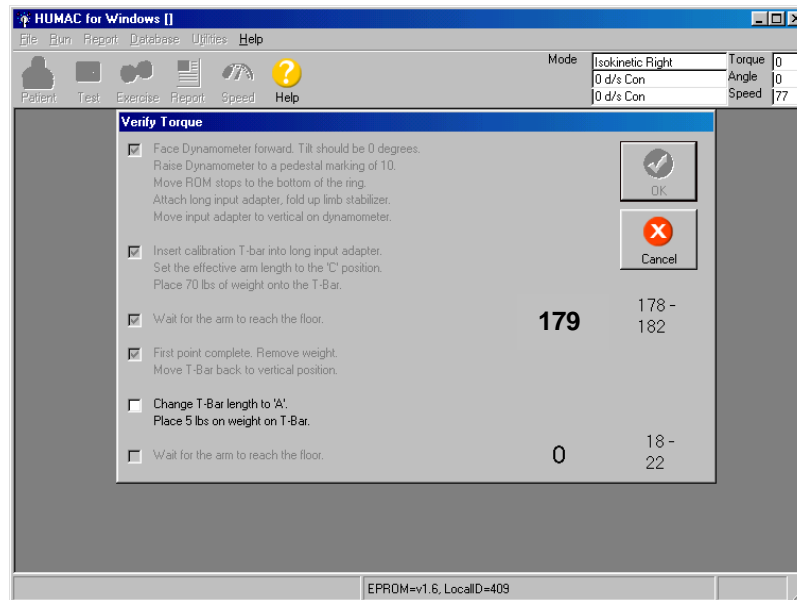
3. The weight should be falling smoothly. After the weight reaches the floor and stops falling, check this box. The HUMAC will set the speed back to 60 deg/sec. The number to the right of the screen shows the peak torque. This should be 178 to 182 ft-lbs. High or low values may indicate bouncing of weights during calibration while arm is moving. If out of range, repeat calibration once, making sure weights fall smoothly, followed by verification. If the calibration and verifications range is still not correct, call CSMI (781-255-1292).



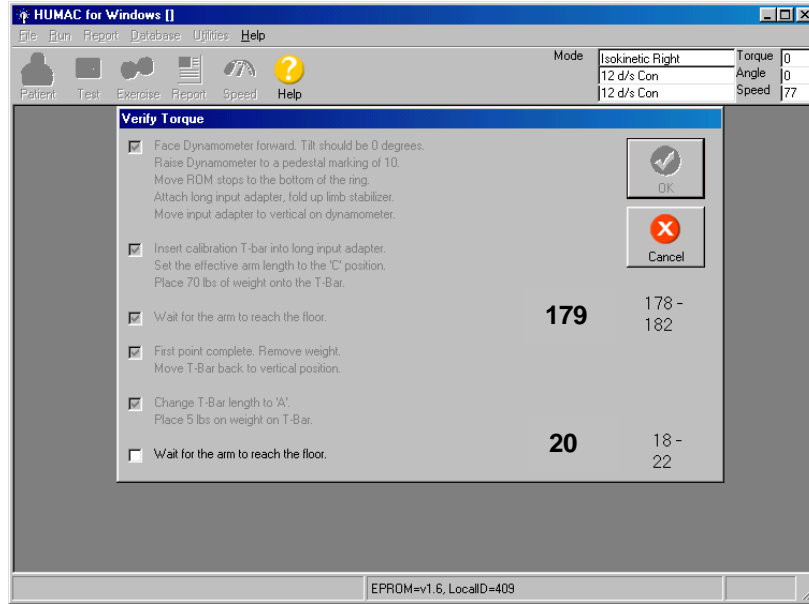
4. Return the T-Bar to the vertical position. After you check this box the HUMAC will set the speed to 0 deg/sec to hold the adapter in the vertical position.



5. Insert the calibration bar into the adapter at the **A setting** and place 5 pounds to the bar. When you check this box, the HUMAC will set the CYBEX speed to 12 deg/sec and the weight will begin to fall.



6. The weight should be falling smoothly. After the weight reaches the floor and stops falling, check this box. The HUMAC will set the speed back to 60 deg/sec. The number to the right of the screen shows the peak torque. This should be 18 to 22 ft-lbs.



Click OK or hit spacebar.

You've completed the calibrations. These will automatically be recorded on the Calibration Log.

Appendix 2 Johnson Anti-shear Accessory Set-up

JOHNSON ANTI-SHEAR ACCESSORY*

User's Guide

**Patent No. 4407496*

*Copyright 1991 CYBEX Division of LUMEX, Inc.
Ronkonkoma, New York
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Disclaimer:

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Printed in the United States of America

INTRODUCTION TO THE JOHNSON ANTI-SHEAR ACCESSORY

What is Shear?

During knee extension/flexion, the quadriceps tendon acts over the patella, which serves as a fulcrum, and exerts tremendous forces on the tibia. In addition to extending the lower leg, the pull of the tendon attempts to move the tibia up and forward of the tibiofemoral joint. This tibiofemoral translocation sliding is called shear. The femur and the tibia are sliding against one another. During this process, the normally functioning anterior cruciate ligament (ACL) restrains the tibia and limits its forward travel. Similarly, the hamstrings cause posterior shear during forceful knee flexion.

When is Shear a Problem?

Although shearing forces are normal during exercise and activity, under certain conditions there is a potential for damage from excessive tibial translocation. For instance, if the ACL has recently been damaged or repaired, it may not be capable of performing properly. In these circumstances the ACL may be injured further or a surgical repair damaged. Also, the secondary restraints, such as the collateral ligaments, may be placed under greater stress to compensate for the insufficient or lacking primary restraint. These secondary restraints may stretch beyond their normal limits over the course of a rehabilitation and exercise program causing further laxity and allowing the articular surfaces of the tibia and the femur to come into abnormal contact. This can result in unnecessary wear of the articular surfaces, causing crepitus and pain during exercise and normal daily activities.

Without proper precautions, exercising a knee that does not have a fully functional ACL may result in

further damage to the ACL and place other joint structures at risk. A repaired ACL may not be capable of handling the anterior shearing forces generated during uncontrolled exercise and functional movements for many months following surgery.

Shear can be Controlled While Strengthening the Knee:

The Johnson Anti-Shear Accessory was first described by Dave¹ Johnson in 1982. This device makes it possible for patients and athletes with diagnosed or suspected injuries to the ACL and other ligaments of the knee to perform knee extension/flexion just weeks after sustaining the injury and without over stressing the ligaments. It also allows earlier exercise rehabilitation after surgical repair or reconstruction. The dual-pad accessory counteracts anterior shear, controls subluxation of the tibia and allows the compression-loaded articular surfaces to resume a more normal roll-and-glide relationship during terminal extension. It protects the knee while permitting full and efficient development of strength, power and endurance.

The twin tibial contour pads and fulcrum can be adjusted to provide an amount of shearing counterforce appropriate to the individual case, from virtually total control of tibial translocation to a degree of control only slightly greater than provided by the standard CYBEX shin pad. Shearing counterforce can also be progressively decreased during the advanced stages of longer term rehabilitation so that the ACL and other joint structures can gradually adapt to the stresses that will be encountered during the return to full activity.

The Johnson Anti-Shear Accessory Can Help Solve Many Knee Problems***Acute Injury to the Anterior Cruciate Ligament:***

The accessory's unique counterforce mechanism prevents the tibia from being pulled forward by the quadriceps. With limited stress on the ACL itself, the healing ligament can remodel along the lines of stress without elongating.

Repaired or Reconstructed ACL:

Counterforce mechanism also allows earlier exercise and rehabilitation after surgical repair or reconstruction.

Injury to Posterior Cruciate Ligament:

By limiting posterior shear during flexion, the accessory promotes healing of an injured posterior cruciate ligament.

Chronic Laxity That Hasn't Been Repaired:

Individuals with chronic laxity can strengthen hamstrings and quadriceps to increase functional control with eliminating or reducing tibiofemoral crepitus and pain that may have previously accompanied knee extension.

Post Meniscectomy:

Because the meniscus acts as a secondary stabilizer during knee extension, removal of meniscus, especially a large portion, often results in increased anterior laxity.

Any Significant Knee Injury That Might Involve or Compromise the ACL:

Because the ligaments, capsule and cartilage of the knee have overlapping functions and multiple movement, injuries are common. The accessory should be used as a precautionary measure until ACL involvement or compromise has been ruled out.

Adjusts for Any Patient

As explained in the following operating instructions, the shin pads of the anti-shear accessory can easily be adjusted to accommodate varying leg lengths and secured in place. The amount of counterforce to anterior shear is selected by adjusting the fulcrum position. The molded polyurethane pads surround the tibia, distributing force over a large area with minimum pressure. This helps reassure clients and makes leg extensions more comfortable, providing further motivation. Extra-long Velcro® straps can even fit around a knee orthotic.

Clinical Guidelines

Both testing and exercise of any knee with significant joint laxity (particularly injured or surgically repaired anterior cruciate ligaments) have always been cause for concern. The Johnson Anti-Shear Accessory is designed to help clinicians deal with many of these problems. One study by Timm³ has demonstrated its validity as a shear-restricting tool.

The position of the fulcrum assembly determines the amount of counterforce to shearing forces. Moving the fulcrum assembly distally (away from the knee) decreases the force applied to counteract tibial translocation. Moving the fulcrum assembly proximally (toward the knee) increases the force applied to counteract tibial translocation. Malone² recommends that the pivot position be initially set midway, and then adjusted proximally if more counterforce is required. Once properly set for the client, the distance between the two pads generally does not have to be changed. However, in the final stages of rehabilitation, it may be desirable to progressively increase shearing stresses on joint structures. In this case, the fulcrum may be progressively moved distally.

Certain surgical procedures (particularly, most intra-articular ACL repairs) warrant extremely conservative treatment with long term use of the Anti-Shear Accessory and appropriate limitation of range of motion. Malone² also recommends using the Anti-Shear Accessory only for extension(quadriceps) exercise for clients with a large amount of instability and/or secondary capsular involvement. During hamstring exercise (flexion), an anterior shifting force is placed on the proximal pad. For extremely lax clients, it may therefore be desirable to use the standard single tibial contour pad for flexion exercise.

Safe Exercise and Testing Is the Clinician's Responsibility

The Johnson Anti-Shear Accessory is an extremely useful tool for earlier rehabilitative exercise of diagnosed ACL injuries, surgical repairs and reconstructions, chronic anterior laxity and a number of injuries to other joint structures that can cause

increased stresses on the ACL. *However, it is the clinician's responsibility to ascertain when a patient is ready for resistive exercise.* Experienced users recommend careful evaluation of the patient's status before prescribing exercise, submaximal exercise programs with controlled progression towards maximal exercise, range limiting depending on injury or surgical procedure, and use of the Johnson Anti-Shear Accessory on all at-risk patients.

Testing with the Johnson Anti-Shear Accessory

The use of this accessory for testing has been documented in only one study³, in which no significant difference was found in torque curves whether testing was performed with the Accessory or the tibial contour pad. Further research on normal knee quantifying differences in torque measurements and torque curve shapes is necessary and would be welcomed.

PART	DESCRIPTION	PART NUMBER
A	Locking Knob (aluminum)	260AK039
B	Inside tube assembly	2600S030
C	Locking knob, 3/8-24x3/4	PP460011
D	Fulcrum assembly	2600S004
E	Upper and lower molded pad	PR010002
F	Outside tube	2600P020
G	Padded Velero strap for upper pad	2600S047
H	Padded Velero strap for lower pad	2600S046
I	Pivot tube assembly	2600S010
J	Orthotron II Anti-Shear Accessory input adapter	2610P001*
K	Straight input adapter (CYBEX 300 Series and Orthotron KTs)	2600P001

* The Johnson Anti Shear Accessory does not require an additional input adapter when used with the old style Orthotron. The accessory attaches directly to either of the actuator arms on the Orthotron.

Operating Instructions

1. Measure the distance in centimeters (one inch = 2.54 centimeters) from the inferior border of the tibia tubercle to the superior border of the medial malleolus. See Fig. 13.



Figure 13

2. The distance from the top edge of the upper pad to the bottom edge of the lower pad must be set to match this measurement. The white numbers on the black inside tube assembly (B) are used to set this distance.

To set this overall pad-to-pad distance, loosen the knurled aluminum locking knob (A) on the top of the black inside tube assembly (B) by turning the knob counterclockwise (CCW). Slide the tube assembly up or down as necessary, until the correct distance marking appears at the top edge of the chrome outside tube (F). See Fig. 14.

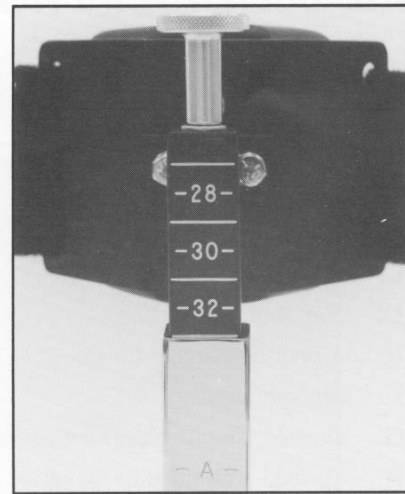


Figure 14

3. Tighten the knurled aluminum locking (A) by turning it clockwise (CW).

The distance from the top edge of the upper pad to the bottom edge of the lower pad now matches the distance from the tibial tubercle to the medial malleolus measured in step 1. See Fig. 15.

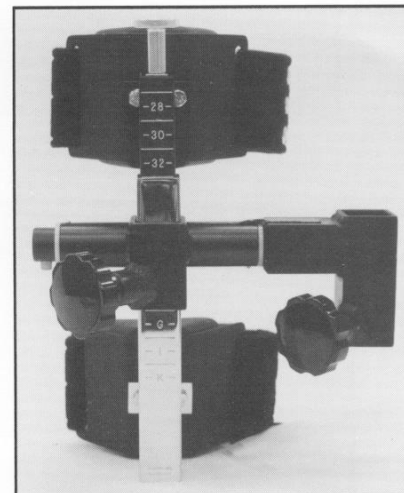


Figure 15

4. Attach the appropriate input adapter (determined by the CYBEX equipment being used) to the input shaft of the dynamometer of actuator being used. See Figs. 16A and 16B.

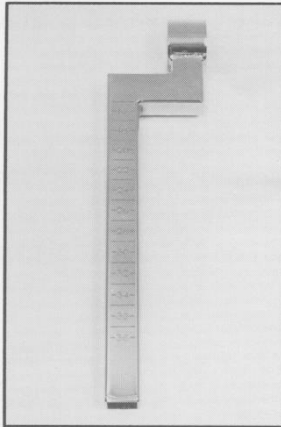


Figure 16A – Orthotron II Anti-Shear Accessory input adapter

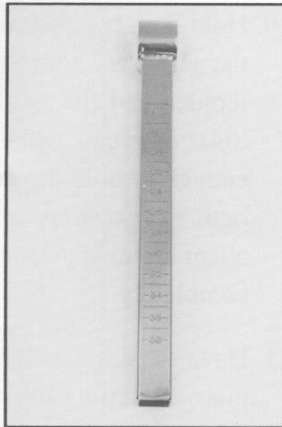


Figure 16B – Straight input adapter for CYBEX II/II+, CYBEX 300 Series and Orthotron KTs

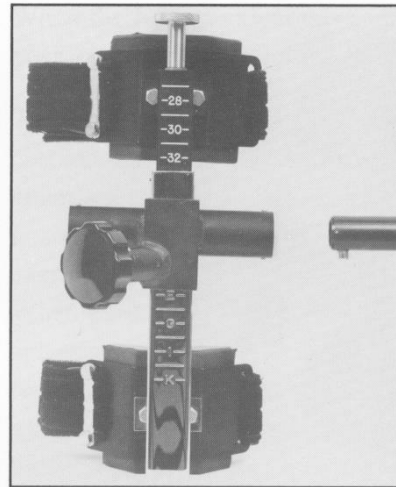


Figure 17

Note: When using the Johnson Anti-Shear Accessory on the Orthotron II or the Orthotron KTs, be sure to attach the input adapter to the actuator according to the instructions in their respective User's Guides making certain to align the engraved dot on the input shaft with the correct marking on the input adapter.

5. Position and stabilize the client for knee extension/flexion according to the guidelines in appropriate User's Guide.

Careful alignment of the knee's axis of rotation is essential when using the Johnson Anti-Shear Accessory.

6. The removable pivot tube assembly (I) allows the anti-shear accessory to be in an upright position (knurled aluminum knob on top) when exercising the left or the right knee.

To remove the pivot tube assembly (I), press in the push button (J) on the end of the tube. Slide the tube out of the fulcrum assembly (D). See Fig. 17.

7. Fig. 18 shows the accessory and pivot tube assembly ready for use on a right knee.

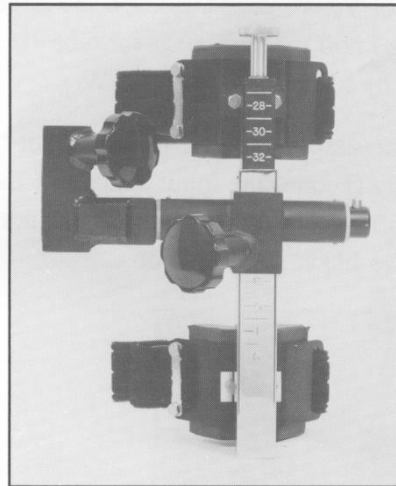


Figure 18

Fig. 19 shows the accessory and pivot tube assembly ready for use on a left knee. Note that locking knob C1 on the pivot tube assembly (I) always the front of the accessory.

Assemble the anti-shear accessory and pivot tube assembly for the leg to be tested by pressing in the push button (J) and slipping the fulcrum assembly over the tube.

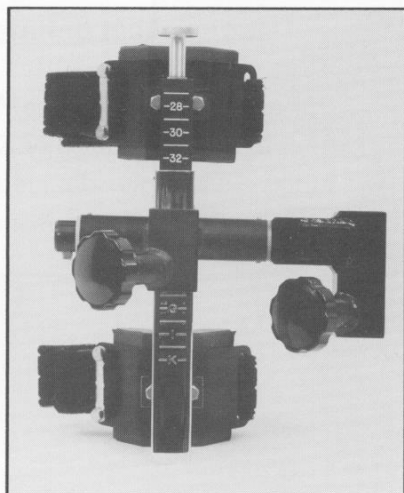


Figure 19

8. Loosen the large black locking knob (C) on the fulcrum assembly (D) by turning the knob CCW. Pull open both Velcro straps. Loosen the large black locking knob (C₁) on the pivot tube assembly (I) by turning the knob CCW.
9. Holding the accessory upright, slip the pivot shaft assembly (I) onto the input adapter of the dynamometer or actuator. See Fig. 20. Do not tighten the two black locking knobs.

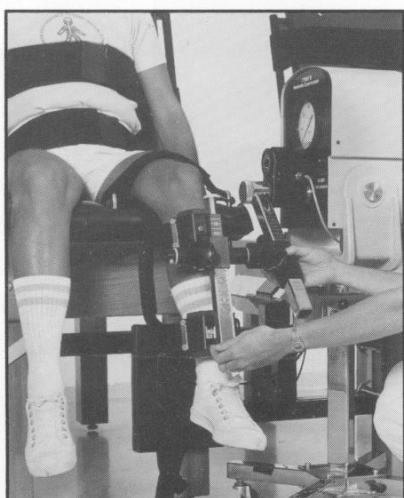


Figure 20

10. Hold the accessory on the adapter and position the accessory so the top edge of the upper molded pad (E) rests at the inferior border of the tibial tubercle. Tighten both black locking knobs enough to hold the accessory in place. Secure both Velcro straps around the leg as tight as client comfort permits. Loosen the locking knobs completely.
11. Have the client extend the leg. Lock the limb in place by setting the unit speed to 0. See Fig. 21.



Figure 21

Tightening the locking knobs with the leg extended helps prevent the the clients tendency to slide forward on the table when exercising.

12. Position the fulcrum assembly (D) just above the mid-point between the two pads. This places slightly more force on the upper pad (E).

Clinical evaluation indicates that splitting contact force 60% upper pad/40% lower pad neutralizes tibial translocation forces during forceful extension. Most clients with significant joint laxity will find this more comfortable. See Fig. 22.

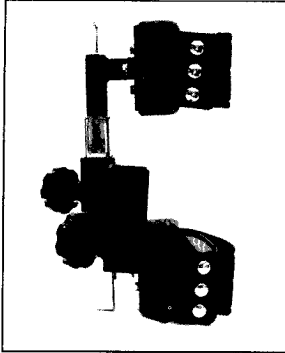


Figure 22

The fulcrum position may be adjusted for the greatest patient comfort during exercise and for the degree of shearing counterforce desired.

13. When the fulcrum assembly is properly positioned, securely tighten both locking knobs.
14. The engraved numbers on the accessory and chrome input adapters should be noted on the client's record to allow quick and accurate positioning of the anti-shear accessory in future exercise or testing sessions.
When used on the old style Orthotron, the anti-shear accessory attaches directly to either input arm of the actuator; an extra adapter is not necessary. In this case, count the number of holes exposed on the input arm to record the location of the accessory.
15. The client is now ready to begin. Perform the test or exercise in the normal fashion for the system used. Refer to the appropriate User's Guide for complete details.

References:

1. Johnson D: *Controlling anterior shear during isokinetic knee extension exercise*. J Orthop Sports Phys Ther 4:23-31, 1982
2. Malone T: *Clinical use of the Johnson Anti-Shear device: how and why to use it*. J Orthop Sports Phys Ther 7:304-9, 1986
3. Timm K: *Validation of the Johnson Anti-Shear Accessory as an accurate and effective clinical isokinetic instrument*. J Orthop Sports Ther 7:298-303, 1986

Appendix 3 MOST Report

Use File, Preferences command to set report heading
 MOST Knee Extension/Flexion Protocol (Page 1 of 2)

MOST ID: MB00001
 Birth date: 1/1/50
 Pref Side: Right

ACROSTIC: GWAS
 Weight: 81 Kilograms
 Tester: B05

Date: 1/7/03
 Sex: True

Protocol: 1 Speed Protocol (60/60)
 Isokinetic Con/Con
 Speed 60/60 Repetitions 4

Manual Position Setting

Chair Back Angle:	85
Chair Back Translation:	M
Chair Seat Fore/Aft Position:	6
Dynamometer Tilt:	0
Dynamometer Height:	3
CW ROM Stop:	-
CCW ROM Stop:	-
Straight Input Adapter:	22
Upper Tube:	31
Lower Tube:	J

RIGHT SIDE

Repetition	Extensors		Flexors	
	Peak Torque	Angle at Peak	Peak Torque	Angle at Peak
0	360.15	45.9	35.12	69.3
1	355.14	38.4	33.22	69.3
2	350.39	38.4	31.32	69.3
3	345.64	38.4	29.56	69.3
Coeff Var	0.02	0.09	0.1	0.

LEFT SIDE

Repetition	Extensors		Flexors	
	Peak Torque	Angle at Peak	Peak Torque	Angle at Peak
0	331.14	38.4	24.27	69.3
1	327.07	38.4	22.51	69.3
2	323.	38.4	20.88	69.3
3	318.93	38.4	19.39	69.3
Coeff Var	0.02	0.	0.13	0.

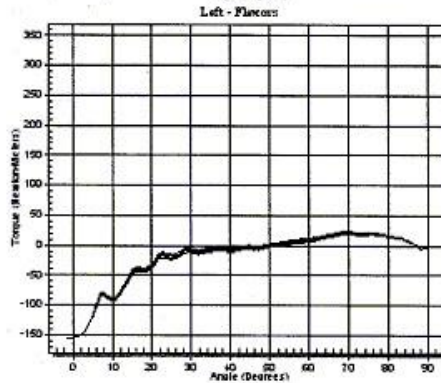
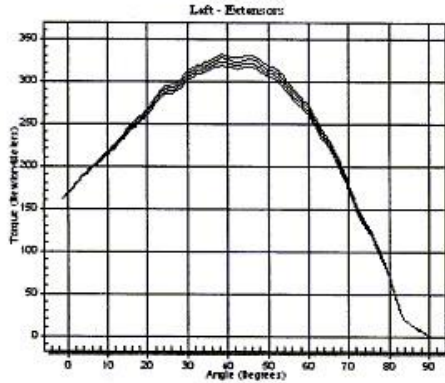
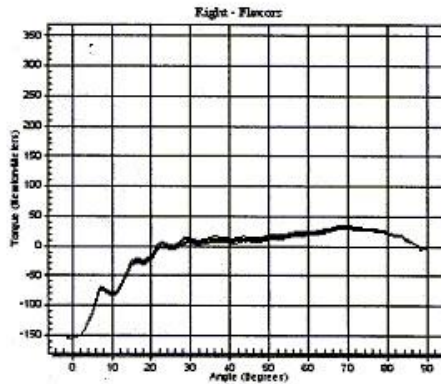
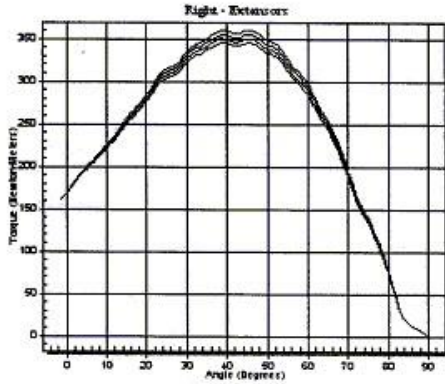
HUMAC for Windows Version: 4.2.4 Copyright Computer Sports Medicine, Inc., 1982-2002.

Use File, Preferences command to set report heading
MOST Knee Extension/Flexion Protocol (Page 2 of 2)

MOST ID: MB00001
Birth date: 1/1/50
Pref Side: Right

ACROSTIC: GWAS
Weight: 81 Kilograms
Tester: B05

Date: 1/7/03
Sex: True



HUMAC for Windows Version: 4.2.4 Copyright Computer Sports Medicine, Inc., 1982-2002.

Appendix 4 Setting the Computer for the MOST Report



Setting the Computer for the MOST Report

The MOST report is enabled by setting a registry key on the computer. This prevents the report from appearing for standard HUMAC users.

1. Select **Start, Run**.
2. Enter **REGEDIT** in the **Open** box and click **OK**.
3. From the registry editor, open the **HKEY_CURRENT_USER** folder.
4. Open the **SOFTWARE** folder.
5. Open the **VB and VBA Program Settings** folder.
6. Open the **HUMAC** folder.
7. Click on the **Options** folder.
8. From the menu, select **Edit, New, String Value**.
9. Enter **MOST** as the **New Value #1**.
10. Double click the **MOST** name and enter **True** as the **Value data**.
11. Click **OK** to save the value.
12. Select **Registry, Exit** to save your changes.

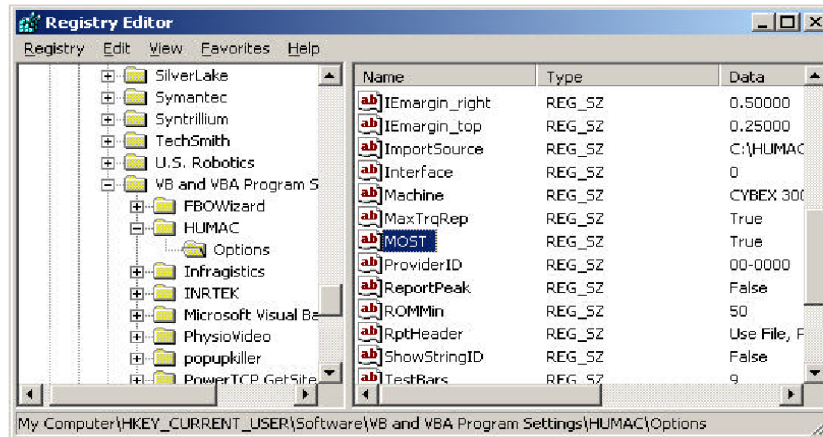


Figure 1 - Registry with MOST Key

File: I:\Humac\Windows\Setting_the_Computer_for_a_MOST_Report.doc

CSMI • 57 Providence Hwy - #5 • Norwood, MA 02062 • 781-255-1292 • 781-255-1293-Fax
Home Page: www.csmisolutions.com • e-mail: info@csmisolutions.com

Appendix 5 Error Year Changes to 2000 When Entering Data**Error Year Changes to 2000 When Entering Dates**

PRB: *You enter a date and the year changes to 2000 when you leave the field.*

SYMPTOMS

You enter a date, e.g. 10/16/2002 and leave the date field. The year then changes to 2000.

CAUSE

This is caused by a problem in the Date control.

RESOLUTION

1. Select **Start, Search**.
2. Select the **All Files and Folders**.
3. Enter **PVDATEEDIT.OCX** as the file to search for.
4. Start the search. It should find the file in **C:\Windows\System32**.
5. Delete the **PVDATEEDIT.OCX** file.
6. Place the HUMAC CD in the computer. When the setup program starts, select the **Repair** option.

STATUS

This corrects the problem.

File: I:\Humac\Windows\Errors\Error Year Changes to 2000 When Entering Dates.doc

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Appendix 6 Cybex and sEMG Back-up Procedures

HUMAC (Cybex) Data Backup

A backup of the HUMAC data needs to be created weekly and uploaded to the Coordinating Center. Check to ensure that the C:\HUMACBackup folder exists on the computer. If not, then create it before you run the HUMAC program. Run the HUMAC program, and using the menu bar at the top of the screen, chose File->Database->Backup to get this screen:

The screenshot shows a dialog box for backing up HUMAC data. It is divided into two main sections: 'Destination' and 'Files to Backup'.
 - The 'Destination' section has a 'Browse' button and a text field containing 'A:\HUMAC Backup.ZIP'.
 - The 'Files to Backup' section contains four checked checkboxes: 'HUMAC Database', 'Calibration Data', 'Error Log', and 'Real-Time Data Files'.
 - On the right side, there are two traffic light icons: a green one labeled 'Start' and a red one labeled 'Stop'.
 - At the bottom, there is a progress bar showing '0%' and two buttons labeled 'OK' and 'Help'.

Click “Browse” and set the destination folder to be C:\HUMACBackup and the filename for the backup should be named either:

MB_Cyyyymmdd.ZIP (at Alabama)

MI_Cyyyymmdd.ZIP (at Iowa)

where yyyymmdd represents today’s date (e.g., 3 April 2009 would be entered as 20090403).

If you cannot name the file using the above convention at this point, let the HUMAC software name the file as “HUMAC Backup.ZIP”

Ensure that all 4 types of files listed under “Files to Backup” have checks in the boxes (as shown above). Start the backup by clicking the “Start” button. The progress meter will move from 0% to 100%. Once the backup is 100% complete, click “OK” and exit the HUMAC software.

Check the C:\HUMACBackup folder (using “My Computer” in Windows XP, or “Computer” in Vista) and if the backup file created has the name “HUMAC Backup.ZIP” then rename it to the correct name using the MB_Cyyyymmdd.ZIP or MI_Cyyyymmdd.zip format described above.

Transferring Data to the SF Coordinating Center

Follow instructions in Secure Data Gateway operations manual.

Surface EMG (sEMG) Data Backup

The sEMG data will also be uploaded once per week to the Coordinating Center using the Secure Data Gateway.

Labview data files (.lvn) are stored in the C:\EMGdata folder. Open that folder:

in Windows XP: use “My Computer” and click on the C: drive and then the EMGdata

in Vista: use “Start”, then “Computer” and click on the C: drive and then the EMGdata

Then in the C:\EMGdata folder, create a new folder named:

MB_Eyyyyymmdd (at Alabama)

MI_Eyyyyymmdd (at Iowa)

where yyyyymmdd represents today’s date (e.g., 3 April 2009 would be entered as 20090403).

Move any Labview (.lvn) files created in the week since the last backup into the newly created folder. Then “right-click” the mouse button on the folder name and select “Send to-> Compressed (zipped) folder”. This will create a zip file which then needs to be uploaded to the Coordinating Center. Do not delete any of these zip files from your computer until you get confirmation from the Coordinating Center

Transferring Data to the SF Coordinating Center

Follow instructions in Secure Data Gateway operations manual.