

Biodex System 2 Manual

Applications/Operations



*Biodex Medical Systems, Inc. • Brookhaven R & D Plaza • 20 Ramsay Road • Box 702
Shirley • New York • 11967-0702 • 516-924-9000 • Fax 516-924-9241*

TABLE OF CONTENTS

Introduction

Before Proceeding

1. Controls and Adjustments

Powerhead

Accessory Chair

Positioning Chair

Controller

Standard Powerhead Attachments

Adjusting the Footplate (for All Ankle Patterns and Knee: Tibial
Internal/External Rotation)

2. Operation

Considerations for Safe Operation

General Guidelines (The Setup Mode)

Testing and Exercise in the Passive Mode (Sample Procedure)

Testing and Exercise in the Eccentric Mode (Sample Procedure)

Testing and Exercise in the Isokinetic Mode (Sample Procedure)

Testing and Exercise in the Isometric Mode (Sample Procedure)

3. Clinical Considerations For Joint Testing and Exercise

Proper Testing Technique

Physiological Considerations

Rehabilitation Considerations

4. Setup and Positioning For Standard Test and Exercise Patterns

Knee Extension/Flexion

Knee Tibial Internal/External Rotation

Ankle Plantar/Dorsiflexion (Seated)

Ankle Plantar/Dorsiflexion (Prone)

Ankle Inversion/Eversion

Hip Abduction/Adduction (Lying on Side)

Hip Extension/Flexion (Supine)

Hip Internal/External Rotation (Prone)

Shoulder Extension/Flexion (Seated)

Shoulder Abduction/Adduction (Seated)

Shoulder Hor. Abduction/Adduction (Supine)

Shoulder Hor. Abduction/Adduction (Prone)

Shoulder Internal/External Rot. in Modified Neutral Position

Shoulder Diagonal 1 (Standing)

Shoulder Diagonal 1 (Supine)

Shoulder Diagonal 2 (Standing)

Shoulder Diagonal 2 (Supine)

Elbow Extension/Flexion

Forearm	Pronation/Supination
Wrist	Extension/Flexion (With Forearm Pronated)
Wrist	Radial/Ulnar Deviation

5. Reference Materials

Suggested Test Speeds

Tutorial

Research Articles and Abstracts

Legal Precedents

Bibliography

6. Appendices

Biodex Multi-Joint Systems Parts and Components

General Product Warranty

INTRODUCTION

Congratulations, you've made an excellent choice!

By selecting a BIODEX Multi-Joint System 2 AP, you have acquired the most advanced, versatile and reliable technology ever developed for testing and rehabilitation of the human musculoskeletal system. You've also joined the BIODEX team of satisfied customers who benefit from unsurpassed product education, customer service, promotional and clinical support.

With your new system, you can offer testing and rehabilitation services for the knee, ankle and hip plus the shoulder, elbow and wrist. Modes of operation include Isokinetic (concentric), Isometric, Eccentric and Passive (continuous). What's more, you'll be able to test and exercise over the broadest range of speeds and torques available today. If you add the Back, Lift and Work Simulation options, your Multi-Joint System is transformed into a comprehensive clinic.

You'll also appreciate the new BIODEX Advantage Software package that comes with your system. An improved patient database prompts quick and easy retrieval of patient information. Pull down menus make protocol selection and patient setups a snap. The wide variety of output reports allows numeric and graphic information to be printed in a number of different formats. Third party payers and referring physicians receive information that is neither incomplete nor overwhelming.

Biofeedback is provided by the high resolution color graphics monitor. Torque curves, bar graphs and pie charts can be selected to encourage patient compliance with exercise protocols.

The versatility of the BIODEX Multi-Joint System 2 AP facilitates effective treatment of a broad range of patients and pathologies. The future certainly looks bright for you and your patients! Thank you for allowing BIODEX to be a part of it.

Before Proceeding:

Before you get started with any of the setups described in this manual, there are a few preliminary points to consider which will help ensure safe and smooth operation of your Biodex System.

First of all, make sure that your system wiring and cables are routed away from any area where they might be stepped on or rolled over by wheeled equipment.

For testing and exercise with the single-chair configuration, it is suggested that the positioning chair be set to its minimum height before allowing a subject to mount or dismount. It may also help to have a fixed location from which all subjects approach and leave the chair.

Be aware that use of System 2 AP technology requires professional expertise for discerning appropriate treatment techniques. Each subject's unique situation should be taken into account before beginning any type of testing or rehabilitation program. Be sure you fully comprehend the operating instructions, as well as the considerations, both physical and clinical, discussed throughout the manual before attempting to set up a subject for testing or exercise. In fact, we encourage you to practice setups and positioning with a healthy subject before attempting to set up an injured patient.

This manual has been designed to provide clinicians with general operating guidelines for the single chair configuration.

Instructions for each of the patient setups provided later in this manual assume that the clinician is starting with the system in its neutral position, as illustrated on pages 4 and 5.

To assist our users and stimulate interest in developing protocols, this manual contains a "*Clinical Applications*" section where appropriate. These comments come from the clinical experience of our users as well as from published journals.

Lastly, please note that the setups presented in this manual are intended to cover most patient protocols. However, because the BIODEX System 2 is so versatile and adaptable, you may find additional setups possible. It is suggested that the clinician try the setups presented herein before attempting any setup improvisations (especially for testing applications). If you do use a pattern that deviates from the manual, be sure to fully document it in your "Patient File" notes.

***NOTE:** Please do not attempt installation or repair on your own. Call BIODEX Customer Service first, they'll be glad to help.*

For additional technical advice, service or educational information, contact Biodex personnel at the following address:

Biodex Medical Systems
Brookhaven R&D Plaza
20 Ramsay Road, Box 702
Shirley, New York 11967-0702
(516) 924-9000
1 (800) 224-6339 (Customer Service only)
TELEX: 797566
FAX: (516) 924-8355



System 2 Double Chair Neutral Position



System 2 Single Chair Neutral Position

CONTROLS AND ADJUSTMENTS

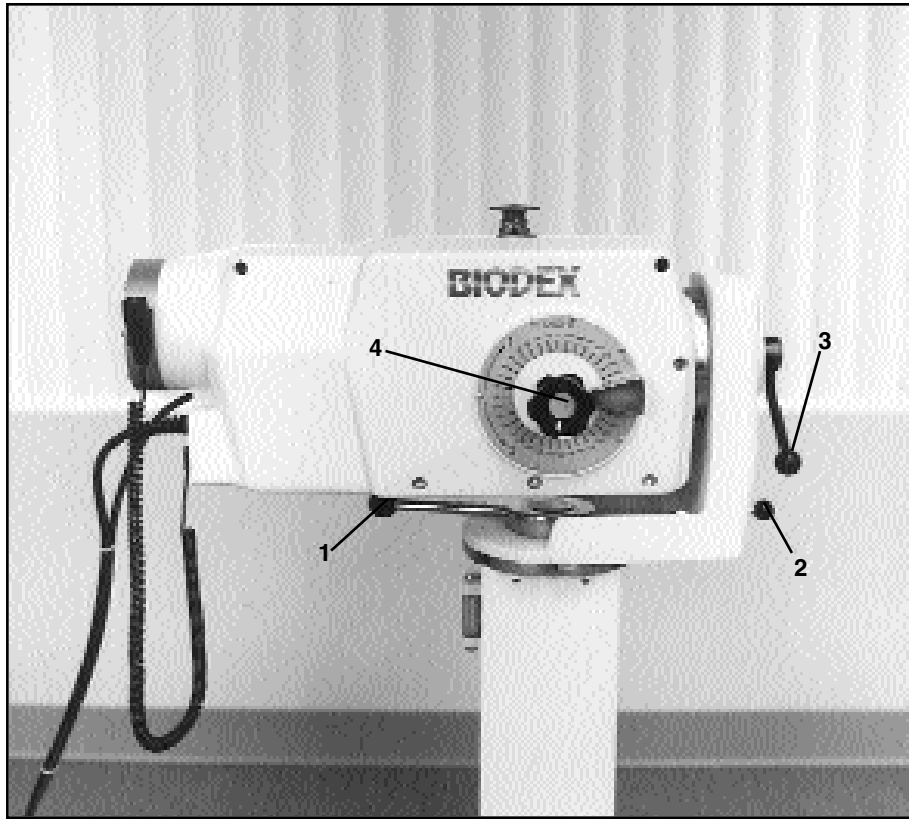


Figure 1.1: Powerhead positioning controls and adjustments. Except where noted, these are the same for both the single and double chair.

1. Powerhead Rotation Handle
2. Powerhead Release Lever
3. Powerhead Tilt handle
4. Shaft Red Dot (on powerhead shaft under locking knob)

Powerhead

POWERHEAD ROTATION: To rotate the powerhead in a horizontal plane, loosen the POWERHEAD ROTATION HANDLE by turning it counter-clockwise (CCW). Next, pull out on the POWERHEAD RELEASE LEVER and, while holding the lever out, swivel the powerhead to the approximate desired position. To secure the powerhead rotation position, release the lever and continue to rotate the powerhead until it automatically locks in place at the next detent. Ensure the powerhead has fully engaged the detent and retighten the rotation handle in a clockwise (CW) direction before positioning the subject.

For the double chair configuration, the powerhead locks in at 45° increments from the neutral position. On the single chair, the powerhead has 360° of free horizontal rotation locking in detents at increments of 0, 45, 60, 75, 90, 105, 120, 135 and 180 degrees to the left or right of the neutral position.

POWERHEAD TILT: Permits rotation of the powerhead on a vertical plane allowing the shaft axis to tilt upward or downward from the horizontal position. To tilt the powerhead, loosen the POWERHEAD TILT HANDLE in a CCW direction and gently push or pull the powerhead to the desired position. Tighten the handle firmly to secure the powerhead in place. For convenience, the lever part of the handle assembly may be repositioned by pulling it away from the powerhead, rotating it to the desired position. Use the POWERHEAD TILT SCALE to note powerhead tilt.

POWERHEAD HEIGHT (Not shown in photo): The powerhead can be raised or lowered over a range of approximately 14". For the double chair, adjustment is made by loosening the POWERHEAD HEIGHT LOCKING HANDLE. On the single chair setup, the POWERHEAD HEIGHT HANDLE is loosened. In either case, simply apply hand pressure to the top or underside of the powerhead to respectively raise or lower it. Apply the pressure on line with the axis of the mounting post to avoid resistance caused by twisting or binding of the assembly. Retighten the locking handle to lock the powerhead in position. Use the POWERHEAD HEIGHT SCALE to note the new powerhead height.

***NOTE:** The weight of the powerhead is counterbalanced by a pneumatic assembly in the mounting post. When the locking handle is loosened, the powerhead may tend to gently rise or fall, depending on the weight of attachments affixed to the powerhead shaft. After proper height is established, always secure the locking handle.*

POWERHEAD FOOT PEDALS (Single chair only, not shown in photo): The powerhead FOOT PEDALS allow the powerhead to move along the travel in a horizontal plane left or right of the positioning chair. To move the powerhead, press down on either foot pedal and slide the powerhead to the desired location. Release the foot pedal to lock the powerhead in place. To ensure stability, check that the powerhead is fully locked in a detent (i.e., try to shake the powerhead). Use the POWERHEAD POSITION SCALE on the travel to note powerhead position.

SHAFT RED DOT (powerhead shaft): The small red dots on the ends of the powerhead shaft provide indexes for proper alignment of accessory and shaft during setup. When affixing any accessory to the powerhead shaft, position the accessory so that its dot aligns with the powerhead SHAFT RED DOT. Failure to properly align the dots may result in a reduced range of motion or in improperly positioned mechanical safety stops.

NOTE: *If the controller is switched to ON when there is no attachment on the powerhead shaft, the shaft may rotate to a position that prohibits proper attachment of accessories. The shaft may easily be returned to the proper position by the following method:*

1. *Switch to Setup mode.*
2. *Press ON, press START.*
3. *Turn powerhead BALANCE adjustment knob to make shaft rotate slowly in desired direction.*
4. *Press STOP when shaft RED DOT is in proper position (0° on POWERHEAD REFERENCE SCALE).*
5. *Affix appropriate accessory to shaft. Press the ON button and readjust balance if necessary.*

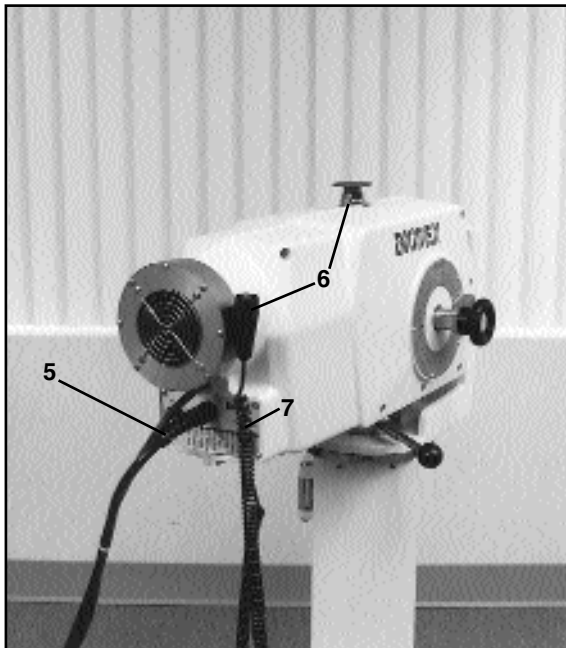


Figure 1.2: Additional powerhead controls.

5. Balance
6. Comfort Stops (powerhead, remote)
7. Status Panel (LED's)

NOTE: For the following controls and adjustments, refer to Figure 1.2.

BALANCE: The BALANCE adjustment dial provides a means of “zeroing out” signals that may cause undesirable directional bias of the powerhead shaft. Such signals may result from changes in component temperatures or from changes in the resting state of the torque sensing assembly which occur when accessories of different masses are affixed to the shaft.

Balance should always be checked after an accessory has been affixed to the shaft and after any accessory’s effective lever arm length has been changed. Balance should be checked with the controller in Setup mode.

Generally, balance adjustments are performed with the accessory in a position of *minimum gravity effect*. This means that whenever possible, the accessory should be positioned so that it exerts no rotational force (torque) upon the powerhead shaft. In other words, a properly balanced fixture should have not bias toward either direction 1 or 2.

Balance should never be used to hold an accessory in any particular position (against the effect of gravity).

In a few instances, it may be necessary to balance a particular fixture with its center of gravity positioned directly above the powerhead shaft. This method is sometimes necessary when a setup configuration or a fixtures mechanical stop does not allow the accessory arm to be lowered to a position of minimum gravity effect.

If balance adjustment is not performed, the shaft’s directional bias may produce undesirable accessory movement occurring without torque input from the subject. Errors in torque values (plus in one pattern direction, minus in the other) may also result. It should be noted that even when balance is grossly out of adjustment, the shaft’s directional bias will result in no more than a few foot-pounds of rotational torque or resulting torque value error. *System safety features are not adversely affected by balance adjustments.*

NOTE: Balance should always be adjusted before a patient is placed on the unit.

COMFORT STOPS (powerhead, remote): These buttons provide the subject with the ability to instantaneously terminate exercise in any mode. Depressing either the large red button atop the powerhead or the black hand-held remote button causes immediate cessation of powerhead shaft rotation.

The principal purpose of this control is to guard against moving the subject into a portion of the range of motion that, for any reason, is contraindicated. It should be noted that activating a COMFORT STOP after the onset of discomfort may result in a stoppage of movement while the subject is still in the undesirable portion of the range. Should this occur, the operator should immediately switch the controller to SETUP mode, free the shaft, and allow rotation toward a more comfortable point in the subject's ROM. With the shaft free, the operator should manually place the subject in the flexed position so that the limb does not move in the direction of gravity.

Educating the subject about the use of the COMFORT STOPS (prior to exercise) also serves to improve confidence and motivation by reducing apprehension regarding the equipment.

***NOTE:** As a safety precaution, the system will not function in any mode if the REMOTE COMFORT STOP is not connected to the powerhead.*

STATUS/DIAGNOSTICS PANEL (LEDs): This panel provides information to assist in trouble-shooting of powerhead / controller problems. Always be sure to record which LED's light before attempting to correct the problem or restart the system. It also suggested that you contact your BIODEX Service Representative whenever the status panel indicates a malfunction.

Accessory Chair Adjustments (System 2 Single Chair only)

Refer to Figures 1.3 and 1.4.

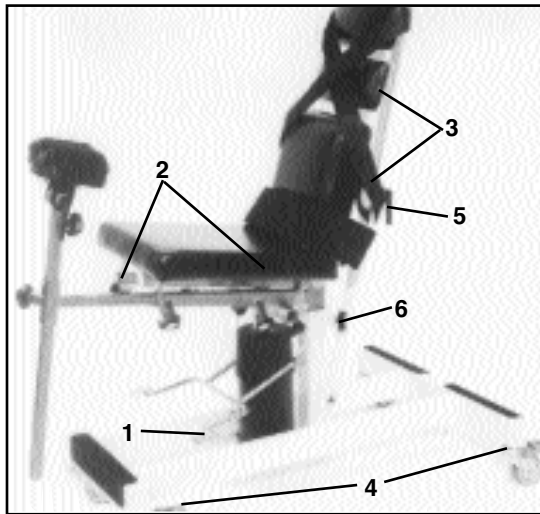


Figure 1.3: Accessory Chair adjustments.

1. Seat Height Treadles
2. Receiving Tubes
3. Stabilization Straps
4. Wheel Locks
5. Seatback Tilt Handle
6. Seat Height Adjustment Locking Knob



Figure 1.4: Accessory Chair attachments.

8. Multi-Support Pad
9. Footrest
10. T-Bar Adapters (2)

SEAT HEIGHT: The Accessory Chair seat may be raised or lowered over a range of approximately 6-1/2" inches. To raise or lower the seat, first loosen the seat height adjustment locking knob, then step on either of the two seat height foot treadles and pump the pedal until the seat reaches the desired position. Tighten the locking knob to secure the seat in place. To lower the seat, loosen the locking knob then depress the pedal fully, holding it down until the seat lowers to the desired height. Again, tighten the locking knob to secure the seat in position.

RECEIVING TUBES: There are four receiving tubes and corresponding locking knobs located beneath the seat, two in front and one on each side. These tubes receive the T-Bar adapters and footrest. Tighten the appropriate locking knob to secure an adapter or the footrest in place.

STABILIZATION STRAPS: The Accessory Chair is supplied with a pelvic strap and pair of shoulder straps. Both straps are secured around the Accessory Chair's strap support bars.

WHEEL LOCKS: Each of the four Accessory Chair wheels can be individually locked in place by pressing down on the outer portion of the caster's brake lever. To release the wheel, press down on the caster's small release lever (at the center of the brake lever).

HEAD PAD ADJUSTMENT: To adjust the vertical position of the head pad, loosen the head pad adjustment locking knob and raise or lower the head pad to the desired position. Tighten the locking knob to secure the pad in place.

SEATBACK TILT: This adjustment allows a full, continuous range of seatback angle settings from vertical to horizontal. To adjust the seatback tilt, loosen the seatback tilt handle. Adjust the seatback to the desired angle and retighten the handle to lock the seatback firmly in place. Use the seatback tilt scale to note the new position.

LUMBAR SUPPORT (Lower): To reposition the lower lumbar support, loosen the lumbar support locking knob. The support can be moved up or down over a range of approximately five inches.

Positioning Chair Adjustments (System 2 Single Chair only)

Refer to Figures 1.5, 1.6 and 1.7.

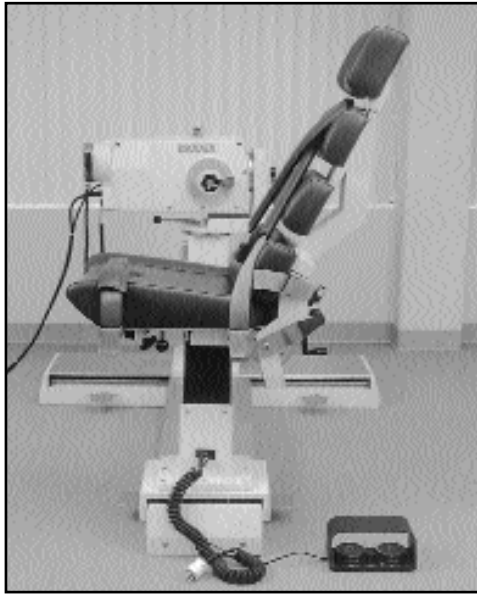


Figure 1.5: Positioning Chair adjustments.

1. Seat Rotation Handle
2. Receiving Tubes (only one visible in photo)
3. Chair Foot Pedals
4. Seat Height Pedals

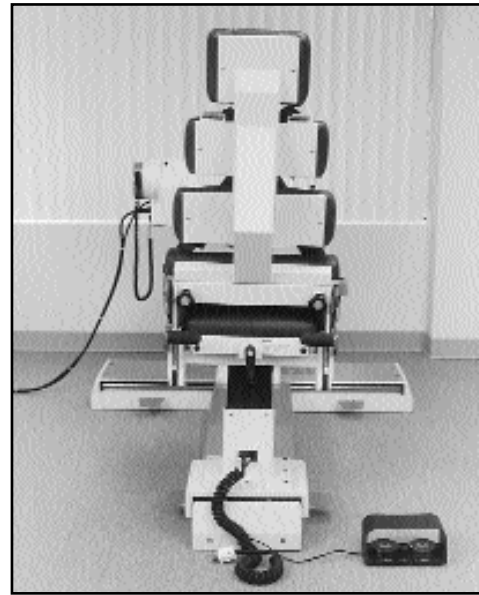


Figure 1.6: Positioning Chair adjustments.

5. Lumbar Support Adjustment Knobs
6. Seatback Tilt Handle
7. Seatback Fore/Aft Handle



Figure 1.7: Positioning Chair attachments.

8. Multi-Support Pad
9. Footrest
10. Long Adapter
11. Medium Adapter
12. Short Adapter

SEAT ROTATION: Like the powerhead, the seat has 360° of rotation in the horizontal plane. The seat, however, locks in at specific increments of 15, 30, 45, 135, 150, 165 and 180 degrees to the left or right of the neutral position.

To rotate the seat in either direction, pull up on the knobbed SEAT ROTATION HANDLE beneath the seat, swivel the seat to the desired position and release the handle to lock the seat in place. Anytime you release the handle, the seat automatically locks in place at the next detent. Ensure the seat is fully locked in the detent before allowing any subject to perform a test or exercise pattern.

CHAIR FOOT PEDALS: The CHAIR FOOT PEDALS allow fore/aft adjustment of the positioning chair in relation to the powerhead. To move the chair along the travel, press down on either foot pedal and slide the chair to the desired location. Release the foot pedal to lock the chair in place. To ensure stability, check that the chair is fully locked in a detent. Use the CHAIR POSITION SCALE to note the new position.

SEATBACK TILT: This adjustment allows a full, continuous range of seatback angle settings from vertical to horizontal. To adjust the seatback tilt, push both SEATBACK TILT HANDLES down fully down. Adjust the seatback to the desired angle and slide the handles back up to the top position to lock the seatback firmly in place. Use the SEATBACK TILT SCALE to note the new position.

SEAT HEIGHT: The motorized seat may be automatically raised or lowered over a range of approximately 14 inches. To adjust the seat height, press the UP or DOWN BUTTON on the SEAT HEIGHT PEDALS. The seat may be raised or lowered with the subject seated. Ensure, however, that all wires are clear and there are no accessories, etc. resting on the seat before you begin to raise or lower it.

SEATBACK FORE/AFT: Crank the SEATBACK FORE/ AFT HANDLE in a CW direction to move the seatback forward on the seat. Crank the handle in a CCW direction to move the seatback toward the rear of the seat.

LUMBAR SUPPORT (Lower): To reposition the lower lumbar support, turn the two inside locking knobs on the back of the support in a CCW direction until loose. Lift up or push down on the support until the desired position is achieved. Turn the locking knobs in a clockwise direction until tight to secure the lumbar support in place.

STABILIZATION STRAPS: The Positioning Chair is fitted with a THIGH STRAP and buckle (secured at the seat frame), a PELVIC STRAP and buckle

(secured near the base of the seatback frame), and a pair of SHOULDER STRAPS and buckles (secured at the base of the seatback). To secure any strap, lift the buckle handle, insert the strap into the buckle and pull until tight but not uncomfortable on patient. Press the buckle handle all the way down to secure.

RECEIVING TUBES: There are three receiving tubes located beneath the seat, one in the center (front) and one on each side. These tubes receive the T-Bars and footrest.

CONTROLLER

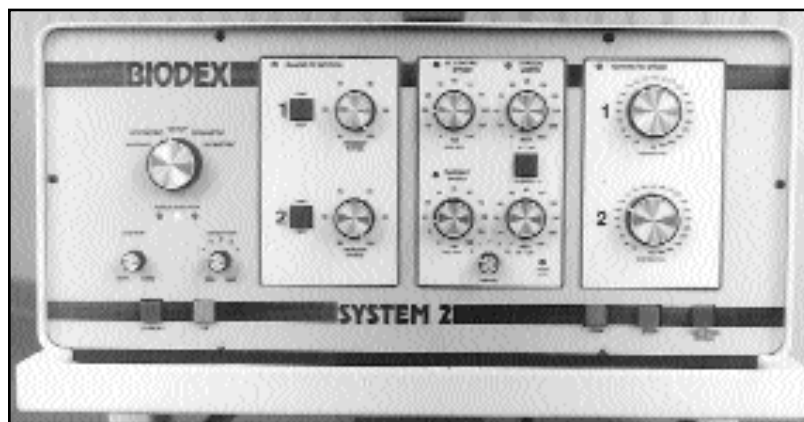


Figure 1.8: The same Controller is used for both single and double chair configurations.

POWER SWITCH (rear panel): Controls main power supply to controller and powerhead. Contains a circuit breaker to protect against extreme power surges. Breaker is reset by switching to ON position.

MODE (dial): Use this dial to select one of five modes of operation available to the user: Setup, Passive, Eccentric, Isokinetic or Isometric.

FORCE INDICATOR: Illumination of any of these three LED's reveals that the powerhead's torque sensing assembly is generating a signal. The green LED indicates that the sensor is active, but no torque is being sensed. The left red LED indicates torque in shaft direction 2. The right red LED indicates torque in shaft direction 1.

Clinical Applications:

Many clinicians use the FORCE INDICATOR as biofeedback during rehabilitation

in the Isometric and Passive modes.

CUSHION (dial): The controller limits the subject's range of motion by signaling the powerhead to prevent further shaft rotation when a preset range limit has been raised. The CUSHION adjustment dial provides a means of varying the point at which deceleration starts. When a "hard" cushion is selected, deceleration begins relatively close to the stopping point. When a "soft" cushion is chosen, deceleration starts earlier.

Because the point at which deceleration begins is a function of velocity as well as the selected cushion setting, the actual portion of the range of motion used to decelerate varies with changes in selected isokinetic exercise speeds.

NOTE: *The CUSHION adjustment knob does not function in Setup or Eccentric mode.*

Clinical Applications:

As a general rule, hard cushions are selected for testing, soft cushions for rehabilitation applications. If pain prohibits the use of the hard cushion, or if a protocol calls for use of the soft cushion, there will be some decrease in time at isokinetic speed. This is especially true in a small range of motion or at high speeds.

SENSITIVITY (dial): The SENSITIVITY dial is used to control the powerhead's rate of acceleration as a response to torque input while the subject is below the preselected exercise velocity. The accessories used to link specific joints to the powerhead are rigid devices with effective lever lengths that vary with changes in adjustment or configuration. As a result, they are potential torque producers, especially when acted upon by gravity or when flexing as a result of changes in applied force. In some instances, the system response to fixture-generated torque results in rapid oscillation of the accessory (the system is responding to flexing metal that is trying to reach a state of equilibrium). This is the most common indication that sensitivity adjustment is required. During exercise and test repetitions, subject mass and pad compression have a moderating effect on mechanical oscillation. Significant vibration, therefore, will generally occur only with a sudden change of direction or cessation of force production.

System sensitivity should be set as high as possible without resulting in unwanted oscillations. This adjustment provides a means of varying shaft acceleration to compensate for the characteristics of individual accessories. "A" is the lowest sensitivity setting. "E" is the highest. "A" is used for large attachments such as the Back Attachment, "E" for the wrist attachment. Note that lowering the sensitivity setting may result in a reduction of system response to subtle accessory-generated torques.

The recommended sensitivity settings provided in the setup instructions and on accessory labels should be considered as starting points. If an accessory vibrates or oscillates during setup, testing or exercise, switch to the next lower value until the problem ceases.

***NOTE:** Sensitivity should not be confused with signal “damping”, a function not employed in the BIODEX System. Changing the sensitivity setting has no effect on torque data at the preselected exercise velocity.*

STANDBY (BUTTON): Press this button to cancel previously set range of motion limits. STANDBY should always be pressed prior to setting up a new subject and before subsequent test or exercise on same person.

Do not use the STANDBY button to stop the system while a subject is in motion. Instead, use the COMFORT STOPS, followed by the STOP button on the controller.

ON (button): Press the ON button, followed by START, to allow powerhead shaft rotation in the Setup mode. If STOP is flashing, press STOP first, then ON followed by START.

LIMIT SET (buttons #1, #2): The LIMIT SET buttons are used in Setup mode to select range of motion limits appropriate for the upcoming test or exercise protocol. Depressing a LIMIT SET button allows shaft rotation in the direction indicated by the button’s number (1 or 2). Release the button to set the end ROM limit. A flashing button indicates that the range of motion limit for the corresponding direction of shaft rotation has been cancelled. As a safety precaution, no mode other than Setup can be activated when either LIMIT SET button is flashing.

Range limits should always be set after the subject is positioned and before switching to a test or exercise mode. Limits should not be set at points that are beyond the safe maximum allowable range of motion for the individual exercise subject.

The LIMIT SET buttons should be used to set the “target”, or final safe maximum range of motion, for the specific test or exercise to be performed. The PERCENT RANGE DIALS may be used to reduce this working range prior to initiating the test or exercise, thereby allowing gradual increase in range as the session progresses.

***NOTE:** Always assume that previously set ROM limits are inappropriate for successive subjects and for successive joints on the same subject. Always set new limits when testing a new subject or moving from one joint to the next.*

NOTE: When in the Isometric mode, the shaft may be moved by pressing (and holding) the LIMIT SET button corresponding to the direction the shaft must turn. Releasing the button locks the shaft at the new position. This function of the LIMIT SET buttons has no effect on range of motion limits previously established in Setup mode.

Clinical Applications:

During exercise, limits can be moved within, but never beyond, the range established in the Setup mode. Before proceeding with a test or exercise bout, always ensure a comfortable range of motion for the subject.

PERCENT RANGE (dials 1 and 2): Use these dials to selectively reduce the total range of motion established during setup. Each dial setting represents the percentage of the present range of motion that can be attained in the dial's corresponding direction (1 or 2). For example, when the upper PERCENT RANGE dial is set at 100%, the direction 1 range limit established during Setup is maintained. At 50%, only half of the Setup range of motion in direction 1 can be attained. It should be noted that each dial's value represents percentage relative to the Setup range-of-motion limits. If each dial is set at 50%, little or no range of motion results because each direction loses the last 50% of its range, with a net result of zero or near zero range of motion.

When in Setup mode, PERCENT RANGE dials are automatically overridden and a given value of 100% to prevent setting limits that could be increased when in an exercise mode.

ECCENTRIC SPEED (dial): This dial sets angular velocity (in degrees/second) for testing or exercise in the Eccentric mode. NOTE that initiation and continuance of shaft movement in this mode requires the subject to maintain specific levels of force production (see Eccentric mode).

PASSIVE SPEED (dial): This dial sets angular velocity (in degrees/second) for testing or exercise in the Passive mode.

NOTE: When the START button is pressed to initiate testing or exercise in this mode, shaft velocity increases gradually (over a period of approximately 10 seconds) to safely and comfortably bring the subject up to protocol speed.

TORQUE LIMITS (dials #1, #2): The TORQUE LIMIT adjustment dials provide a means of keeping subjects below an operator-specified level of torque production while performing eccentric contractions in the Passive or Eccentric

mode. When a subject exerts an eccentric torque in excess of the torque limit selected, the powerhead shaft stops rotating until the subject's force output is reduced to a value below that limit. The subject must therefore work below the limit threshold if he or she is to continue through the range of motion.

The upper (#1) TORQUE LIMIT adjustment dial controls the torque limit for force applied in Direction 1. The lower (#2) dial sets the limit for Direction 2. *NOTE that the TORQUE LIMIT dials correspond to the direction of eccentric force production, not direction of motion.* As an example, to set a torque limit for an eccentric contraction during knee extension (#1), the lower (#2) TORQUE LIMIT dial must be used. The TORQUE LIMIT dials only limit force produced eccentrically.

The numerical values on the TORQUE LIMIT SCALES represent foot-pounds of torque. To attain low-level torque limit settings, depress (and light) the DIVIDE TORQUE BY 10 button to convert the actual settings to one tenth of the foot-pound values displayed.

TORQUE BY 10 (button): When illuminated, this button changes both torque limits to one tenth of the corresponding dial settings. For example, a dial setting of 60 represents 6 foot-pounds when the button is ON.

PAUSE (dial): This dial allows the introduction of time delays between reciprocating patterns of motion during exercise in the Passive mode. The PAUSE function is inactive when the dial is set to zero. Dial numerals indicate approximate delay time (from 0 to 10 seconds).

Clinical Applications:

Among other things, PAUSE may be used to:

- 1. Give commands, especially when patients are working non-reciprocally (concentric/eccentric, eccentric/concentric).*
- 2. Provide neurologically impaired individuals with enough time to prepare for a contraction.*
- 3. Allow the subject time for a brief passive stretch.*
- 4. Apply stimulation at terminal points in the ROM.*

PUSH STOP (LED): Illumination of this LED indicates the system has shut down to protect itself from thermal overload in its servo-motor circuit. This can occur when the system is in heavy use and is not cooling down

sufficiently. Resetting can usually be accomplished by pressing the STOP button. If the problem cannot be associated with extremely heavy usage, and cannot be rectified by short periods of cool-down time, contact the BIODEx Service Department.

ISOKINETIC SPEED (dials 1 and 2): These dials set maximum allowable velocities for each direction of movement in the Isokinetic mode. Dials 1 and 2 set speed for the corresponding shaft directions 1 and 2 (indicated by arrows on the powerhead).

STOP (button): Stops shaft rotation in any test or exercise mode. The STOP button should be pressed anytime a complete stop is warranted.

NOTE: For subject safety and comfort, do not press STOP while the shaft is in motion.

START (button): Press this button to initiate testing or exercise in the Passive, Eccentric, Isokinetic or Isometric mode. Press ON followed by START to allow powerhead shaft rotation in Setup mode.

HIGH SPEED ENABLE: This button flashes when a starting speed of 60 degrees/second or higher is selected in the Passive or Eccentric mode. To begin testing or exercise when this condition exists, the operator must depress the START and HIGH SPEED ENABLE buttons simultaneously. This feature is designed to caution against initiating shaft motion at a speed that may be too high for a particular individual or movement pattern.

AUTO-PROGRAM (button): When depressed, the green Auto-Program button blinks to indicate that auto-programming is prepared to function as selections are made from the system's software menus and windows. Once the test begins with Auto-Programming selected, the button stays illuminated to indicate that this option is active.

In Auto-Programming mode, the system controls settings for speed (isokinetics), position (isometrics) or force (isotonics) in each direction based on the selected protocol. Once the test or exercise begins, appropriate speed / force / position changes are automatically initiated or requested prior to the first set and immediately following completion of each additional set.

NOTE: Auto-Programming requires an AP Controller or AP-Upgrade.

Standard Powerhead Attachments

Many of the powerhead attachments used for testing and rehabilitation on

the BIODEX System 2 are interchangeable between the single and double chair configurations. Shown below are the attachments used at the time this manual was released. Please note that in some instances, such as Elbow: Extension/Flexion and Shoulder: Internal/External Rotation, attachment parts may be combined to produce the most accurate and comfortable setup for certain individuals.

NOTE: For a complete listing of System 2 parts and components, see “BIODEX System 2 Parts and Components” in the Appendix section of this manual.

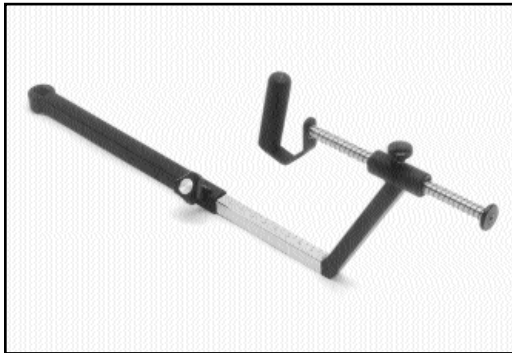


Figure 1.9
Shoulder Attachment

Patterns:
Shoulder: Ex/Flex
Ab/Ad
Diagonals

Elbow: Ex/Flex

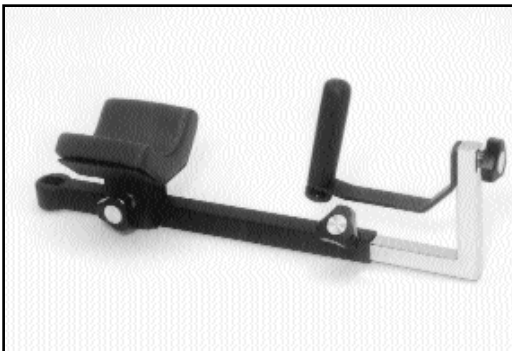


Figure 1.10
Wrist Attachment with Forearm Support Pad
(assembled from A of Elbow/Shoulder Attachment, B, the Forearm Support Pad, and C of Wrist Attachment)

Patterns:
Shoulder: In/Ex Rotation
Elbow: Ex/Flex (remove Forearm Support Pad)



Figure 1.11
Knee Attachments

Patterns:
Knee: Ex/Flex
Hip: Ab/Ad
Ex/Flex
In/Ex Rotation



Figure 1.12
Forearm/Wrist Attachment

Patterns:
Wrist: Ex/Flex
Radial/Ulnar Deviation
Forearm: Pro/Supination



Figure 1.13
Footplate Attachment

Patterns:
Knee: Tibial In/Ex Rotation
Ankle: Plantar/Dorsiflexion
Inversion/Eversion



Figure 1.14
Accessories Cart

The Combination Ankle Attachment (#820-331)

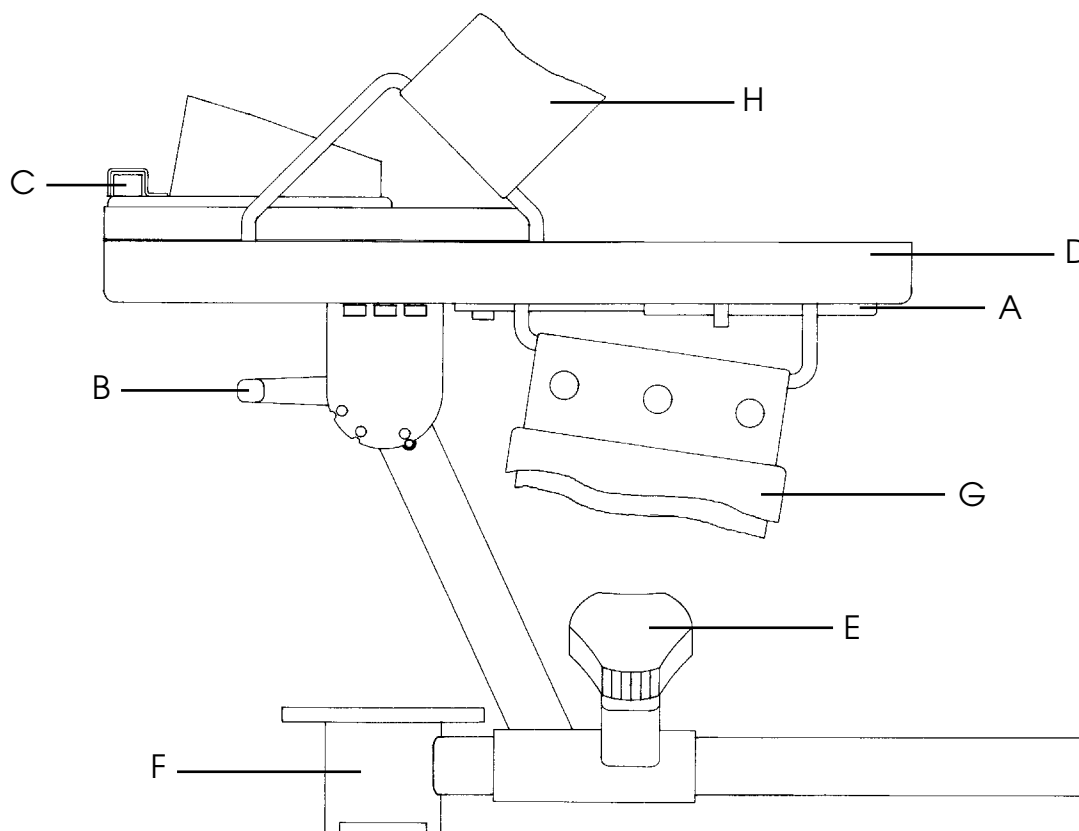


Figure 1. The Combination Ankle Attachment adjustment mechanisms.

- A. Footplate Rotation Lever
- B. Footplate Tilt Lever
- C. Heelcup Release Buttons
- D. Footplate
- E. Adapter Locking Knob
- F. Ankle Attachment Adapter
- G. Toe Strap
- H. Ankle Strap

The Combination Ankle Attachment (#830-331) can be used with either the Single Chair or Double Chair Biodex System. It is color-coded to facilitate setting up for all ankle patterns plus tibial internal/external rotation of the knee. To prepare the attachment for use, simply line up the appropriate color-coded position dots for footplate tilt and rotation with the red dots on the attachment shaft and Footplate Rotation Lever (i.e., for internal/external rotation, the green footplate tilt dot should be aligned with the red dot on the attachment shaft and the green footplate rotation dot should be aligned with the red dot on the Footplate Rotation Lever).

The footplate color codes are as follows:

White Dot to Red Dot:	Ankle: Plantar / Dorsiflexion
Green Dot to Red Dot:	Ankle: Inversion / Eversion
Blue Dot to Red Dot:	Knee: Tibial In / Ex Rotation

Adjusting The Footplate (Refer to Figure 1)

FOOTPLATE ROTATION: The Footplate Rotation Lever is located on the underside of the footplate at the toe end. Pull the lever and hold it back while you rotate the footplate until the desired color-coded footplate rotation dot aligns with the red dot on the lever. Release the lever and ensure that the appropriate footplate peg is secured in the lever's notch.

FOOTPLATE TILT: The Footplate Tilt Lever is located on the underside of the footplate just above the color-coded position dots. Loosen the lever and tilt the footplate to align the color-coded dots per test or exercise protocol. Tighten the lever to secure the footplate in place.

HEEL CUP POSITION: To facilitate alignment of the subject's axis of rotation with the powerhead shaft, it may be helpful to raise or lower the patient's foot on the footplate by adjusting the heel cup position. The Heel Cup Release Buttons are located on the top side of the footplate at the heel end. Squeeze the Heel Cup Release Buttons together and slide the support cup to the desired position. Release the buttons to lock the heel cup in place.

Two Heel Cups, one designed with a high, narrow, rubber support for use with patients where it is desirable to perform the exercise without shoes, one designed with a low, wide, plastic support for patients wearing shoes, are provided. The Heel Cups are interchangeable.

To remove or insert either Heel Cup, depress the Heel Cup Release Buttons and slide the cup into or out of the footplate attachment from the toe end. The Heel Cup can then be positioned as explained above.

TOE AND ANKLE STRAPS: Once all adjustments to the footplate have been completed, secure the patient's foot using both the foot and ankle straps.

Positioning the Footplate Adapter

The Ankle Attachment's adapter can be positioned in two different ways as noted by the lettering on the engraved shaft. For inversion/eversion patterns, the adapter must be positioned on the powerhead shaft so that the engraved letters "I/E" face outward from the powerhead. For all other patterns, the engraved letters "P/D" should face out from the powerhead. It is important that you position the adapter correctly for each pattern to ensure full range of motion.

IMPORTANT UPDATE INFORMATION

Ankle: Inversion/Eversion (Seated) With the Combination Ankle Attachment:

With the exception of Ankle: Inversion/Eversion, all patterns using the Combination Ankle Attachment remain the same as those presented in this manual. To test or exercise the Ankle: Inversion/Eversion pattern, please make the following changes in your setups:

Powerhead Orientation:	90°
Powerhead Tilt:	55°
Knee Flexion:	30° - 45°
Ankle Flexion:	75° - 90°

Use of the new Combination Ankle Attachment does not require the seat to be positioned at its highest point. Thus, patients can be positioned with less knee extension than was previously possible. With the new attachment, both the ankle and footplate should be positioned perpendicular to the floor so that the anatomical axis of rotation passes through the body of the talus and fibular malleolus at an angle of 35°.

OPERATION

Considerations for Safe Operation of Your BIODEx System 2

1. Range limits should always be set after the subject is positioned according to protocol and before switching to a test or exercise mode. Limits should never be set at points that are beyond the safe maximum allowable range of motion for the individual subject.

Always assume that previously set limits are inappropriate for successive subjects, or for successive joints on the same subject. Limits should be cancelled by pressing STANDBY at the completion of each test or exercise session. Always press the STANDBY button on the controller panel prior to setup of a new subject or before subsequent setups on the same subject.

2. Range of motion limits should be set so that the mechanical stop on the attachment or fixture will not contact the mechanical stop on the powerhead. Metal-to-metal contact of these parts during operation will override the system's normal deceleration function (cushion), causing harsh impacts at ends of ROM.
3. Always educate subject as to function and use of the COMFORT STOP buttons. Always place the hand-held REMOTE COMFORT STOP (on black coiled cord) in the subject's free hand before the start of any test or exercise session.
4. Remember, Setup mode is used for patient setups and adjustments, not for exercise or testing.
5. For patient safety, do not raise or lower the positioning chair while subject is secured to powerhead attachments.
6. Before pressing the START button, always inform the subject that the input arm will move.
7. During setup, check subject positioning and ability to complete range of motion (slowly) prior to securing stabilization straps. Single chair users should also ensure that both the positioning chair and powerhead are securely locked in detents before allowing subject to move through ROM.
8. Always keep the surrounding area free of equipment and other personnel, especially when the passive mode is to be used. Check for clear, unobstructed path of movement pattern (through complete ROM).

-
9. Do not operate equipment that has malfunctioned until it has been serviced by a qualified technician or use has been approved by a BIODEX service representative.
 10. Use equipment only with recommended power supplies, grounding, and surge suppression. (Refer to BIODEX site survey or contact BIODEX Service Department for specifications).
 11. BIODEX recommends securing the double chair mount to the floor (via screw holes in base) to prevent equipment movement during high force and/or high speed testing or exercise.
 12. The clinician should *always* be present during testing or exercise sessions. Do not allow subjects to test or exercise themselves.

General Guidelines

Readying Controller and Powerhead for Use

The controller should be switched “OFF” via the white POWER switch on its rear panel if the BIODEX will not be used for any extended period of time. As all electrical components have a life expectancy, this practice will minimize the potential for component failures.

When switching the controller “ON” after a long period of non-use (such as overnight), it is advisable to warm up the system by operating the powerhead in the Passive mode for 5 to 10 minutes at 120 degrees/second (with range of motion limits at least 90 degrees apart). This will bring the powerhead’s internal mechanical parts, torque sensing assembly, and lubricants up to a suitable working temperature. Failure to perform this “warm-up” procedure may result in a need to repeatedly adjust powerhead balance while the unit warms up during normal use, especially if ambient temperatures in your facility change significantly during off hours. In extreme cases, thermal effects on the resting state of the torque sensors may introduce a balance bias too significant to zero out until the unit has warmed up sufficiently.

System Calibration

The calibration procedure is performed to give the software known positions and weights in order to calculate various constants used in the program. The calibration is performed through the Clinical DataStation and is detailed in the *BIODEX Advantage Software Manual*.

In general, system calibration should be performed twice a month, the verification procedure once a week. If the clinician is to collect data which will be used in court or research, the calibration and verification procedures should be performed that day.

General Operating Instructions

NOTE: Subject positioning and stabilization are always performed in the Setup mode.

The Setup Mode

The Setup mode is used during the system's preparation, prior to actual exercise or testing. In this mode the powerhead shaft is free to rotate (at 45° per second) so that fixtures can be secured, powerhead balance can be adjusted, range of motion limits can be set, and the subject can be properly positioned and stabilized prior to exercise.

Setup Mode (General Instructions)

1. Turn the controller ON.
2. Set the controller MODE dial to Setup.
3. Press STANDBY.
4. Select SENSITIVITY level depending on attachment (letters A-E).
5. Press ON, press START to allow rotation of the powerhead shaft. If STOP light is flashing push STOP first, then ON followed by START.
6. Turn powerhead BALANCE adjustment dial to make the shaft rotate slowly in the appropriate direction. Press STOP to stop the shaft from rotating once SHAFT RED DOT is in desired position.
7. Attach appropriate fixture to powerhead shaft, secure with locking knob. Position powerhead per test or exercise protocol
8. Press STOP, press START to allow for shaft rotation.
9. Adjust BALANCE so shaft resides at position of minimum gravity effect with no bias in either direction.
10. Seat subject on dual chair, accessory or positioning chair. Set seat rotation, seat height, seatback tilt and seatback fore / aft position. If necessary, install FOOTREST, MULTI-SUPPORT PAD and appropriate T- BAR ADAPTERS.

-
11. Position and stabilize subject correctly for the intended protocol by refining the seat height, seat position and seatback tilt. Powerhead height, angle, rotation, and position (for single chair users), may also need adjustment. Secure appropriate stabilization straps. Be sure to correctly align suggested anatomical axis with the powerhead shaft.
 12. Explain use of hand-held and powerhead COMFORT STOP buttons to subject.
 13. Assist or have subject move through appropriate range of motion in Direction 1 to the limit allowed by subject ability or therapy / test protocol. Press flashing LIMIT SET 1 button.
 14. Assist or have subject move through a range of motion in Direction 2 to the limit allowed by subject ability or therapy / test protocol. Press flashing LIMIT SET 2 button.
 15. Set CUSHION dial as desired.
 16. Set MODE dial to desired mode. Proceed per test or exercise protocol in mode selected.

NOTE: Always be sure the controller settings are correct before engaging this device with the START button. Set range of motion limits after placing subject into restraints. Have subject move through ROM prior to starting test or exercise. Always press STANDBY and re-set range of motion limits when proceeding from one joint, subject or powerhead attachment to another.

Testing and Exercise in the Passive Mode

The unique BIODEX Passive mode allows the powerhead to provide continuous motion at constant velocity, with direction changes occurring only when range of motion limits are reached. Passive mode is selected after the subject has been positioned and stabilized in the Setup mode.

In Passive mode, the powerhead initiates motion when the START button is pressed, requiring no active participation by the subject. During testing or exercise, the individual may, in any combination, maintain relaxed musculature, apply force in the direction of motion (concentric contractions), or apply opposing force against the direction of motion (eccentric contraction), without altering shaft velocity (unless torque limits are exceeded. See TORQUE LIMITS). This mode is used frequently to test and rehab non-reciprocal contraction types (concentric/eccentric, eccentric/concentric), and to select torque limits that will allow work at a prescribed submaximal level.

***NOTE:** The Passive mode may be used for passive exercise, concentric exercise and testing, or eccentric exercise and testing. The Passive mode must be used for non-reciprocal (concentric/eccentric, eccentric/concentric) exercise and testing.*

The following general procedure is provided to help clarify use of the Passive mode.

Passive Mode (General Instructions)

1. Check range of motion limits.
2. Place MODE dial in Passive position. (This creates a “STOP” condition.)
3. Set Direction #1 and #2 TORQUE LIMIT dials to the desired limit value. If these torque values are exceeded eccentrically during motion, the load arm will stop until the torque applied is once again below the acceptable limit. Remember, this feature allows the clinician to control the maximum amount of torque he/she wants the subject to develop. *Note that LIMIT SET dials correspond to the direction of eccentric force production, not direction of motion.* Therefore, to set a torque limit for an eccentric contraction during the extension motion (direction 1), the lower (#2) torque limit dial must be used.
4. Set the PAUSE desired.
5. Explain use of both the hand-held and powerhead COMFORT STOP buttons to subject.

-
-
6. Press the START button. (If the speed is set to more than 60° per second, push HIGH SPEED ENABLE and START simultaneously.)
 7. Remember, the Passive mode will ramp up to the speed you set. It takes approximately 10 seconds for the shaft to reach the pre-selected speed after the START button is pressed. When testing, avoid stopping and starting the unit as the subject begins the test, since some of the data will not be acquired at the pre-selected speed. Use the initial 10 seconds for warm-up if desired.

NOTE: *Always be sure the controller settings are correct before engaging this device with the START button. Set range of motion limits AFTER placing subject into restraints. Have subject move through ROM prior to starting test or exercise. Always re-set range of motion limits or press STANDBY when proceeding from one subject or fixture to another.*

The labels on all reports correspond to the direction of the motion. When testing non-reciprocally, it is very important to label the contraction type correctly when completing the demographics section, (i.e. Test reports state direction 1 first and then direction 2.). Direction 1 correlates to extension and 2 correlates to flexion. If the clinician calls the contraction eccentric/concentric as when testing hamstrings eccentrically, direction 1 will report eccentric flexors (subject resists the extension motion) and direction 2 will report concentric flexors (subject assists the flexion motion).

When using the Passive mode to perform eccentric contractions, it is important that the clinician keep in mind which musculature is involved. When the subject is moving in direction 1 (extension), he/she is eccentrically using the knee flexors. When moving in direction 2 (flexion) the subject is eccentrically using his/her extensors. The reports generated will be labeled extension and flexion. The clinician may want to note under the extension heading “eccentric flexors” and under the flexion heading “eccentric extensors”, especially if the report is to be sent to another clinician or physician.

Clinical Applications:

1. *The Passive mode is frequently used post-operatively for the benefits of continuous passive motion.*
2. *The Passive mode may be used isokinetically in the agonistic direction and then passively in the antagonistic direction or vice versa.*
3. *The Passive mode may be used to exercise or test isokinetically.*

-
4. *If the subject cannot meet the speed, he/she will be passively moved through this portion of the range.*
 5. *The Passive mode may be used for passive stretching. When this is performed, the torque limits in each direction should be set low. If the subject feels uncomfortable, he or she may resist the motion and the unit will stop, e.g., if the clinician is trying to increase flexion the subject will be passively flexed. If at any time the subject is uncomfortable, he/she may resist the flexion movement eccentrically and exceed the torque LIMIT SET (direction 1 limit). This will stop the unit.*

Testing and Exercise in the Eccentric Mode

In this mode, the powerhead responds to torque input by rotating the shaft in an opposing direction at a constant velocity. This “reactive” torque output by the machine causes lengthening of muscle under tension (eccentric exercise). Eccentric mode is selected after the subject has been positioned and stabilized in the Setup mode.

In Eccentric mode, the TORQUE LIMIT adjustment dials are used to specify a range of desired human force output (see TORQUE LIMITS). To initiate shaft motion, the subject is required to exceed a minimum torque threshold corresponding to 10% of the TORQUE LIMIT dial setting. If the subject exceeds the torque limit value selected for either direction of motion, the shaft stops rotating until the subject’s force output is reduced to within the desired range. The subject is therefore required to exceed a specified torque value to achieve motion, and keep torque output below another specified level to continue movement.

When a range of motion limit is reached, the machine stops and waits for human force input (reactive eccentrics) in a direction and level appropriate to continued exercise.

Eccentric Mode (General Instructions)

1. Check range of motion limits.
2. Place MODE dial in Eccentric position. (This creates a “STOP” condition.)
3. Select speed desired during eccentric movements using ECCENTRIC SPEED dial.

-
-
4. Select Direction #1 and Direction #2 torque limits using TORQUE LIMIT #1 and #2 dials. When 10% of the preset torque limit is being applied by the subject, eccentric motion will occur. Eccentric motion will stop when applied torque is removed or rises above the set amount.

NOTE: LIMIT SET dials correspond to the direction of eccentric force production, not direction of motion. Therefore, to set a torque limit for an eccentric contraction during the knee extension (direction 1), the lower (#2) torque LIMIT SET dial must be used.

5. Explain use of hand-held and powerhead COMFORT STOPs to subject.
6. Press the START button. Ask the subject to apply opposing concentric force against the pad or strap. When 10% of the preset torque limit is reached, the load arm will move in an opposite direction of the torque produced. The load arm will not move unless 10% of the proper torque value is continuously applied. This safety feature allows the clinician to control the dynamic parameters of the exercise or test.

NOTE: Always be sure the controller settings are correct before engaging this device with the START button. Set range of motion limits AFTER placing subject into restraints. Have subject move through ROM prior to starting test or exercise. Always re-set range of motion limits or press STANDBY when proceeding from one joint, subject, or fixture to another.

NOTE: At low torque limit settings, the weight of the limb alone may be sufficient to initiate movement through part of the range. The subject then needs to actively exert force to complete the range.

Clinical Applications:

1. The Eccentric mode may be used to perform submaximal or maximal eccentrics.
2. The Eccentric mode may be used to work on proprioception. When torque limits are set, the subject must exert at least one-tenth of the torque limit to keep the shaft moving. If the subject exceeds the limits, the unit will stop.
3. Eccentric contractions performed in the Eccentric mode are termed reactive eccentrics since the subject must input force in order to initiate and maintain movement of the unit.
4. At higher velocities the stretch reflex is more active than at lower velocities. Greater eccentric tension develops at higher velocities before leveling off. This, of course, is subject dependent.

Testing and Exercise in the Isokinetic Mode

In this mode, the powerhead acts to control velocity, allowing the subject to accelerate up to, but no higher than, the maximum speed value selected for each direction of shaft rotation (accommodating resistance). The subject may freely decelerate or change direction of movement at any point within the range of motion. Isokinetic mode is selected after the subject has been positioned and stabilized in the Setup mode.

Because the shaft moves only in the direction of subject applied force, this mode provides concentric muscle loading in both directions of movement.

Isokinetic Mode (General Instructions)

1. Check range of motion limits.
2. Place MODE dial in Isokinetic position. (This creates a “STOP” condition.)
3. Select desired speeds for Direction #1 and #2. Note that different speeds can be chosen for each direction of motion.
4. Set desired CUSHION.
5. Explain use of both the hand-held and powerhead COMFORT STOP buttons to subject.
6. Press the START button. No resistance will be presented to the subject enabling the load arm to move freely. As the subject achieves the pre-selected speeds, the resistance met will equal his/her force output. If the subject movement stops, resistance stops. As the subject produces less force or more force the equivalent opposing resistance is experienced.

NOTE: Always be sure the controller settings are correct before engaging this device with the START button. Set range of motion limits AFTER placing subject into restraints. Have subject move through ROM prior to starting test or exercise. Always reset range of motion limits or press STANDBY when proceeding from one joint, subject, or fixture to another.

Clinical Applications:

1. The Isokinetic mode may be used at higher speeds in order to simulate functional or sports activities.

-
-
2. *The Isokinetic mode may be used with differing bi-directional velocities to simulate functional activities or place the focus of the activity on one specific muscle group.*
 3. *There is a 15-degree physiologic overflow in strength with a limited range of motion strengthening program performed isokinetically (Halbach, 1985).*

Testing and Exercise In the Isometric Mode

In this mode, the powerhead maintains zero velocity at any selected point in the range of motion. Significant change in joint angle and overall muscle length is thereby prevented.

Isometric Mode (General Instructions)

1. Check range of motion limits.
2. Press the START button.
3. Hold down the LIMIT SET #1 or #2 button as required to move to desired position.
4. When limb reaches desired joint angle, release the LIMIT SET button.
5. Explain use of both the hand-held and Powerhead COMFORT STOP buttons to subject.
6. To move to another position, hold down the LIMIT SET button for the desired direction of the new limb position and release after limb has reached new joint angle.

NOTE: *Always be sure the Controller settings are correct before engaging this device with the START button. Set range of motion limits AFTER placing subject into restraints. Have subject move through ROM prior to starting test or exercise. Always reset range of motion limits or press STANDBY when proceeding from one joint, subject, or fixture to another.*

Clinical Applications:

1. *The Isometric mode may be used pre or post surgery with discretion.*
2. *The Isometric mode may be used near a painful range for strength carryover into the painful range. Overflow has been found to be plus or minus 10 degrees.*

-
3. *Isometric holds can be checked for quality of contraction. Monitoring these can help set goals and monitor progress.*

CLINICAL CONSIDERATIONS FOR JOINT TESTING AND EXERCISE

BIODEX Recommendations For Proper Testing Technique

1. Calibrate your system at least twice a month. If you are going to use your data in court or for research, calibrate and verify before a test is performed. The calibration and calibration verification procedures are presented in the *BIODEX Advantage Software Manual*.
2. Be consistent in warm-up procedures, commands and setups. In the scaling procedure, be consistent with instructions (e.g., decide whether the subject will perform all maximal repetitions or perform submaximal reps with one last maximal rep.).
3. Be sure to familiarize the subject with the equipment before testing to eliminate a learning curve.
4. Use proper stabilization techniques, making every attempt to restrict motion to the area of interest. Body parts on either side of the joint(s) being rehabilitated or tested should be firmly secured. Studies have reported significant differences in data generated with and without stabilization. Uncontrolled movement leads to testing errors. If you add or remove stabilization devices, document it.
5. Axis alignment of the powerhead shaft with the subject's axis of rotation is crucial to ensure that during testing and rehabilitation the pattern performed is consistent with the proper tracking of the joint. Correct alignment also helps eliminate stressful loading of the joint and recruitment of other muscle groups.
6. Use standardized setups. If you use an unconventional setup, document it.
7. Make sure to give the correct anatomical reference angle. The internal goniometer of the unit is based on this reference angle.
8. Cue the subject to begin a test at the same time you press the space key on the keyboard.
9. If normative data is used, make sure to follow the protocol used to obtain the normative data (i.e., ROM, CUSHION, reps, speed, setup, stabilization).
10. Consider collecting normative data for specific populations. The more closely the subject fits the population profile, the more applicable the normative data will be.

-
11. Document clearly and concisely so that another clinician would be able to repeat the same test.
 12. Use the same order consistently for reporting the index numbers of all moveable indexed parts. If these numbers need to be changed for any reason, make sure to record the changes.
 13. Develop standard testing protocols so that bodies of normative data may be collected nationwide.

Physiological Considerations

Passive Mode

1. Passive motion may be used to warm-up and cool-down a subject, stretching ROM, and to perform contract/relax protocols. Used during rest periods, passive motion can help prevent muscles from “tightening up” before the next set of repetitions.
2. By instructing the subject to move the limb at a speed that will keep the green FORCE INDICATOR ON and the red FORCE INDICATORS OFF, the Passive mode can be used to provide biofeedback and stimulate proprioceptors.
3. In the case of poor muscle strength, passive mode allows for active assistive motion which will initiate or continue motion of the subject.

Eccentric Mode

1. It is possible to generate 30-40% more force eccentrically than concentrically. (Set the torque limits appropriately.) In that the stimulus for strength gain is contraction intensity, it is suggested by some research that eccentric contractions will result in significant strength gains. (Knuttgen, H.G., et. al., 1971; Komi, P.V., 1972).
2. There is patient specific eccentric speed above which muscular force will not increase. (Knuttgen, H.G., et. al.:1972).
3. Eccentric contraction involves a “training” of the non-contractal elements of muscle so that the muscle “learns” to function in a higher force environment. (Komi, P.V.,1972).

Isokinetic Mode

1. Exercising at a specific speed has shown strength gains which overflow to both faster and slower speeds. The exact amount of such physiological

overflow is still debatable. However there is enough research to demonstrate that by exercising at every 30 degrees/second, physiological overflow will occur with regards to specific strengthening at each speed exercised. (Davies, G.J., 1987.)

2. In the Isokinetic mode the FORCE-VELOCITY relationship of muscle dictates that as speed of contraction increases the muscular tension (and therefore torque) decreases. (Davies, G.J., 1987.)
3. Exercising at as many speeds as possible can help alleviate the debate over specificity of speed of exercise, which pertains to strength gains specific to the speed exercised. A velocity spectrum is recommended which will start the subject at either a high or low speed, depending on the pathology and status of the subject, and progress to other speeds. Varying the number of repetitions (i.e., less reps at slow speeds, more reps at high speeds), will help keep the work performed consistent over the range of the velocity spectrum.
4. Exercising submaximally has shown excellent benefits for endurance gains. This will limit compression on joints, tension developed in the muscles and tendons, and generally allows the subject to do larger numbers of sets or repetitions, which transfers to daily activities.

Isometric Mode

1. The Isometric mode can be used very effectively to initiate contractions submaximally. Make sure to stabilize other body parts that can be used for compensation. Relaxation can sometimes be assisted by the application of heat, cold, or biofeedback.
2. Isometric holds can be checked for quality of contraction. Monitoring these can help set goals and monitor progress.

Range of Motion

1. As the available range of motion decreases for a particular joint, as in short arc exercise, the speed of movement should decrease also. Limited range of motion will not always provide sufficient time for the joint to reach high speeds.
2. Joints that have a greater range of motion, such as shoulders, can generally achieve higher speeds of exercise. Conversely, joints that have less range of motion, such as ankles, cannot produce the higher speeds.

Rehabilitation Considerations

1. Electrical stimulation may be used in conjunction with any of the test or exercise modes on the Biodex.
2. Keep in mind the stretch shortening cycle. It has been found that an eccentric contraction performed before a concentric contraction results in a more forceful concentric contraction than a concentric contraction performed alone. (Duncan, P., et. al., 1989)
3. Immediately post exercise, some subjects exhibit joint effusion. Application of ice while moving passively at 20 degrees per second has been reported to reduce post exercise swelling and discomfort.
4. To aid in the reduction of lactic acid accumulated in the muscle, a rest time of 90 seconds has been recommended (Ariki, 1985) between exercise bouts. Clinical time frames and other considerations may alter this.
5. In doing a velocity spectrum exercise protocol, 3 minutes has been recommended (Ariki, 1985) between velocity spectrum sets.
6. Consider ending a rehabilitation set by work or time, especially if the goal is to improve endurance.
7. Giving a subject copies of their rehabilitation reports can help with motivation.
8. In eccentric exercise, the force increases as the velocity of contraction increases (up to a certain point) which is in contrast to concentric exercise in which the force decreases as the speed of contraction increases. (Davies, G.J., 1987.)
9. It has been suggested that eccentric exercise produces that greatest force in the least amount of time (Komi & Cavanaugh, 1977).
10. Eccentric contractions enhance muscle force production and are less costly metabolically than concentric contractions (Bosco & Komi, 1979, Asmussen, 1953).
11. Submaximal exercise prevents neural dissociation, promotes articular cartilage nourishment and proprioception, and retards muscular atrophy.
12. Exercise at high angular velocities causes smooth gliding surfaces to be quickly brought together resulting in less compressive forces.

-
13. Eccentric rehabilitation is usually performed no more than two times a week secondary to delayed onset muscle soreness.
 14. Delayed Onset Muscle Soreness (DOMS effect) is not usually apparent until two days after treatment. Work submaximally to minimize and develop protocols accordingly.
 15. Very often clinicians use the following progression during the rehabilitation process: Passive mode, isometrics, multi-angle isometrics, sub-maximal eccentrics, concentric isokinetics.
 16. Contract/relax may be performed in the Passive mode. Range of motion limits are selected to include the entire range the subject should be able to achieve that day. It is recommended that the LIMIT SET buttons are set *no more* than five degrees outside of the beginning range. PERCENT RANGE dials are then decreased to an appropriate level so that the entire range is comfortable. The subject is placed on the unit with the comfort stop in hand. As the subject is passively moved in one direction, he/she exerts force in the opposite direction. The torque limit in the opposing direction must be set low enough so that the subject exceeds the limit and performs an isometric contraction. At this time, the clinician slightly increases the range of motion using the PERCENT RANGE dial in the appropriate direction. The procedure is repeated for as many cycles as desired.

(e.g.: A subject has limited knee extension and greater range is desired. The controller is set in the Passive mode. LIMIT SET buttons are set five degrees greater than the present range of motion. The PERCENT RANGE dials are then turned down so that the range is appropriate for the subject's present limits. The subject is given the hand-held COMFORT STOP. The subject begins the movement into extension (direction 1). The direction 2 torque limit has been turned down to 20 ft-lbs. Near the end of the range of extension, the subject flexes (exerts a force greater than 20 ft-lbs in direction 2) for 5 seconds. The clinician turns up the PERCENT RANGE dial slightly in direction 1. The subject relaxes and is carried into extension. The PAUSE dial may be set between 1 and 4 seconds for a brief stretch. If the subject is uncomfortable at any point in time, the comfort stop should be pressed and the Controller turned to "Setup" to free the input arm.)

17. When crepitus is present, try using a stethoscope to determine in what range you hear the crepitus. Use the PERCENT RANGE dials to decrease the range and limit it to areas where there is no crepitus.

-
18. The BIODEX System 2 is a very versatile piece of equipment, making it difficult to document every possible setup position. If a non-documented position is used, document it. If it becomes a position that is used often, send the information to Biodex.

SETUP AND POSITIONING

The following section details BIODEX System 2 setup and positioning for each of the standard test and exercise patterns. Included is information on mechanical and anatomical aspects for both single and double chair configurations. Please note that positioning and stabilization of the subject is always accomplished while in the Setup mode. For specific information on the Setup mode, see “OPERATION: The Setup Mode.”

It is suggested that clinicians who are not familiar with the BIODEX System read the preceding chapters and practice each setup with a healthy subject before attempting to position any person for actual testing or exercise.

While the following setups are standard, it should be noted that other positioning setups are possible. The BIODEX System 2 is extremely versatile and can accommodate to many test and rehabilitation needs. If you find a new setup to be especially useful in your practice, be sure to document it and pass the information along so it can be included in future updates of this manual.

REMINDER: *Each of the following setups assumes that the clinician will be starting with the BIODEX System 2 in it's respective neutral position. For an illustration of the neutral position for single and double chair configurations, refer to the Introduction Section, pages 4 and 5.*

Knee: Extension/Flexion (Double Chair)



Figure 4.1

Quick Reference

Powerhead Orientation:	0°
Powerhead Tilt:	0°
Seatback Tilt:	15°
Sensitivity:	C
Hip Flexion:	85°
Axis of Rotation:	Compromise axis is a line drawn through the femoral condyles on a sagittal plane.
Ready Position:	Full Flexion

Parts Needed

Powerhead:	Knee Attachment (left or right)
Accessory Chair:	Not used for this pattern.

Knee: Extension/Flexion (Single Chair)

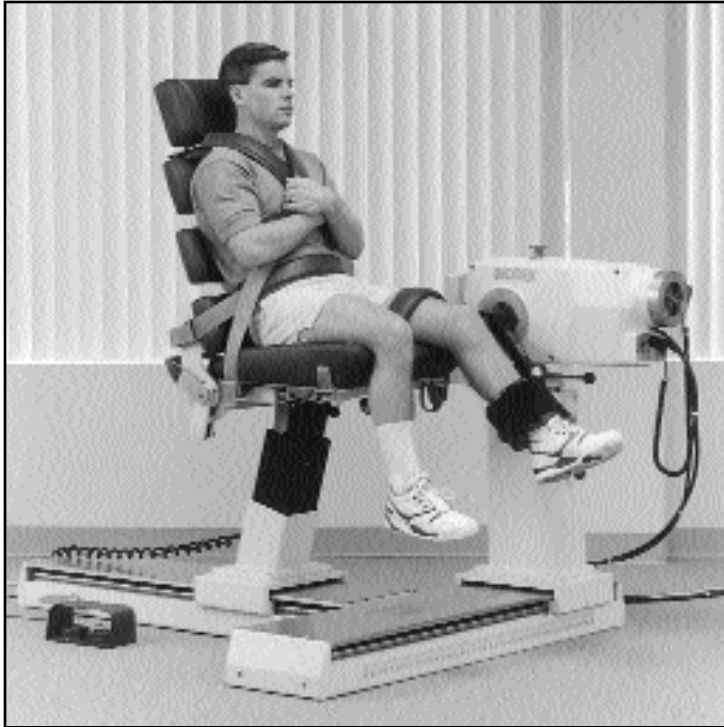


Figure 4.2

Quick Reference

Powerhead Orientation:	0°
Powerhead Tilt:	0°
Seat Orientation:	0°
Seatback Tilt:	15°
Sensitivity:	C
Hip Flexion:	85°
Axis of Rotation:	Compromise axis is a line drawn through the femoral condyles on a sagittal plane.
Ready Position:	Full Flexion

Parts Needed

Powerhead:	Knee Attachment (left or right)
Positioning Chair:	No additional parts required.

Knee: Extension/Flexion

Because of multiple factors such as stability through mostly ligamentous and muscular support, the bearing of high forces, and the fact that it is located between the body's two longest lever arms, the knee is one of the most commonly injured joints in the body. The knee is also the most commonly tested and rehabilitated joint on the BIODEx System.



Figure 4.3



Figure 4.4

Setup and Positioning

1. Affix KNEE ATTACHMENT (Figure 4.3) to powerhead shaft so that shaft and fixture red dots align. Secure with locking knob. Press STOP, press START. With attachment arm in the vertical position adjust balance. If the balance is correctly adjusted, there will be no bias in either direction.
2. Seat subject on chair and align knee axis of rotation with powerhead shaft.

Because the knee has 6° of freedom occurring around three axes, there is no single fixed joint axis. The best compromise axis for exercise and testing is a line drawn in the sagittal plane through the femoral condyles (Figure 4.4).

3. Adjust KNEE ATTACHMENT length so that calf pad placement is proximal to the malleoli and below the prominent calf musculature. The

pad should not impede dorsiflexion of the ankle. The pad may be placed in different positions for treatment of certain pathologies or to improve subject comfort. Be sure to use the same pad placement for the same subject when testing. Firmly secure limb to attachment with padded shin strap. Strap should be tight, but should cause no discomfort.

4. Stabilize subject with thigh strap, pelvic strap, and shoulder straps. Instruct subject to cross arms over chest to minimize involvement of upper body musculature.
5. Place REMOTE COMFORT STOP in subject's hand. Explain the purpose for the COMFORT STOP.
6. Set range of motion limits. Move limb through range of motion to check for proper alignment and subject comfort. Make sure straps do not impede range of motion. Readjust ROM Limit if necessary.
7. Select mode and proceed as required by test/therapy protocol.

Ready Position:
Full Flexion

Knee: Extension/Flexion with Alternate Attachments (for both Single and Double Chair Systems)

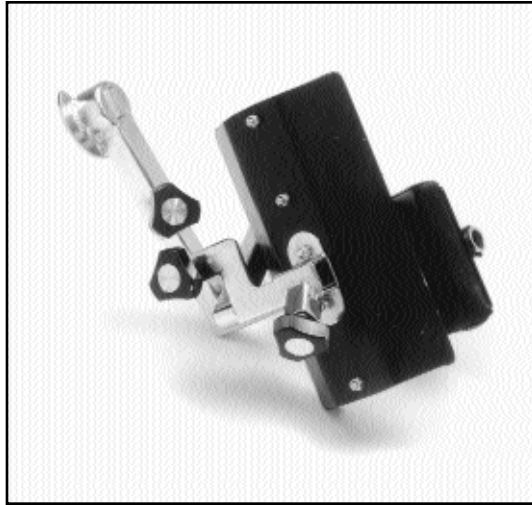


Figure 4.5

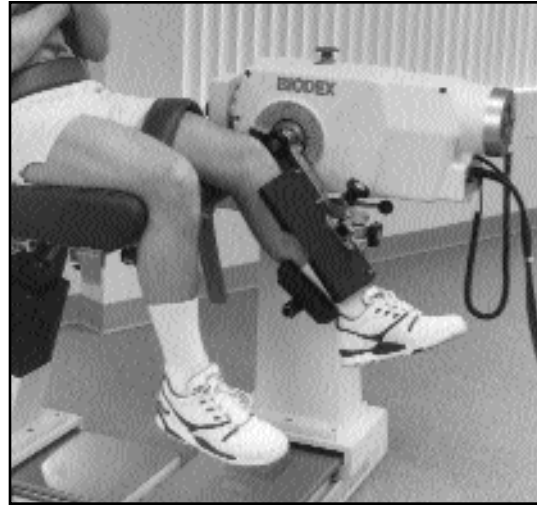


Figure 4.6



Optional Sheer Reduction Attachment

Figure 4.7
Optional Anti-Compression Attachment

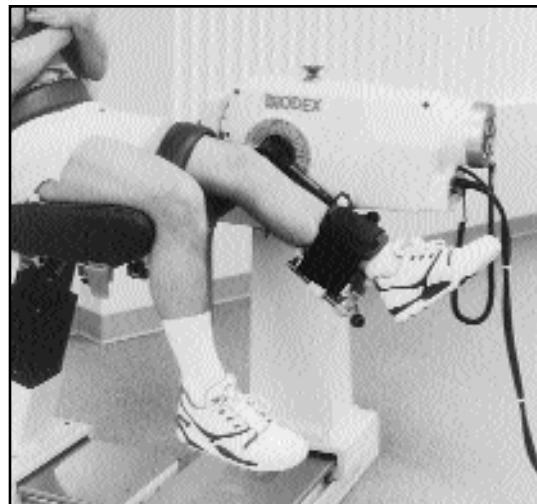


Figure 4.8

Clinical Applications of Biodex Operating Modes:

Passive Mode

1. The passive mode is frequently used post-operatively, especially with anterior cruciate ligament repairs, abrasion arthroplasties, and total knee replacements, for the benefits of continuous passive motion.
2. The passive mode may be used to passively move the limb in one direction and concentrically assist or eccentrically resist in the other direction (i.e., in early rehab for ACL reconstructions, the limb may be moved passively through partial range extension. The subject may then assist or resist flexion with voluntary effort).
3. The passive mode may be used for active-assisted exercise (i.e., a subject status post medial meniscectomy may be moved passively through a range where voluntary effort cannot be exerted and may assist in the parts of the range where able).
4. The passive mode may be used to do eccentric/concentric or concentric/eccentric contractions. After an ACL reconstruction, the hamstrings may be worked concentrically and eccentrically through limited range and then through the full range. At end stage rehab, the quadriceps may be worked at the end of the range, both concentrically and eccentrically, to decrease an extensor lag.

Eccentric Mode

1. The eccentric mode may be used maximally or submaximally to replicate functional activities. The role of submaximal eccentrics has been greatly overlooked. With ACL reconstructions, the hamstrings may be worked through full range eccentrically with submaximal effort.
2. Specific areas of weakness in a range of motion such as quadriceps extensor lag may be worked eccentrically at the last 30° of extension with submaximal effort.
3. Submaximal eccentrics may be used to protect injured or grafted structures (i.e., post-operatively, subjects may exercise in the eccentric mode with the torque limits set very low. If the subject were to exceed the set torque limit, the input shaft would stop).

Isokinetic Mode

1. The isokinetic mode may be used at high speeds to simulate functional or athletic activities.

-
-
2. The isokinetic mode may be used for bi-directional velocities (i.e., during early ACL reconstruction rehabilitation, the hamstrings may be worked at low speeds and the quadriceps at high speeds. At end stage rehab, the quads may be worked at low speeds and the hamstrings at high speeds).

Isometric Mode

1. The isometric mode may be used with pre- or post-operative subjects or when pain is a factor. Multi-angle isometrics are recommended.

Additional Comments

1. The pause may be used for passive stretching or to perform contract/relax for the facilitation of motion. This is especially important after a total knee replacement when early motion is crucial. The pause may also be used when working in the passive mode to do eccentric or non-reciprocal contractions.
2. All modes may be used in combination with electrical stimulation.
3. With dynamic anterior cruciate rehabilitation, pay attention to the shin pad placement. Research has shown that while working the quadriceps group, less stress is placed on the ACL when the pad is placed in the proximal position. For hamstring work, place the pad in a more distal position. Isometrically, an unpublished study by Kevin Wilk, P.T. (Birmingham, AL) showed that the opposite pad placement is appropriate.
4. Subjects may be worked through only a partial range using the electronic stops and percent range dials. This is especially important when dealing with fragile surgeries post-operatively.
5. When treating the knee, total leg strength should be considered, especially the strength of hip abductors and adductors.
6. It has been found that most ACL injuries occur during deceleration. Eccentric exercise is an important part of the rehabilitation process.
7. Because a subject is proximally stabilized, very little substitution will occur. Proximal stabilization lends itself to joint isolation.
8. The clinician may consider rehabilitating the hamstrings with the subject bent forward so that the pelvis is rotated anteriorly and the hamstrings are worked through additional range. Documenting any deviations from standard positions is essential.

-
-
9. The seatback of the positioning chair may be adjusted to accommodate any hip angle the clinician finds appropriate.

Notes:

Knee: Tibial Internal/External Rotation (Double Chair)



Figure 4.9

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	180° (Accessory Chair)
Seatback Tilt:	15° (Accessory Chair)
Footplate Tilt:	0°
Sensitivity:	E
Ankle Flexion:	0°
Knee Flexion:	60°
Hip Flexion:	45°
Axis of Rotation:	Longitudinal axis of the tibia, slightly medial to the bone's actual center line.
Ready Position:	Full Internal Rotation

Parts Needed

Powerhead:	Footplate Attachment
Accessory Chair:	Short T-Bar Adapter, Multi-Support Pad, Footrest (optional)

Knee: Tibial Internal/External Rotation (Single Chair)

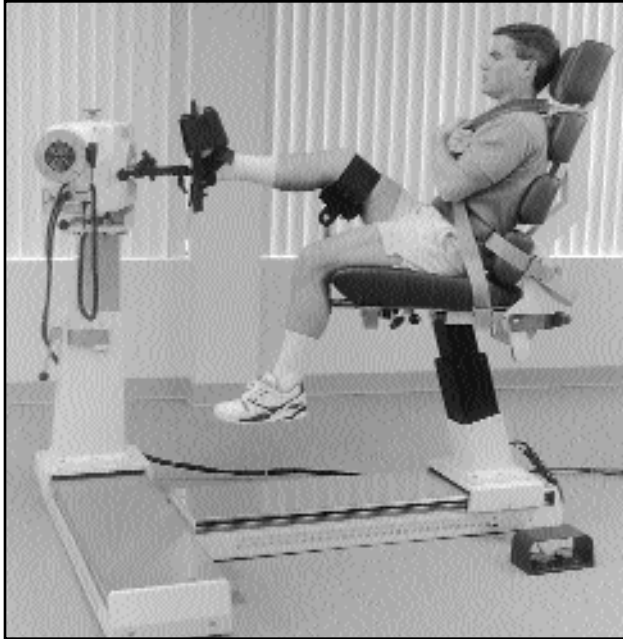


Figure 4.10

Quick Reference

Powerhead Orientation:	45°
Powerhead Tilt:	0°
Seat Orientation:	45°
Seatback Tilt:	15°
Footplate Tilt:	0°
Footplate Color Code:	Blue dot to red dot.
Sensitivity:	E
Ankle Flexion:	0°
Knee Flexion:	60°
Hip Flexion:	45°
Axis of Rotation:	Longitudinal axis of the tibia, slightly medial to the bone's actual center line.
Ready Position:	Full Internal Rotation

Parts Needed

Powerhead:	Footplate Attachment
Positioning Chair:	T-Bar Adapters (short and medium), Multi-Support Pad, Footrest (optional)

Knee: Tibial Internal/External Rotation

Anterior cruciate ligament injuries are some of the most involved injuries that occur at the knee. Rehabilitation of the ACL deficient knee or ACL intra-articular or extra-articular repairs, is a delicate process that involves great skill on the part of the clinician and a versatile, sophisticated piece of isokinetic equipment. Tibial internal/external rotation is an integral part of ACL rehabilitation.



Figure 4.11

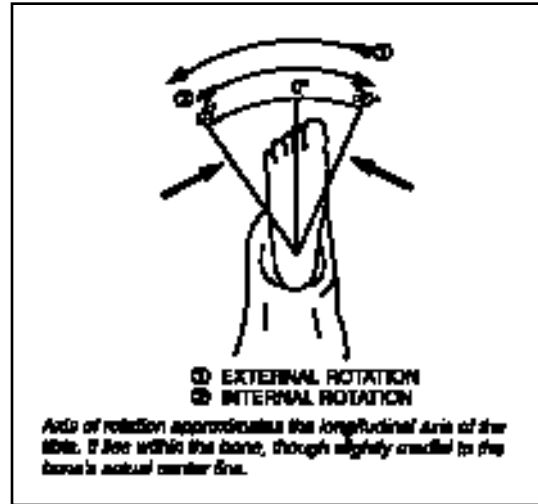


Figure 4.12

Setup and Positioning

1. Prepare the FOOTPLATE for this pattern by aligning all the blue color code dots.
2. Affix FOOTPLATE ATTACHMENT to powerhead shaft so that shaft and attachment red dots align at 90° on the powerhead scale. Secure with locking knob. The FOOTPLATE should be positioned perpendicular to the floor (heelcup at bottom) with 0° tilt.
3. Seat subject on positioning or accessory chair and roughly align powerhead with knee to be tested. Place the subject's foot in the footplate so that powerhead shaft axis aligns with the longitudinal axis of the tibia (Figure 4.12).
4. Adjust heel support on the footplate to maintain proper vertical position of foot. To do this, squeeze the HEEL SUPPORT BUTTONS together and

slide the support to the desired position. Release the buttons to lock the support in place.

5. Install the MULTI-SUPPORT PAD as shown in Figures 4.13 and 4.14. The pad should be positioned under subject's thigh, proximal to the knee as shown in Figure 4.10. Loosen the MULTI-SUPPORT PAD ADJUST LEVER and tilt the padded end of the multi-support to an approximate 60° angle for support of thigh and tibia. Tighten the lever to lock the pad in position. Secure the MULTI-SUPPORT STRAP. Install FOOTREST if desired.

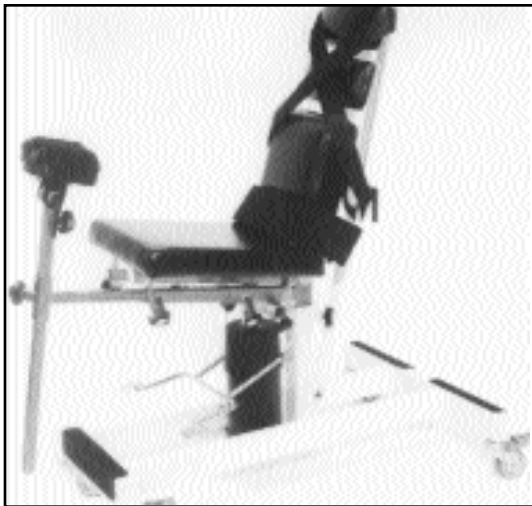


Figure 4.13 Multi-Support Pad placement (Double Chair).



Figure 4.14 Multi-Support Pad placement (Single Chair).

6. Place Remote Comfort Stop in subject's hand. Explain the purpose of the COMFORT STOP.
7. Stabilize subject with shoulder and pelvic straps.
8. Set range of motion limits by depressing and releasing the red limit set buttons at the appropriate point in the ROM. It does not matter which direction is set first. Move subject through desired range of motion to check for proper alignment and subject comfort. Readjust ROM limits if necessary.
9. Select mode and proceed as required by test/therapy protocol.

Ready Position:
Full Internal Rotation

Clinical Applications of Biodex Operating Modes:

Passive Mode

1. After ACL surgery, subjects may be started on limited range, passive, tibial internal/external rotation. One direction may be stressed depending on whether there is an associated antero-medial, postero-lateral or antero-lateral rotary instability. The passive mode may also help the subject understand the motion.
2. The passive mode may be used for non-reciprocal contraction types. In this way the focus may be placed on either the internal or external tibial rotators (i.e., with an antero-medial or postero-lateral instability, the subject may internally rotate concentrically and then resist the equipment while moving into external rotation. This will strengthen the popliteus, semitendinosus and semimembranosus, both concentrically and eccentrically. The subject may do just the opposite to strengthen the biceps femoris with an antero-lateral instability).

Eccentric Mode

1. Submaximal eccentrics may be used in the early stages of ACL reconstruction (i.e., the torque limits may be set very low in directions 1 and 2. If the subject exceeds these limits while rotating in either direction, the input arm will stop. This will protect the structure from sustaining high loads).

Isokinetic Mode

1. The clinician may use the isokinetic mode in a limited range of motion (i.e., if there is an associated antero-lateral rotary instability, the subject may be worked from a neutral position to an externally rotated position to strengthen the biceps femoris. The electronic stops may be used to limit the range. If there is an antero-medial or postero-lateral rotary instability, the opposite procedure may be used).
2. The isokinetic mode may be used at bi-directional velocities (i.e., to stress internal rotation of the tibia, set the direction of internal rotation at a low speed and external rotation at a high speed).

Isometric Mode

1. Isometrics may be used at multiple angles to protect delicate graft structures in either internal or external rotation.

Additional Comments

1. The pause may be used in the passive mode to isometrically contract either the tibial internal or external rotators at the end of the range.

-
2. The pause may be used in the passive mode to give the clinician time to instruct the subject on the contraction type to next be performed (isometric, eccentric, or concentric).

Notes:

Ankle: Plantar/Dorsiflexion (Seated) (Double Chair)

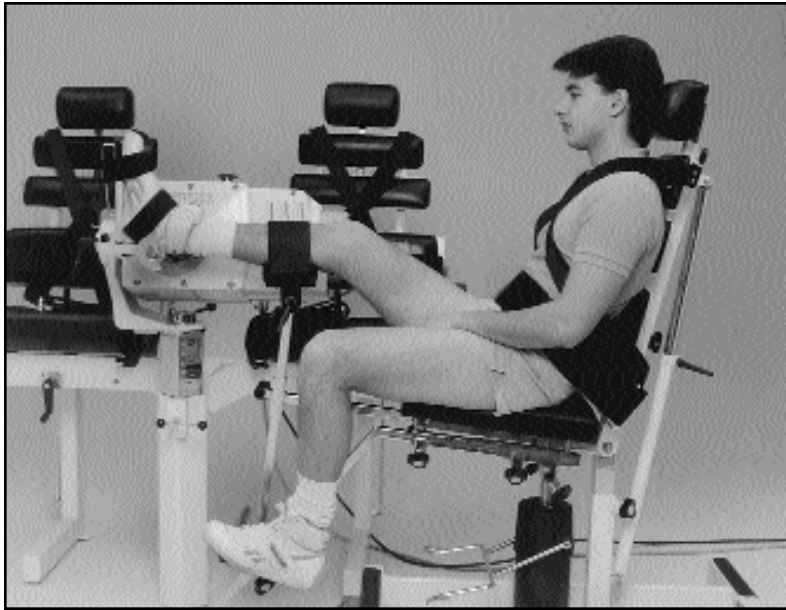


Figure 4.15

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	16°
Seat Orientation:	90° (Accessory Chair)
Seatback Tilt:	15° (Accessory Chair)
Sensitivity:	E
Ankle Flexion:	0°
Knee Flexion:	30°
Hip Flexion:	60°
Axis of Rotation:	In neutral position, axis passes through the body of talus, fibular malleous, and through or just below the tibial malleous.
Ready Position:	Full Plantarflexion

Parts Needed

Powerhead:	Footplate Attachment
Accessory Chair:	T-Bar Adapter, Multi-Support Pad, Footrest (optional)

Ankle: Plantar/Dorsiflexion (Seated) (Single Chair)

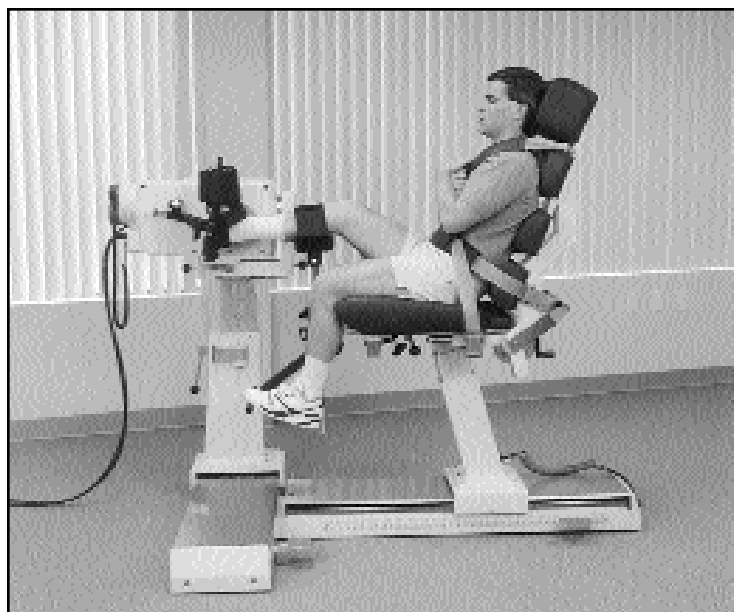


Figure 4.16

Quick Reference

Powerhead Orientation:	0°
Powerhead Tilt:	0°
Seat Orientation:	0°
Seatback Tilt:	15°
Footplate Tilt:	0°
Footplate Color Code:	White dot to red dot
Sensitivity:	E
Ankle Flexion:	0°
Knee Flexion:	30°
Hip Flexion:	60°
Axis of Rotation:	In neutral position, axis passes through the body of talus, fibular malleous, and through or just below the tibial malleous.
Ready Position:	Full Plantarflexion

Parts Needed

Powerhead:	Footplate Attachment
Positioning Chair:	T-Bar Adapters (short and medium), Multi-Support Pad, Footrest (optional)

Ankle: Dorsiflexion/Plantarflexion (Seated)

The ankle joint or talocrural joint is really three joints (tibiotalar, fibulotalar, and tibiofibular) formed by the superior portion of the body of the talus fitting within the cavity created by the combined distal ends of the tibia and fibula. The subtalar joint is the articulation between the talus and calcaneus.

Motions at the ankle are rarely true single plane motions. This holds for dorsiflexion/plantarflexion, which usually occurs in conjunction with other movements.



Figure 4.17

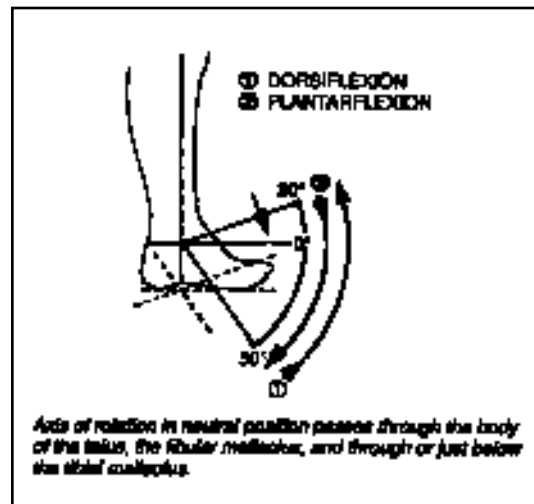


Figure 4.18

Setup and Positioning

1. Prepare the FOOTPLATE for this pattern by aligning the white color code dot to the red dot.
2. Affix FOOTPLATE to powerhead shaft so that shaft and fixture red dots align. Secure with locking knob. The FOOTPLATE should be positioned perpendicular to the floor (heelcup at bottom) with 0° of FOOTPLATE tilt so that the footrest faces the positioning or accessory chair. See Figures 4.15 and 4.16.
3. Seat subject on positioning or accessory chair and instruct subject to rest foot on footplate with leg extended. With sole of subject's foot flat against FOOTPLATE, adjust powerhead height and chair position to obtain

desired knee and hip flexion. Adjust FOOTPLATE to ensure ankle axis aligns with input shaft. Axis of rotation in neutral position passes through the body of the talus, the fibular malleolus, and through or just below the tibial malleolus.

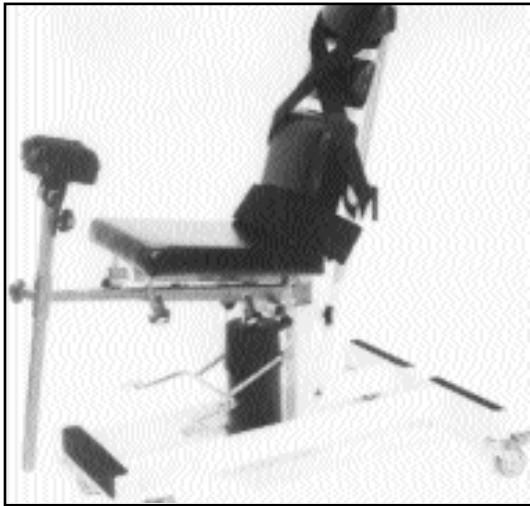


Figure 4.19 Multi-Support Pad placement (Double Chair).



Figure 4.20 Multi-Support Pad placement (Single Chair).

4. Install MULTI-SUPPORT PAD as shown in Figures 4.19 and 4.20. Loosen the MULTI-SUPPORT PAD ADJUST LEVER and tilt the pad so that it will support the tibia in a horizontal position, see Figures 4.15 and 4.16. Tighten the lever to lock the pad in place. The pad should be positioned under calf (distal to knee) to support limb in a horizontal position with desired degree of hip and knee flexion. Secure the MULTI-SUPPORT STRAP. Install FOOTREST if desired.

***NOTE:** Because the origin of insertion of the gastrocnemius is above the knee, the extent of ankle dorsiflexion will generally increase with increased knee flexion and decrease with knee extension. Positioning should be recorded for valid comparisons and reproducibility. Suggested knee flexion is 30°, hip flexion is 60°. Record these angles for valid comparisons and reproducibility.*

5. Adjust heel support on the footplate to maintain proper vertical position of foot. To do this, squeeze the HEEL SUPPORT BUTTONS together and slide the support to the desired position. Release the buttons to lock the support in place. Secure foot straps.
6. Stabilize subject with shoulder straps, pelvic strap, and multi-support

strap. Do not secure the MULTI-SUPPORT STRAP so tightly as to inhibit motion.

7. Place REMOTE COMFORT STOP in subject's hand. Explain the purpose of the COMFORT STOP.
8. Set range of motion limits. Depress and release the red ROM Limit Set buttons when the range of motion is appropriate in each direction. It does not matter whether direction 1 or 2 is set first. Move subject through desired range to check for proper positioning and comfort. Reset range limits if necessary.
9. Select mode and proceed as required by test/therapy protocol.

Ready Position:

Full plantarflexion

Clinical Applications of Biodex Operating Modes:

Passive Mode

1. The passive mode may be used after a period of immobilization for the for the benefits of continuous passive motion.
2. The passive mode may be used to perform non-reciprocal contractions (e.g., many times the plantarflexors are considered to be the more essential muscle group to be rehabilitated after injury. The plantar-flexors may be worked both concentrically and eccentrically in the passive mode.

Eccentric Mode

1. The eccentric mode may be used to strengthen the musculotendinous junction. Many times injuries occur at the ankle secondary to eccentric loading to failure. It may be especially important to rehab athletes in the eccentric mode.

Isokinetic Mode

1. The isokinetic mode may be used at bi-directional velocities. This is especially important at the ankle complex where the muscular strength is so unbalanced. Many clinicians work the plantarflexors at lower speeds and the dorsiflexors at higher speeds.

Isometric Mode

1. Multi-angle isometrics may be used pre- and post-operatively or after periods of immobilization.

Additional Comments

1. The ankle is known to be unstable in the plantarflexed position which is an important fact to keep in mind when dealing with athletes.
2. It has been stated that peroneal and dorsiflexor strengthening may help in resisting an inversion/plantarflexion injury.
3. The gait cycle may be simulated by using the passive mode in this sequence:
 - a. Subject works eccentrically and resists plantarflexion (heelstrike).
 - b. Subject works eccentrically and resists dorsiflexion (footflat).
 - c. Subject concentrically assist the plantarflexion motion (toe off).
 - d. Subject concentrically assists the dorsiflexion motion (swing phase).
4. It has been suggested for the subject to work barefoot with a piece of malleable material between his/her foot and the attachment to work the intrinsics of the foot.
5. When rehabilitating the ankle, it is important to consider total leg strength.
6. If swelling is a consideration, the powerhead may be raised. If cramping is a problem, the powerhead may be lowered to bring the ankle into a more dependent position to allow enhanced blood flow.
7. Optionally, the seatback can be placed in the horizontal position to allow testing or exercise in the supine position.

Ankle: Plantarflexion/Dorsiflexion (Prone) (Double Chair)

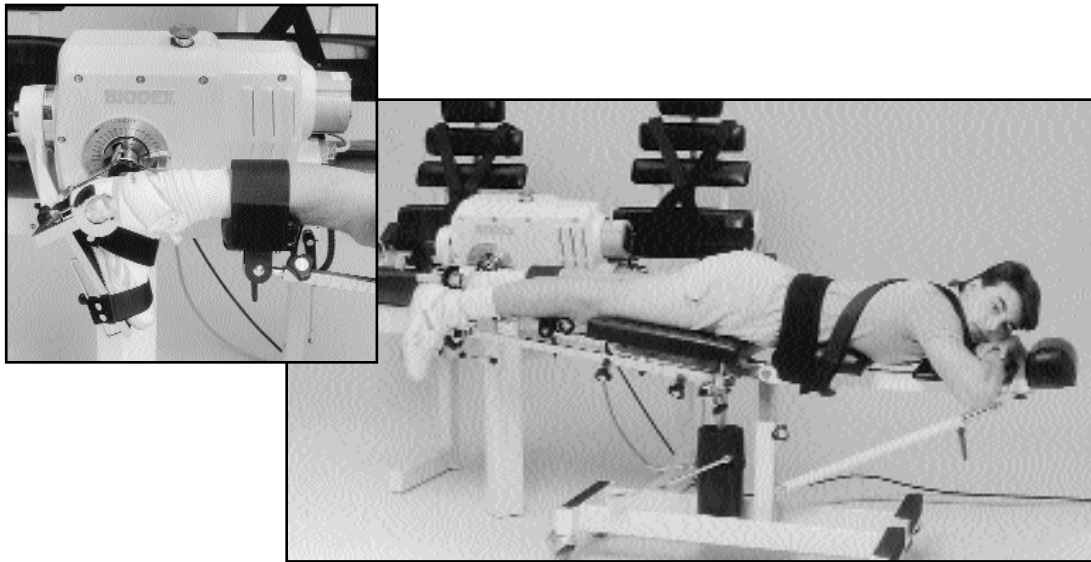


Figure 4.21

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	16°
Seat Orientation:	90° (Accessory Chair)
Seatback Tilt:	Fully Reclined (Accessory Chair)
Footplate Tilt:	0°
Sensitivity:	E
Ankle Flexion:	0°
Knee Flexion:	0°
Hip Flexion	0°
Axis of Rotation:	In neutral position, axis passes through the body of talus, fibular malleous, and through or just below the tibial malleous.
Ready Position:	Full Dorsiflexion

Parts Needed

Powerhead:	Footplate Attachment
Accessory Chair:	Multi-Support Pad and Adapter

Ankle: Plantarflexion/Dorsiflexion (Prone) (Single Chair)

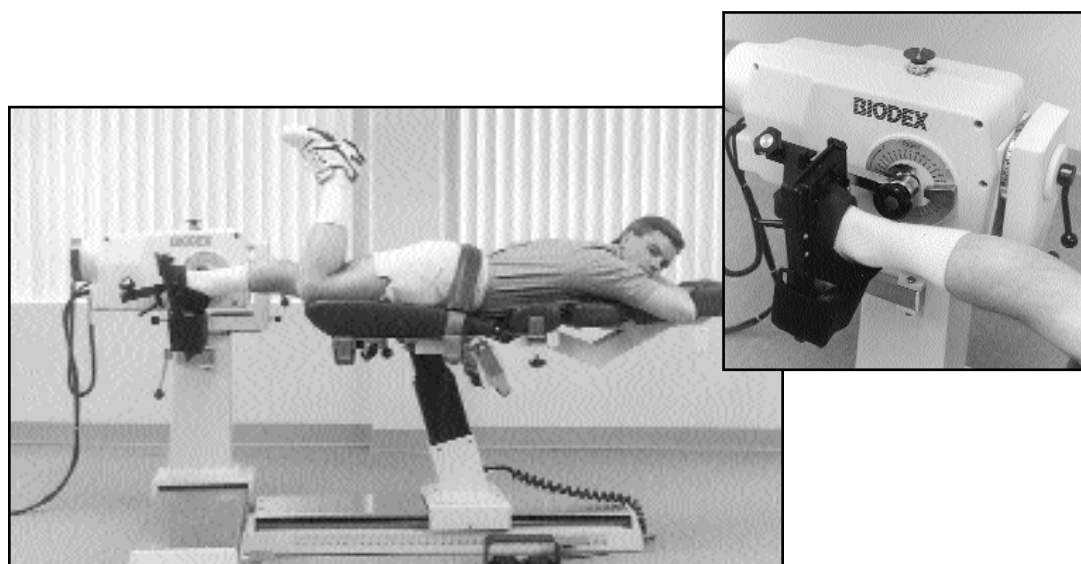


Figure 4.22

Quick Reference

Powerhead Orientation:	0°
Powerhead Tilt:	0°
Seat Orientation:	0°
Seatback Tilt:	Fully Reclined
Footplate Tilt:	0°
Footplate Color Code:	White dot to red dot
Sensitivity:	E
Ankle Flexion:	0°
Knee Flexion:	0°
Hip Flexion:	0°
Axis of Rotation:	In neutral position, axis passes through the body of talus, fibular malleous, and through or just below the tibial malleous.
Ready Position:	Full Dorsiflexion

Parts Needed

Powerhead:	Footplate Attachment
Positioning Chair:	T-Bar Adapters (short and long), Multi-Support Pad and Adapter

Ankle Plantarflexion/Dorsiflexion (Prone)

Ankle Dorsiflexion/Plantarflexion is frequently performed in the prone position allowing the stronger muscle group (the plantarflexors) to work against gravity and the weaker group (the dorsiflexors) to be assisted by gravity.



Figure 4.23

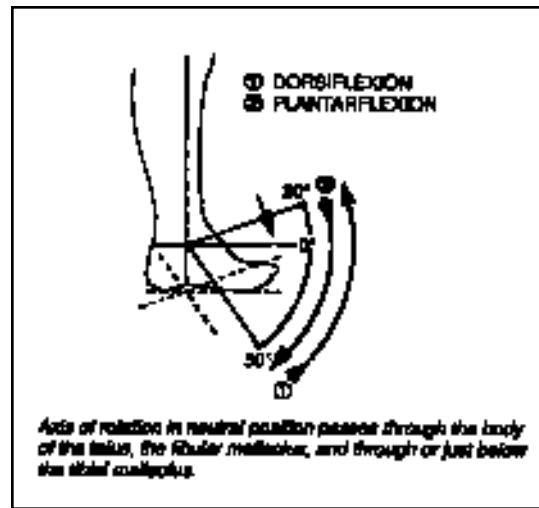


Figure 4.24

Setup and Positioning

1. Prepare the FOOTPLATE for this pattern by aligning the white color code dot with the red dot.
2. Affix FOOTPLATE to powerhead shaft so that FOOTPLATE and shaft red dots align. Secure with locking knob. The FOOTPLATE should be positioned vertical to the floor (heelcup at top) with 0° of FOOTPLATE tilt so that the footrest faces the seat.
3. Fully recline the SEATBACK and instruct subject to lie prone on seat with leg to be tested closest to the powerhead. If necessary to support opposite limb, position MULTI-SUPPORT PAD under anterior tibia. See Figures 4.25 and 4.26.

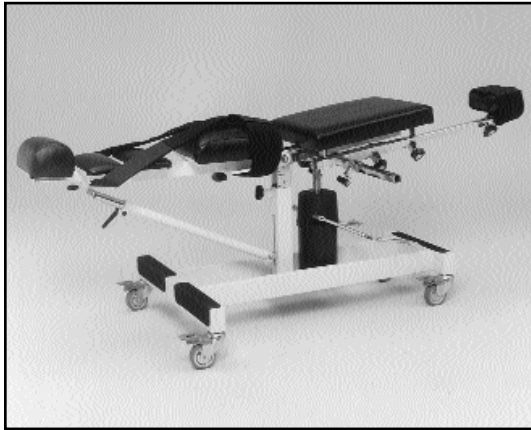


Figure 4.25 Multi-Support Pad placement (Double Chair).

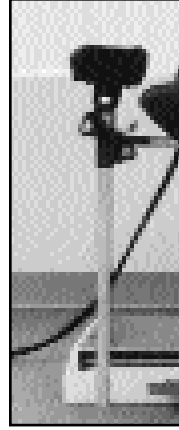


Figure 4.26 Multi-Support Pad placement (Single Chair).

4. Position chair so that subject can place sole of foot flat against FOOTPLATE. Adjust powerhead height so that powerhead shaft aligns with axis of rotation.
5. Set range of motion limits. Depress and release the red ROM LIMIT SET buttons when the ROM is appropriate in each direction. It does not matter whether direction 1 or 2 is set first. Move subject through desired range of motion to check for proper positioning and subject comfort. Reset ROM limits if necessary.
6. Place REMOTE COMFORT STOP in subject's hand. Explain the purpose of the stop.
7. Stabilize the subject with PELVIC STRAP and MULTI-SUPPORT STRAP. Do not secure the MULTI-SUPPORT STRAP so tightly as to inhibit motion.
8. Select mode and proceed as required by test/therapy protocol.

Ready Position:
Full Dorsiflexion

***NOTE:** The headings on the reports will be reversed in this position, meaning dorsiflexion is printed as plantarflexion and vice versa.*

Clinical Applications:

Same as Ankle Plantarflexion/Dorsiflexion (Seated).

Additional Comments:

1. Neurological retraining is important in the first three weeks of rehabilitation.
2. After a lateral ligamentous sprain, the dorsiflexors may be rehabilitated before the plantarflexors since less inversion/eversion occurs with dorsiflexion. Limit set buttons and ROM percent dials should be set accordingly.
3. Headings will be reversed on the reports.

Notes:

Ankle: Inversion/Eversion (Double Chair)

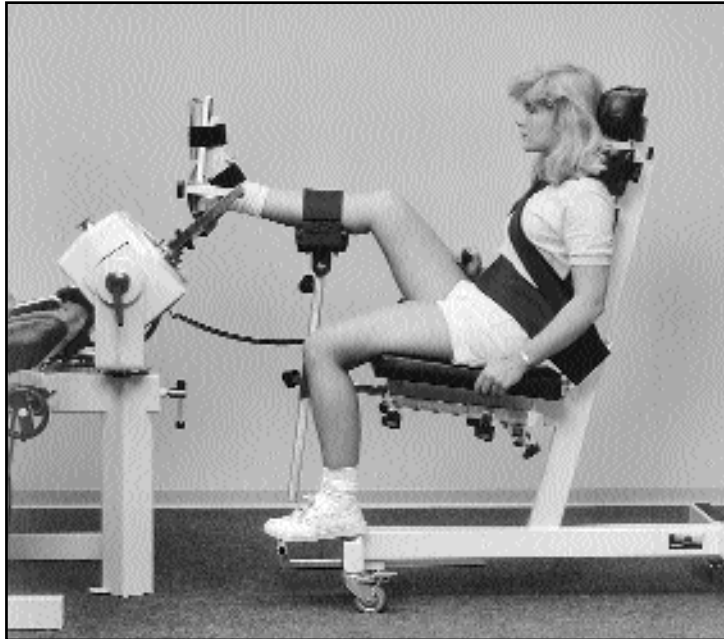


Figure 4.27

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	35° (shaft up)
Seat Orientation:	180° (Accessory Chair)
Seatback Tilt:	15° (Accessory Chair)
Footplate Tilt:	45°
Sensitivity:	E
Ankle Flexion:	0°
Knee Flexion:	30°
Hip Flexion:	45°
Axis of Rotation:	Passes through the fibula malleolus and the body of the talus.
Ready Position:	Full Inversion

Parts Needed

Powerhead:	Footplate Attachment
Accessory Chair:	Short or Medium T-Bar Adapter, Multi-Support Pad and Adapter

Ankle: Inversion/Eversion (Single Chair)

NOTE: If using the new Combination Ankle Attachment (#830-331), please make the following modifications to your Ankle Inversion/Eversion setups:

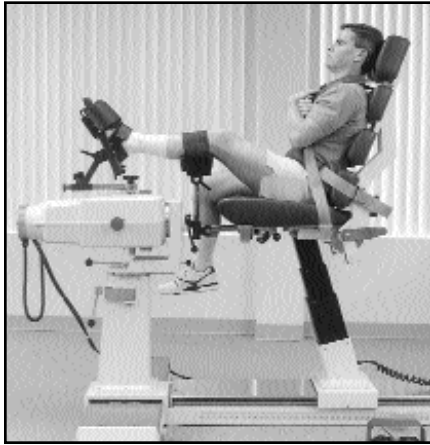


Figure 4.29

malleolus at an angle of 35°.

*Powerhead Orientation 90°:
Powerhead Tilt: 55°
Knee Flexion: 30°-45°
Ankle Flexion: 75°-90°*

Use of the new Combination Ankle Attachment does not require the seat to be positioned at its highest point. Thus, patients can be positioned with less knee extension. With the new attachment both the ankle and the footplate should be positioned perpendicular to the floor so that the anatomical axis of rotation passes through the body of the talus and fibular

Quick Reference

Powerhead Orientation:	0°
Powerhead Tilt:	90° (shaft up)
Seat Orientation:	0°
Seatback Tilt:	15°
Footplate Tilt:	45°
Footplate Color Code:	Green dot to red dot
Sensitivity:	E
Ankle Flexion:	0°
Knee Flexion:	30°
Hip Flexion:	60°
Axis of Rotation:	Passes through the fibula malleolus and the body of the talus.
Ready Position:	Full Inversion

Parts Needed

Powerhead:	Footplate Attachment
Positioning Chair:	T-Bar Adapters (short and medium), Multi-

Support Pad

Ankle: Inversion/Eversion (Seated)

The ankle is vulnerable to inversion injuries making injuries to the anterior talofibular complex a common occurrence that may be difficult to rehabilitate.

Recurrent injuries to the lateral ligamentous complex have been shown to decrease athletic performance.



Figure 4.29

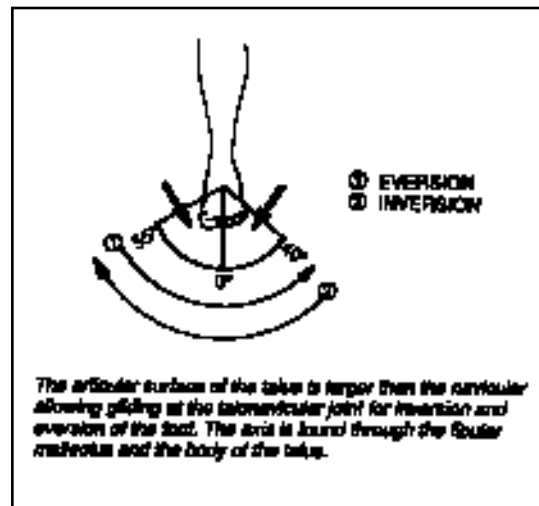


Figure 4.30

Setup and Positioning

1. Prepare the FOOTPLATE for this pattern by aligning the green color code dot to the red dot.
2. Recline the SEATBACK approximately 15°.
3. Affix FOOTPLATE to powerhead shaft so that red dots align. Secure with locking knob. The FOOTPLATE should be positioned perpendicular to the floor (heelcup at bottom) with 45° of FOOTPLATE tilt so that the footrest faces the positioning chair.
4. Seat subject on positioning chair and instruct subject to extend leg and rest foot on FOOTPLATE. With the subject's foot resting on the FOOTPLATE in the neutral position (0° inversion/eversion, 0° plantar/dorsiflexion), adjust FOOTPLATE so that powerhead shaft aligns with ankle inversion/eversion axis of rotation while the tibia is

horizontal to the floor.

The ankle axis of rotation for this pattern is found through the fibular malleolus and the body of the talus (Figure 4.30). Suggested knee flexion is 30°, hip flexion is 45°. Record these angles for valid comparisons and reproducibility.

5. Install MULTI-SUPPORT PAD as shown in Figures 4.31 and 4.32. Pad should be positioned under calf (distal to knee) to support limb with desired degree of hip and knee flexion. Install FOOTREST if desired.
6. Adjust heel support on the FOOTPLATE to maintain proper vertical position of foot. To do this, squeeze the HEEL SUPPORT BUTTONS together and slide the support to the desired position. Release the buttons to lock the support in place. Secure FOOT STRAPS.
7. Stabilize subject with SHOULDER STRAPS, PELVIC STRAP, and MULTI-SUPPORT STRAP. Do not secure the MULTI-SUPPORT STRAP so tightly as to inhibit motion.
8. Place REMOTE COMFORT STOP in subject's hand. Explain the purpose of the COMFORT STOP.
9. Set range of motion limits. Depress and release the red ROM LIMIT SET buttons when the range of motion is appropriate in each direction. It does not matter whether direction 1 or 2 is set first. Move subject through desired range to check for proper positioning and comfort. Reset range limits if necessary.
10. Select mode and proceed as required by test/therapy protocol.

Ready Position

Full Inversion

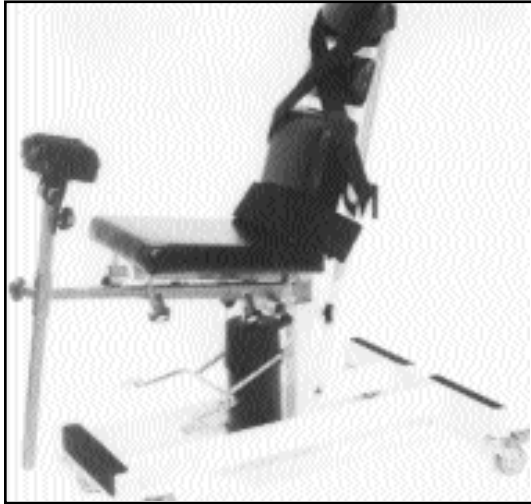


Figure 4.31 Multi-Support Pad placement (Double Chair).



Figure 4.32 Multi-Support Pad placement (Single Chair).

Clinical Applications of Biodex Operating Modes:

Passive Mode

1. The PASSIVE mode may be used after immobilization for the benefits of continuous passive motion. The PASSIVE mode may also be used to assist with neurologic retraining in the first few weeks after injury or surgery.
2. The PASSIVE mode may be used after a lateral ligamentous sprain to evert submaximally and passively invert. Inversion may be limited by ROM LIMIT SET buttons or PERCENT RANGE dials if warranted.
3. The PASSIVE mode may be used after lateral ligamentous sprain to work the evertors both concentrically and eccentrically. Range of motion may be limited as stated above.

Eccentric Mode

1. The ECCENTRIC mode may be used to perform maximal or submaximal activities to simulate function or sports activities.

Isokinetic Mode

1. The ISOKINETIC mode may be set bidirectionally. In the case of a lateral sprain, evertors may be set at relatively low speeds and invertors at higher speeds. Range of motion should be limited as warranted.

Isometric Mode

1. Multi-angle isometrics may be performed in the ISOMETRIC mode. Strength carry-over has been found to be plus or minus ten degrees. Isometrics may be used to stress either the agonist or antagonist.

Additional Comments

1. Ankle inversion injury has been noted to be caused by eccentric peroneal activity to failure.
2. A piece of malleable foam may be placed between the subject's bare foot and the attachment to work the intrinsic of the foot during rehabilitation.
3. Athletes who have poor static balance have been found to have weak evertors. Evertor strengthening may be helpful.
4. Consider the importance of total leg strength in the process of rehabilitating the ankle.
5. The ankle may be rehabilitated in an elevated position if edema is present.
6. If swelling is a consideration, the Powerhead may be raised. If cramping is a problem, the Powerhead may be lowered to bring the ankle into a more dependent position, allowing enhanced blood flow.

Hip: Hip Abduction/Adduction (Lying on Side) (Double Chair)

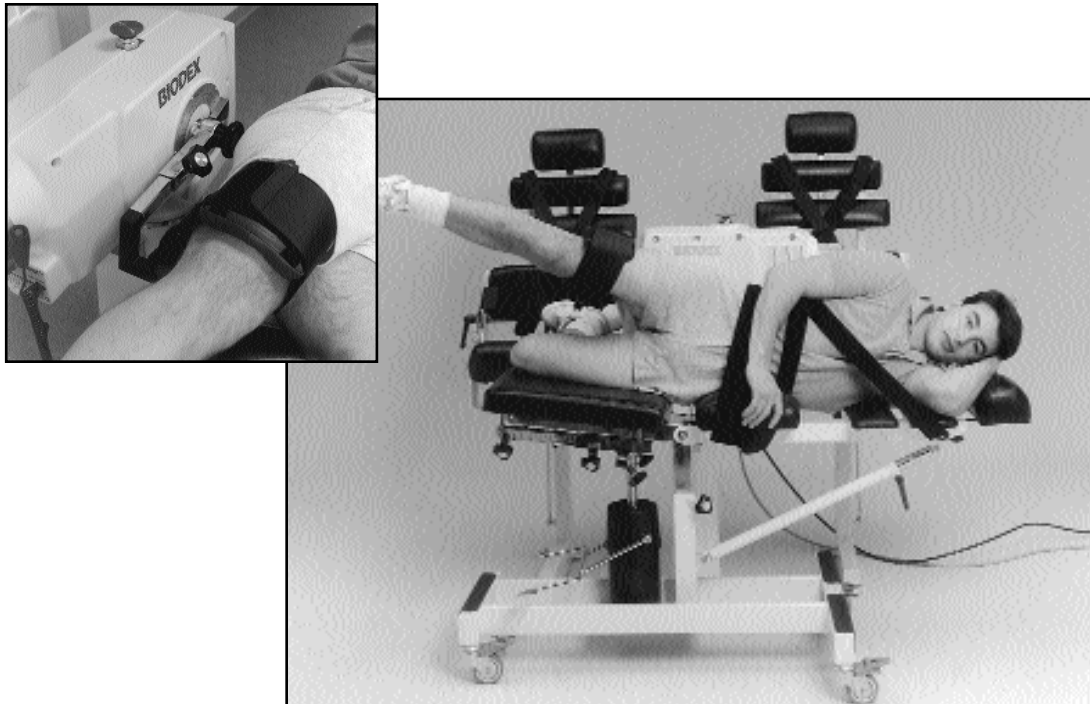


Figure 4.33

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	90° (Accessory Chair)
Seatback Tilt:	Fully Reclined (Accessory Chair)
Sensitivity:	C
Ankle Flexion:	0°
Knee Flexion:	0°
Hip Flexion:	0°
Axis of Rotation:	Superior and medial to greater trochanter.
Ready Position:	Full Adduction

Parts Needed

Powerhead:	Knee Attachment (or Wrist upper with Knee lower)
Accessory Chair:	Short T-Bar Adapter, Multi-Support Pad

Hip: Hip Abduction/Adduction (Lying on Side) (Single Chair)

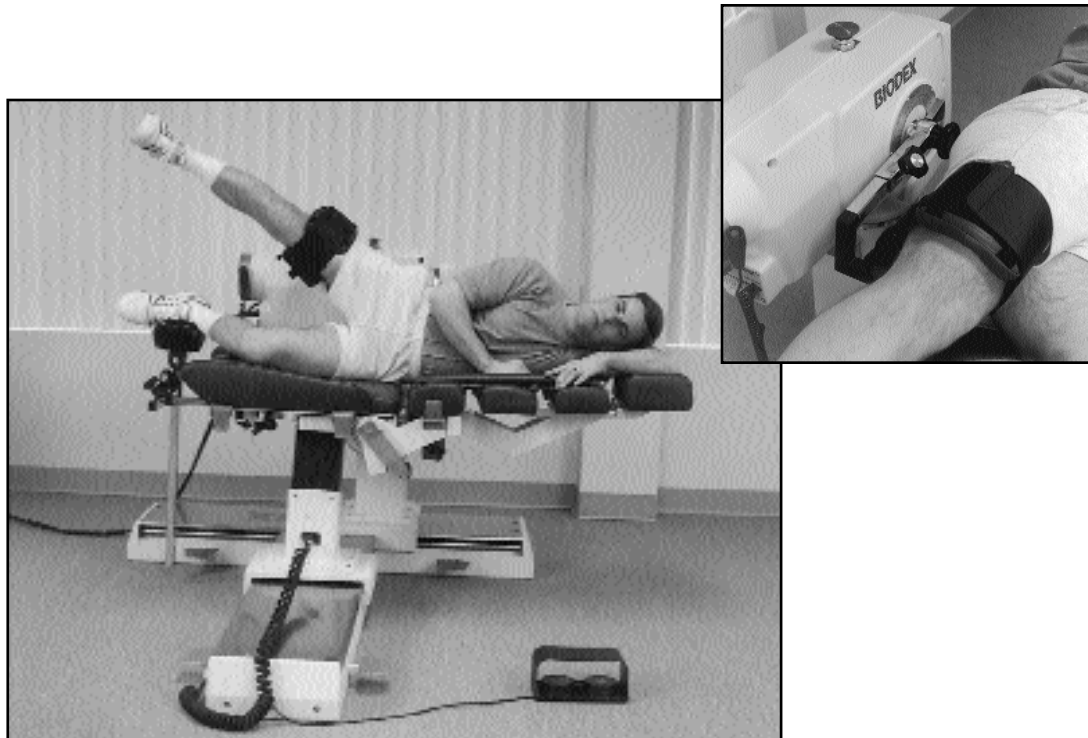


Figure 4.34

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	90°
Seatback Tilt:	Fully Reclined
Sensitivity:	C
Ankle Flexion:	0°
Knee Flexion:	0°
Hip Flexion:	0°
Axis of Rotation:	Superior and medial to greater trochanter.
Ready Position:	Full Adduction

Parts Needed

Powerhead:	Knee Attachment (or Wrist upper with Knee lower)
Accessory Chair:	Short T-Bar Adapter, Multi-Support Pad

Hip: Abduction/Adduction (Sidelying)

The abductors of the hip are very important in maintaining a level pelvis. When standing on one leg, there is a tendency for the opposite pelvis to drop which is countered by the gluteus medius, minimus and tensor fascia lata.



Figure 4.35

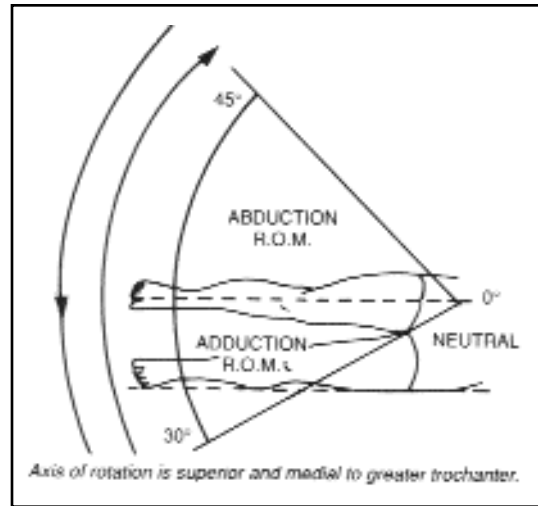


Figure 4.36

Setup and Positioning

1. Affix KNEE ATTACHMENT (or upper part of WRIST ATTACHMENT with knee pad attached if femur length is too short) to powerhead shaft so that red dots align. Secure with locking knob.
2. Install MULTI-SUPPORT PAD to support subject's opposite limb as shown in Figures 4.37 and 4.38. The pad should be positioned immediately adjacent to the seat with groove height equal to seat cushion height.



Figure 4.37 Multi-Support Pad placement (Double Chair).



Figure 4.38 Multi-Support Pad placement (Single Chair).

3. Instruct subject to lie on side on positioning chair with hip to be tested on top. Subject should face away from powerhead with hip axis of rotation aligned with powerhead input shaft. Opposite limb is flexed at the knee so that foot can rest on MULTI-SUPPORT PAD (if necessary).
4. Align powerhead shaft with axis of rotation for the upper hip. Axis of rotation for this pattern is superior and medial to the greater trochanter. Adjust attachment length so that knee pad is positioned just proximal to the popliteal fossa (Figures 4.33 and 4.34).
5. Place Remote Comfort Stop in subject's hand. Explain the purpose of the COMFORT STOP.
6. Set range of motion limits. Press and release the red ROM limit set buttons when the ROM is appropriate in each direction. It does not matter whether you set direction 1 or 2 first. Move subject through desired range to check for proper positioning and comfort. Reset range limits if necessary.
7. Select mode and proceed as required by test/therapy protocol.

READY POSITION

Full Adduction

Clinical Applications

1. It is important to rehabilitate the hip abductors/adductors after a traumatic knee injury, especially in ACL rehab.
2. Abductor strengthening is a necessary component in rehabilitation of a Trendelenburg gait. The passive mode may be used to perform non-reciprocal contraction types.

Notes:

Hip: Extension/Flexion (Supine) (Double Chair)

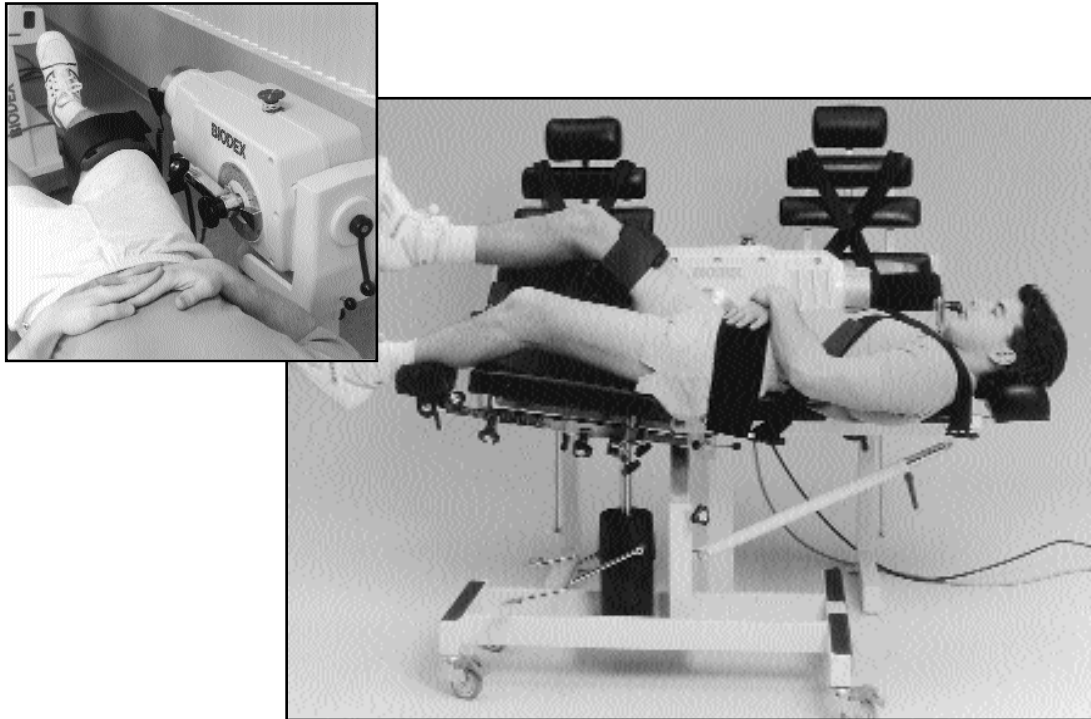


Figure 4.39

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	90° (Accessory Chair)
Seatback Tilt:	Fully Reclined (Accessory Chair)
Sensitivity:	C
Ankle Flexion:	0°
Knee Flexion:	0°
Axis of Rotation:	Superior and anterior to greater trochanter when limb is in neutral position.
Ready Position:	Neutral Extension

Parts Needed

Powerhead:	Knee Attachment (or Wrist upper with Knee lower)
Accessory Chair:	T-Bar Adapter (short or medium), Multi-Support Pad

Hip: Extension/Flexion (Supine) (Single Chair)

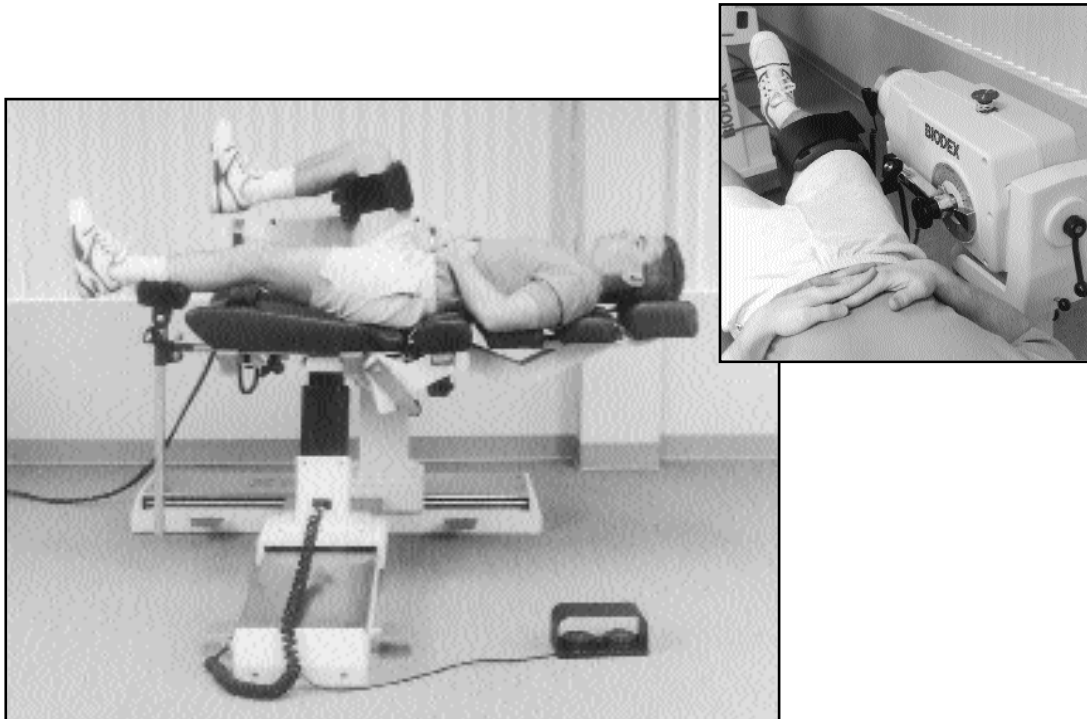


Figure 4.40

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	90°
Seatback Tilt:	Fully Reclined
Sensitivity:	C
Ankle Flexion:	0°
Knee Flexion:	0°
Axis of Rotation:	Superior and anterior to greater trochanter when limb is in neutral position.
Ready Position:	Neutral Extension

Parts Needed

Powerhead:	Knee Attachment (or Wrist upper with Knee lower)
Positioning Chair:	T-Bar Adapters (short and medium), Multi-Support Pad

Hip: Extension/Flexion (Supine)

The hip is a multiaxial ball and socket joint which consists of the articulation between the head of the femur and acetabulum of the os coxae.

There are a number of bursae at the hip. The iliopsoas bursa covers the anterior aspect of the hip joint and inflammation may cause anterior hip pain.



Figure 4.41

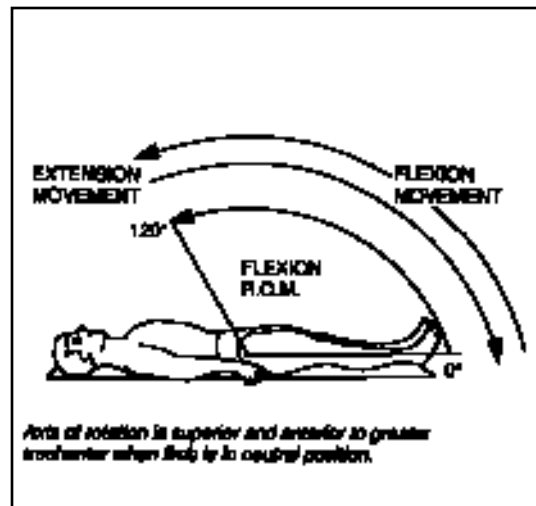


Figure 4.42

Setup and Positioning

1. Affix KNEE ATTACHMENT (or upper part of WRIST ATTACHMENT with knee pad attached if femur length is too short) to powerhead shaft so that red dots align. Secure with locking knob.
2. Install MULTI-SUPPORT PAD as shown in Figures 4.43 and 4.44.
3. Instruct subject to lie supine on chair with hip to be tested closest to the powerhead. Adjust chair and powerhead so that shaft aligns with the axis of rotation of the hip. The axis of rotation of the hip in this pattern is slightly superior and anterior to the greater trochanter. Adjust KNEE ATTACHMENT length so that thigh support is just proximal to the popliteal fossa.
4. Place Remote Comfort Stop in subject's hand. Explain the purpose of the COMFORT STOP.

-
5. Set range of motion limits. Press and release the red ROM limit set buttons when the ROM is appropriate in each direction. It does not matter whether you set direction 1 or 2 first.
 6. Move limb through range of motion to check for proper alignment and subject comfort. Readjust ROM Limit Set buttons if necessary.
 7. Select mode and proceed as required by test/therapy protocol.

READY POSITION

Neutral Extension

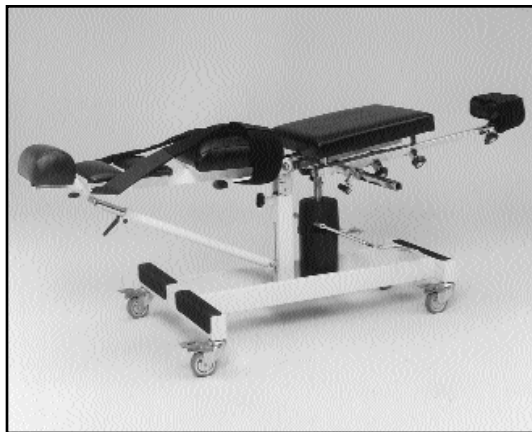


Figure 4.43 Multi-Support Pad placement (Double Chair).



Figure 4.44 Multi-Support Pad placement (Single Chair).

Clinical Applications of Biomedex Operating Modes:

Passive Mode

1. The passive mode may be used for the benefits of continuous passive motion after a Total Hip Replacement.
2. Many times in cases of degenerative joint disease (DJD) the cartilage in the area does not undergo the absorption and squeezing out of synovial fluid necessary for adequate nutrition. The passive mode may be used for this problem, especially for older persons who use their joints less frequently and through small ranges of motion. The passive mode may be used as a preventative measure to reduce capsular tightening at the hip.

Hip: Internal/External Rotation (Prone) (Double Chair)

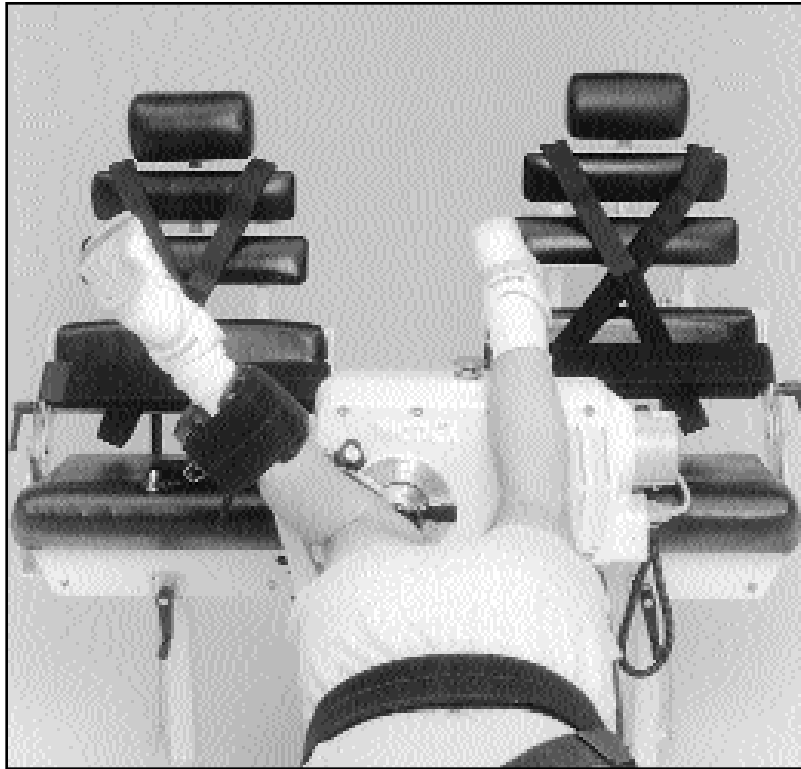


Figure 4.45

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	180° (Accessory Chair)
Seatback Tilt:	Fully Reclined (Accessory Chair)
Sensitivity:	C
Ankle Flexion:	0°
Knee Flexion:	90°
Axis of Rotation:	Mechanical axis of femur (line through the center of hip and knee joints).
Ready Position:	Full Internal Rotation

Parts Needed

Powerhead:	Knee Attachment
Accessory Chair:	No additional parts required.

Hip: Internal/External Rotation (Prone) (Single Chair)

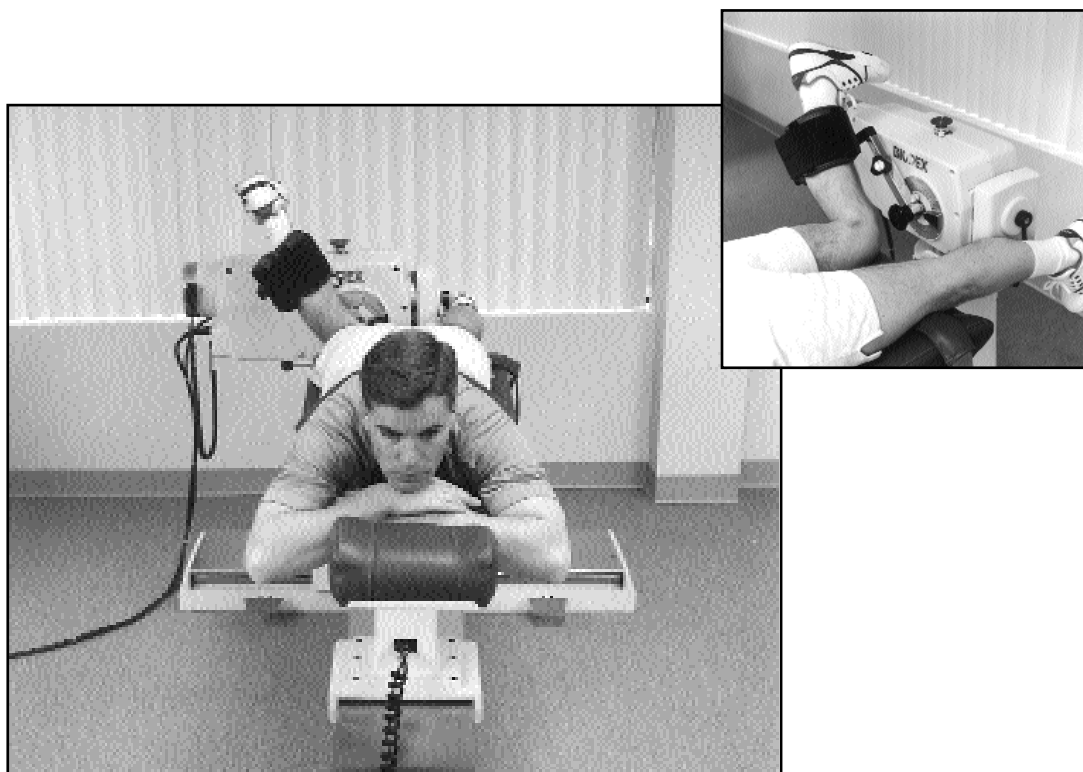


Figure 4.46

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	0°
Seatback Tilt:	Fully Reclined
Sensitivity:	C
Ankle Flexion:	0°
Knee Flexion:	90°
Axis of Rotation:	Mechanical axis of femur (line through the center of hip and knee joints).
Ready Position:	Full Internal Rotation

Parts Needed

Powerhead:	Knee Attachment
Positioning Chair:	No additional parts required.

Hip: Internal/External Rotation (Prone)

The hip rotators comprise the group of deep pelvic muscles. The piriformis muscle is of special importance because of its proximity to the sciatic nerve.



Figure 4.47

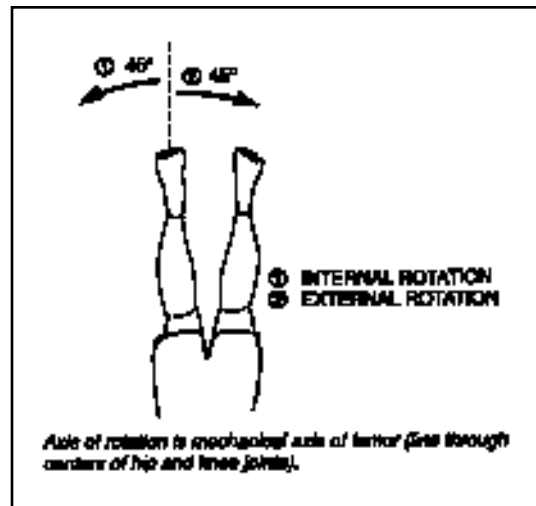


Figure 4.48

Setup and Positioning

1. Set SEATBACK on accessory or positioning chair to the fully reclined position.
2. Affix KNEE ATTACHMENT to powerhead shaft so that red dots align. Secure with locking knob.
3. Instruct subject to lie prone on chair with feet closest to powerhead. Adjust chair and powerhead height and position so that shaft aligns with the axis of rotation of the hip. For this pattern, axis of rotation runs longitudinally through the middle of the femur. Adjust KNEE ATTACHMENT length so that the padded end is placed just proximal to the ankle joint (Figures 4.45 and 4.46). Secure attachment to subject's leg with strap. Subject can rest opposite leg against the powerhead so that it does not interfere with the test or exercise motion.
4. Place Remote Comfort Stop in subject's hand. Explain the purpose of the COMFORT STOP.

-
5. Set range of motion limits. Press and release the red ROM limit set buttons when the ROM is appropriate in each direction. It does not matter whether you set direction 1 or 2 first.
 6. Move limb through range of motion to check for proper alignment and subject comfort. Readjust ROM Limit Set buttons if necessary.
 7. Select mode and proceed as required by test/therapy protocol.

READY POSITION

Full Internal Rotation

Clinical Applications

1. The rotators may be strengthened in all modes. Strengthening the rotators may be especially important in the rehabilitation of total hip replacements and cases of degenerative joint disease. ROM limits must be set taking into account the patient's pathology, pain tolerance, and stage of recovery.

Shoulder: Extension/Flexion (Seated) (Double Chair)

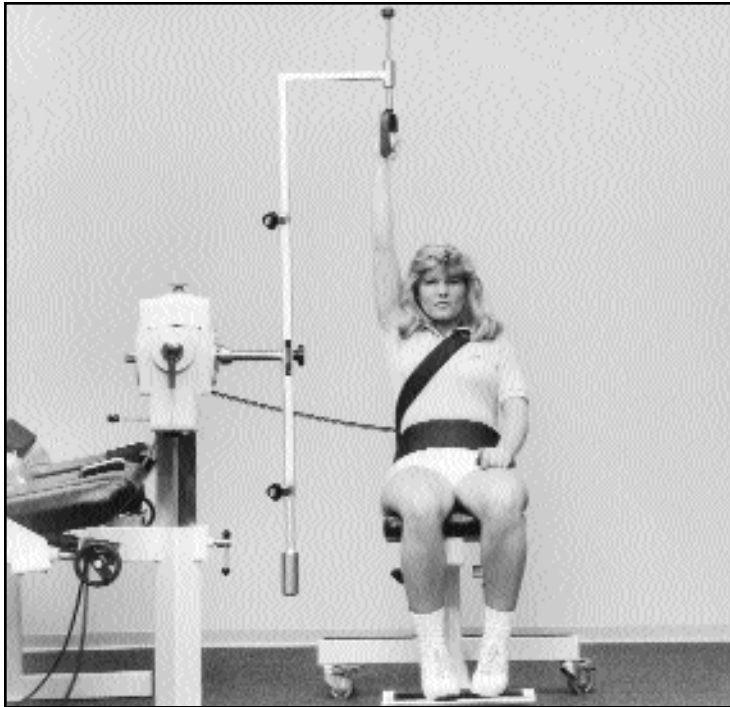


Figure 4.49

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	90° (Accessory Chair)
Seatback Tilt:	15° (Accessory Chair)
Sensitivity:	A
Hip Flexion:	75°
Shoulder Abduction:	0°
Axis of Rotation:	Compromise axis for Shoulder Extension / Flexion is acromial process in the sagittal plane.
Ready Position:	Full Flexion

Parts Needed

Powerhead:	Shoulder Attachment
Accessory Chair:	Footrest (optional)

Shoulder: Extension/Flexion (Seated) (Single Chair)

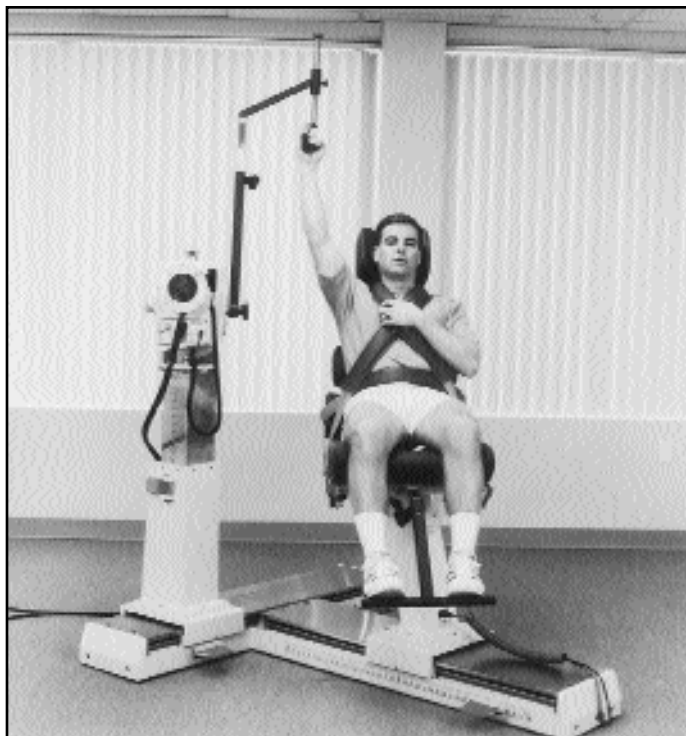


Figure 4.50

Quick Reference

Powerhead Orientation:	135°
Powerhead Tilt:	0°
Seat Orientation:	135°
Seatback Tilt:	15 to 30°
Sensitivity:	B or C
Axis of Rotation:	Compromise axis for Shoulder Extension/Flexion is acromial process in the sagittal plane.
Ready Position:	Full Flexion

Parts Needed

Powerhead:	Shoulder Attachment
Positioning Chair:	Footrest (optional)

Shoulder: Extension/Flexion (Seated)

Shoulder extension/flexion is a motion that is usually initiated early in the rehabilitation process, however, clinicians must be careful not to cause impingement. An impingement sign is produced when the shoulder is fully flexed and there is jamming of the greater tuberosity against the antero inferior surface of the acromion. For this reason, the clinician may want to limit flexion range of motion in the early stages of the rehabilitation process.

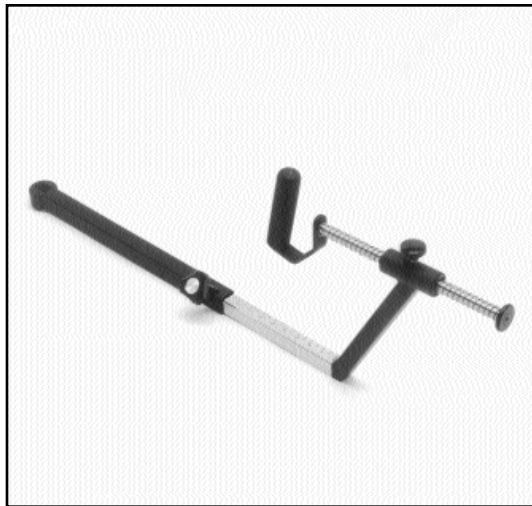


Figure 4.51

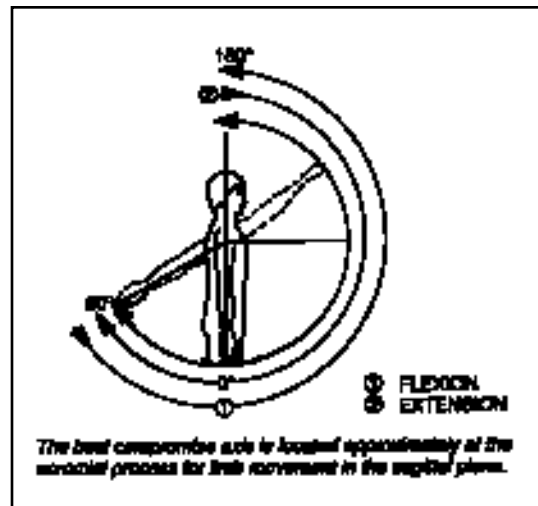


Figure 4.52

Setup and Positioning

NOTE: This pattern may be accomplished with the accessory or positioning chair SEATBACK reclined to any position which provides for both subject comfort and proper alignment of the anatomical axis. (The SEATBACK and powerhead tilt must, however, be set parallel.)

1. Affix SHOULDER ATTACHMENT to powerhead shaft so that red dots align (remove the FOREARM SUPPORT PAD if it is on the attachment). Secure with locking knob.
2. Install FOOTREST in accessory or positioning chair if desired.
3. Seat subject and adjust powerhead and chair position so that powerhead shaft aligns with subject's shoulder extension/flexion axis of rotation. Since the shoulder complex is composed of so many joints, and the glenohumeral joint itself allows for global motion, the best compromise

axis for shoulder extension/flexion is at the acromial process in the sagittal plane (Figure 4.52).

4. Adjust chair-to-powerhead distance so that handgrip is on same plane (sagittal) as subject's arm.
5. With subject's arm in neutral position (0°) with thumb forward, instruct subject to grasp handgrip. Adjust handle length so that Handgrip slide assembly is in approximate middle of range. To do this, unscrew the locking knob and slide the assembly in the appropriate direction. Tighten the knob to secure. Move subject through desired range of motion to insure that slide does not contact end stops or make contact with the floor at any point in range of motion. Readjust handle length if necessary.
6. Place REMOTE COMFORT STOP in subject's free hand. Explain the purpose of the COMFORT STOP.
7. Set range of motion limits. It does not matter which direction is set first. Move limb through range of motion to check positioning and subject comfort. Readjust ROM limits if necessary.
8. Stabilize subject with pelvic and SHOULDER STRAPS.
9. Select mode and proceed as required by test/therapy protocol

Ready Position

Full Extension

Clinical Applications of Biodex Operating Modes:

Passive Mode

1. The passive mode may be used initially for the benefits of continuous passive motion. It has been suggested that early re-establishment of neural pathways without stressing an inflamed capsule is essential.
2. It has been suggested to increase anterior shoulder flexibility in the acute phase of a rotator cuff strain without offering resistance. The passive mode may be used to carry the limb into the flexed position. The subject may be instructed to assist the extensors as the arm is moved into direction 2.
3. It has been suggested by some clinicians that submaximal eccentrics that can be performed in the passive mode may be used to treat subjects with bicipital tendonitis.

-
4. With adhesive capsulitis, the subject may be placed in the passive mode with a four second pause at end range.

Isokinetic Mode

1. The isokinetic mode may be used bi-directionally to focus on one specific muscle group (i.e., in an impingement syndrome the flexors may be worked at a fast speed through a limited range and the extensors at a lower speed).

Isometric Mode

1. Isometrics may be used immediately pre- and post-operatively. Multi-angle isometrics are recommended to achieve physiological overflow into that portion of the range which has not been exercised.

Additional Comments

1. With impingement syndrome and anterior subluxation, it has been recommended to initially limit motion to under 90 degrees and progress slowly past this point.
2. It is important to consider that glenohumeral motion requires a coordinated effort between the deltoid and the rotator cuff musculature. Working the anterior deltoid non-reciprocally will strengthen this muscle concentrically and eccentrically.

Notes:

Shoulder: Abduction/Adduction (Seated) (Double Chair)



Figure 4.53

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	15°
Seat Orientation:	0° (Accessory Chair)
Seatback Tilt:	15° (Accessory Chair)
Sensitivity:	A
Hip Flexion:	75°
Shoulder Flexion:	0°
Axis of Rotation:	Axis of rotation for this pattern approximates the axis of the acromioclavicular joint, which connects the distal end of the clavicle to the anterior medial portion of the acromial process.
Ready Position:	Full Adduction

Parts Needed

Powerhead:	Shoulder Attachment
Accessory Chair:	Footrest (optional)

Shoulder: Abduction/Adduction (Seated) (Single Chair)

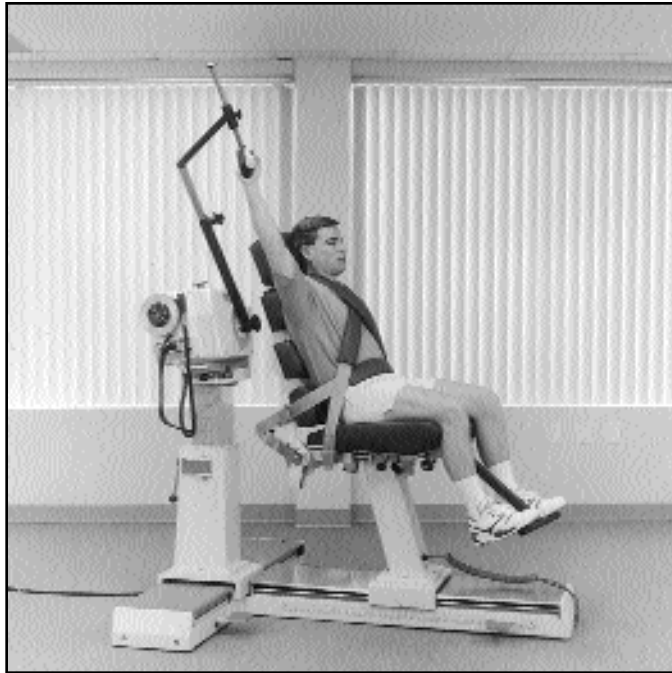


Figure 4.54

Quick Reference

Powerhead Orientation:	75°
Powerhead Tilt:	15°
Seat Orientation:	135°
Seatback Tilt:	15°
Sensitivity:	B or C
Axis of Rotation:	Axis of rotation for this pattern approximates the axis of the acromioclavicular joint, which connects the distal end of the clavicle to the anterior medial portion of the acromial process.
Ready Position:	Full adduction

Parts Needed

Powerhead:	Shoulder Attachment
Positioning Chair:	Footrest (optional)

Shoulder: Abduction/Adduction (Seated)

The shoulder complex is made up of multiple linkages. These include the glenohumeral joint, acromioclavicular joint, sternoclavicular joint, and scapulothoracic articulation. The glenohumeral joint is the most mobile joint in the body with global freedom. Because of this, stability is sacrificed. Only a little more than 1/3 of the head of the humerus makes contact with the cavity at any one time.

Abduction/adduction is usually one of the last motions exercised in rehabilitation of the shoulder. The clinician must exercise great care in order to avoid impingement.



Figure 4.55

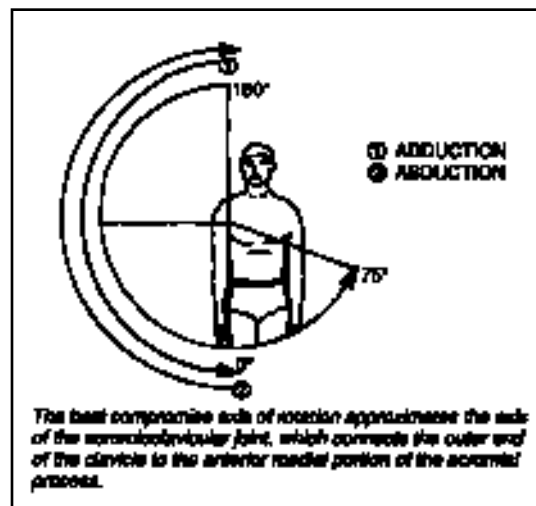


Figure 4.56

Setup and Positioning

NOTE: This pattern may be accomplished with the seatback reclined to any position which provides for both patient comfort and proper alignment of the anatomical axis. The seatback and powerhead tilt must, however, be set to the same angle.

1. Affix SHOULDER ATTACHMENT to powerhead shaft so that red dots align (remove the FOREARM SUPPORT PAD if it is on the attachment). Secure with locking knob.
2. Install footrest in accessory or positioning chair if desired.
3. Seat subject and position chair and powerhead to roughly align the

subject's shoulder axis with the powerhead input shaft. Adjust chair and powerhead to refine axis alignment.

Since the shoulder complex is composed of many joints and the glenohumeral joint itself has global freedom, the best compromise axis is the acromioclavicular joint, connecting the distal end of the clavicle to the anterior medial portion of the acromial process (Figure 4.56).

4. With subject's arm in the neutral position (0°), instruct subject to grasp handgrip. Adjust handle length so that handgrip sliding assembly is in approximate middle of range. handgrip should be on same plane (frontal) as the subject's arm.
5. Set range of motion limits. Move limb through range of motion to check for proper positioning and subject comfort. Readjust ROM limits if necessary.
6. Stabilize subject with pelvic and SHOULDER STRAPS.
7. Place remote comfort stop in subject's free hand. Explain the purpose of the Comfort Stop.
8. Select mode and proceed as required by test/therapy protocol.

Ready Position

Neutral Position (0 degrees)

Clinical Applications of Biodex Operating Modes:

Passive Mode

1. The passive mode may be used initially for the benefits of continuous passive motion. This is especially important post-surgically. It has been suggested that early re-establishment of neural pathways without oversteering an inflamed capsule is essential.
2. The passive mode may be used to work the adductors early in the rehabilitation, both concentrically and eccentrically. Conversely, the abductors may be stressed in the same way later in rehabilitation.

Eccentric Mode

1. The eccentric mode may be used to perform submaximal eccentrics especially in cases of tendonitis.

Isokinetic Mode

1. The isokinetic mode may be used at bi-directional velocities to stress either the abductors or adductors (i.e., in early rotator cuff rehabilitation, the focus may be placed on the adductors). The adductors may be worked at low speeds concentrically and the abductors at higher speeds concentrically. Set limits as appropriate.

Isometric Mode

1. Multi-angle isometrics may be performed (i.e., with adhesive capsulitis, if the subject performs an isometric contraction at the end of the range, he/she will develop strength gains in a greater range due to the overflow principle.

Additional Comments

1. The pause may be used at end range simply to focus on that portion of the range.
2. The limit set buttons and/or percent range dials, may be used in subjects with impingement syndrome to limit the range of motion to 90 degrees or less.
3. It has been recommended in some cases that a strong supraspinatus contraction be present in the first 30 degrees of motion before other strengthening may begin.
4. It has been suggested that strengthening the abductors is very important in the rehabilitation of acromioclavicular separations.
5. It has been suggested that the force of the abducting musculature is very important in establishing equilibrium at the glenohumeral joint and that the supraspinatus helps prevent downward dislocation of the humerus.
6. It has been stated that the long head of the biceps may act as an accessory shoulder abductor. If the glenohumeral joint is externally rotated.
7. For alternate positioning, the seat and powerhead can be positioned at any 15° of rotation.

Notes:

Shoulder: Horizontal Abduction/Adduction (Supine) (Double Chair)

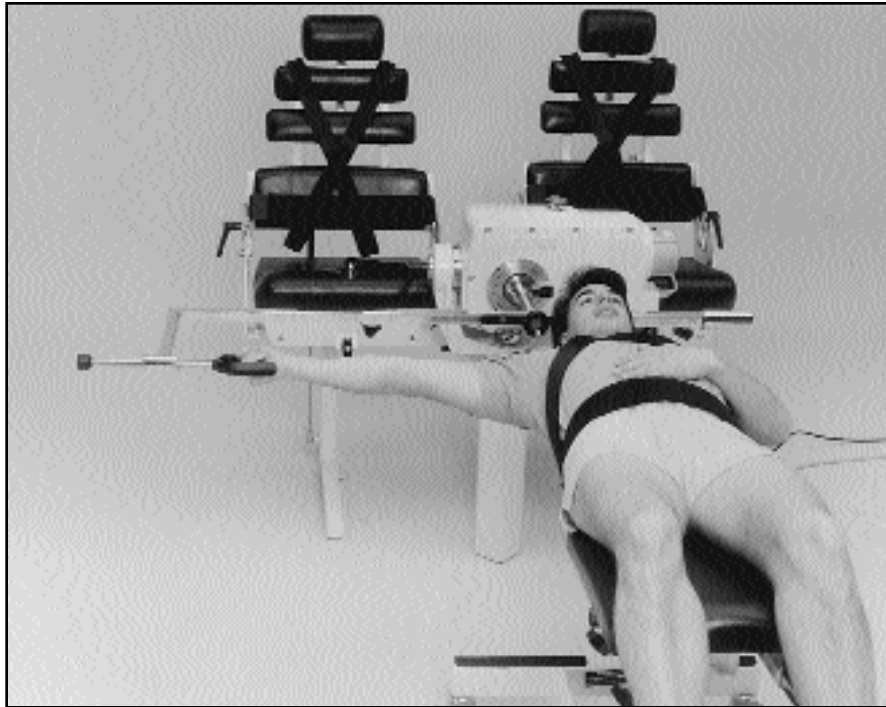


Figure 4.57

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	0° (Accessory Chair)
Seatback Tilt:	Fully reclined (Accessory Chair)
Sensitivity:	A
Hip Flexion:	0°
Shoulder Abduction:	0°
Axis of Rotation:	Compromise axis is medial to acromioclavicular process when limb is in 90° horizontal abduction.
Ready Position:	Full Horizontal Abduction

Parts Needed

Powerhead:	Shoulder Attachment
Accessory Chair:	No additional parts required.

Shoulder: Horizontal Abduction/Adduction (Supine) (Single Chair)

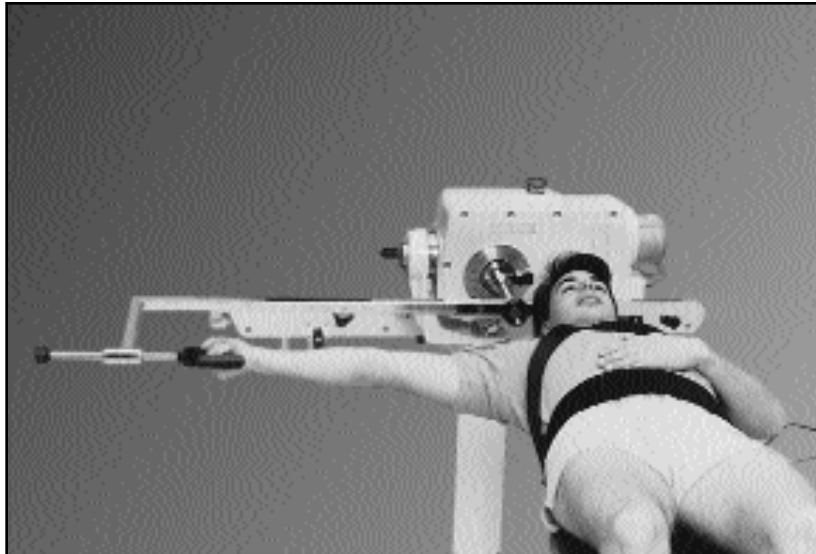


Figure 4.58

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	0°
Seatback Tilt:	Fully reclined
Sensitivity:	B or C
Hip Flexion:	0°
Shoulder Abduction:	0°
Axis of Rotation:	Compromise axis is medial to acromioclavicular process when limb is in 90° horizontal abduction.
Ready Position:	Full Horizontal Abduction

Parts Needed

Powerhead:	Shoulder Attachment
Positioning Chair:	No additional parts required.

Shoulder: Horizontal Abduction/Adduction (Supine)

The horizontal abductors/adductors of the shoulder are instrumental in achieving a good throwing motion and other functional activities.



Figure 4.59

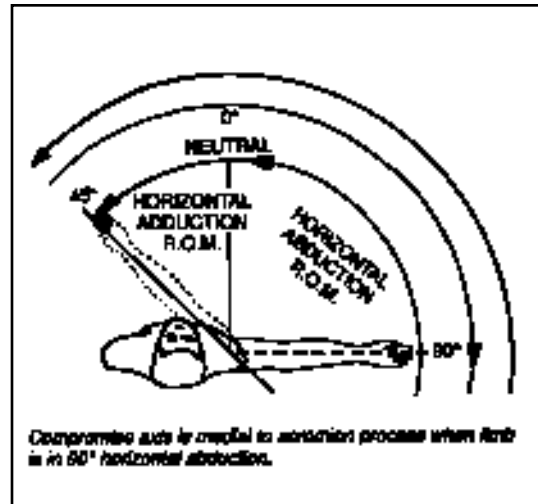


Figure 4.60

Setup and Positioning

1. Affix **SHOULDER ATTACHMENT** to powerhead shaft (remove the **FOREARM SUPPORT PAD** if it is on the attachment) and secure with locking knob.
2. Instruct the subject to lie supine on the accessory or positioning chair with head closest to powerhead. Adjust chair and powerhead position to align powerhead shaft with shoulder axis of rotation. Compromise axis of rotation is medial to acromion process when limb is in 90° of horizontal abduction (Figure 4.60).
3. Adjust chair to powerhead distance so that attachment will be moved horizontally across the subject's chest and there are no obstacles in the way.
4. With the subject's arm in the horizontal position, instruct the subject to grasp the handgrip. Adjust handle length so that the handgrip sliding assembly is in the middle of the range when the subject's arm is horizontally abducted.

-
5. Stabilize subject with Pelvic and Shoulder straps.
 6. Set ROM limits. Check subject comfort. Move subject's limb through the desired ROM to insure that slide does not contact endstops at any point in the range of motion. Readjust handle length and ROM limits if necessary.
 7. Place the remote comfort stop in subject's free hand. Explain the purpose of the COMFORT STOP.
 8. Select mode and proceed as required by test/therapy protocol.

Ready Position

Horizontal Abduction

Clinical Applications of Biodex Operating Modes:

Passive or Eccentric Mode

1. The pectoralis major is important in the cocking phase of throwing. During this phase it is elongated and contracts eccentrically. The pectoralis major may be worked eccentrically in the passive or eccentric modes.
2. The musculotendinous junction of the infraspinatus and teres minor is frequently inflamed during the deceleration phase of throwing once again, these muscles may be worked eccentrically in the passive or eccentric modes in order to replicate this motion and return the athlete back to his sport.

Isokinetic Mode

1. During throwing, the pectoralis major contracts suddenly to propel the arm forward. This may cause an overload at the muscular insertion. The subject may be worked concentrically in the isokinetic mode at high velocities to replicate this action.

Additional Comments

1. This setup may be performed gripless by using the knee pad assembly.

Shoulder: Horizontal Abduction/Adduction (Prone) (Double Chair)

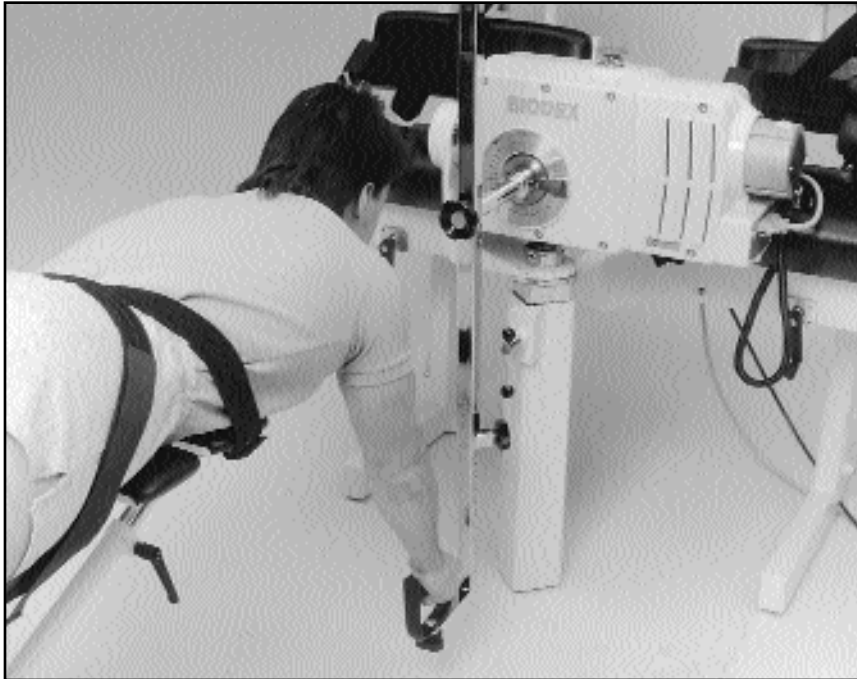


Figure 4.61

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	0° (Accessory Chair)
Seatback Tilt:	Fully reclined (Accessory Chair)
Sensitivity:	A
Hip Flexion:	0°
Shoulder Abduction:	0°
Axis of Rotation:	Compromise axis is medial to acromioclavicular process when limb is in 90° horizontal abduction.
Ready Position:	Full Horizontal Adduction

Parts Needed

Powerhead:	Shoulder Attachment
Accessory Chair:	No additional parts required.

Shoulder: Horizontal Abduction/Adduction (Prone) (Single Chair)

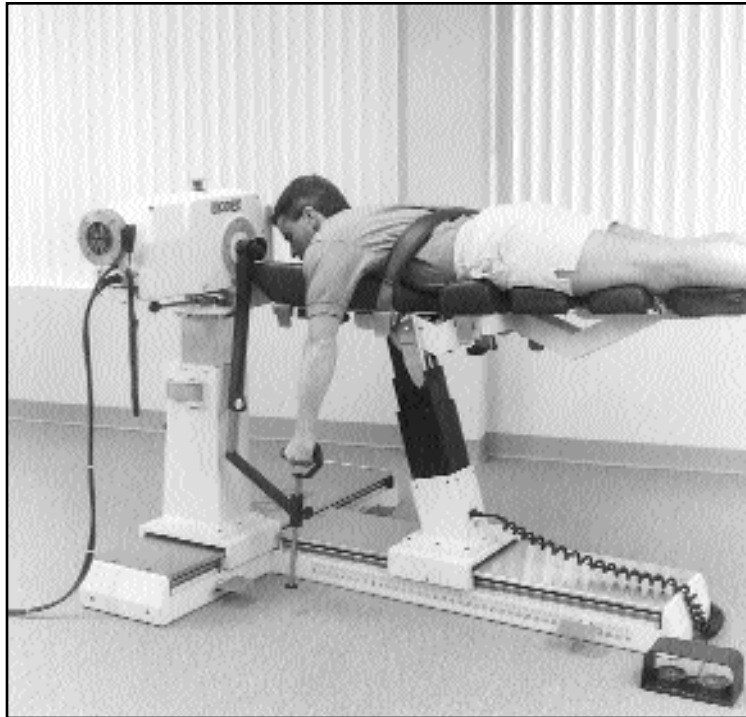


Figure 4.62

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	180°
Seatback Tilt:	Fully reclined
Sensitivity:	B or C
Hip Flexion:	0°
Shoulder Abduction:	0°
Axis of Rotation:	Compromise axis is medial to acromioclavicular process when limb is in 90° horizontal abduction.
Ready Position:	Full Horizontal Adduction

Parts Needed

Powerhead:	Shoulder Attachment
Positioning Chair:	No additional parts required.

Shoulder: Horizontal Abduction/Adduction (Prone)

The horizontal abductors/adductors of the shoulder are instrumental in achieving a good throwing motion and other functional activities.



Figure 4.63

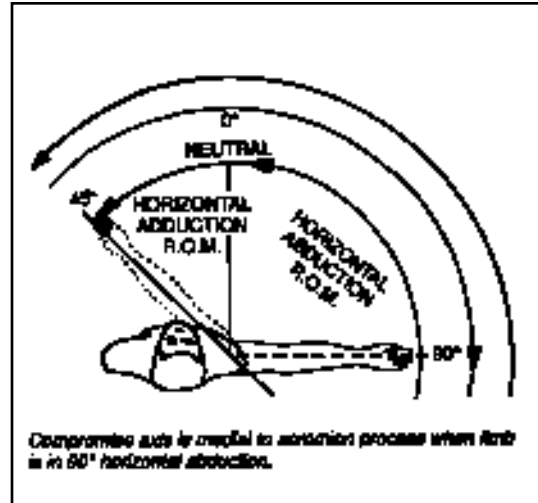


Figure 4.64

Setup and Positioning

1. Affix **SHOULDER ATTACHMENT** to powerhead shaft (remove the **FOREARM SUPPORT PAD** if it is on the attachment) and secure with locking knob.
2. Instruct the subject to lie prone on accessory or positioning chair. Adjust chair and powerhead so that shaft aligns with shoulder axis of rotation. Compromise axis is medial to acromion process when limb is in 90° of horizontal abduction (Figure 4.64).
3. Adjust chair-to-powerhead distance so that attachment will be moved horizontally across the subject's chest. Ensure that there are no obstacles in the way.
4. With the subject's arm in the horizontal position, instruct the subject to grasp the handgrip. Subject's thumb should be grasped around the shorter end of the handgrip approximating the functional position of the hand. Adjust handle length so that the handgrip sliding assembly is in the middle of the range when the patient's arm is horizontally abducted. Handgrip locking knob may be tightened so that handgrip remains in one position or may be loosened to allow it to rotate freely.

-
5. Stabilize subject with Pelvic and Shoulder straps.
 6. Set ROM limits. Check subject comfort. Move subject's limb through the desired ROM to insure that slide does not contact endstops at any point in the range of motion. Readjust handle length and ROM limits if necessary.
 7. Place the remote comfort stop in subject's free hand. Explain the purpose of the COMFORT STOP.
 8. Select mode and proceed as required by test/therapy protocol.

Ready Position

Horizontal Adduction

Clinical Applications

1. Please see Shoulder Horizontal Adduction/ Abduction in supine.
2. This may be an especially comfortable position for postoperative subjects or subjects who have been immobilized.
3. Joint distraction secondary to the pull of gravity may be achieved in this position.
4. Rhythmic oscillations may be performed in the passive mode through a limited range to reduce discomfort and facilitate relaxation.
5. This procedure may be done gripless using the knee pad assembly.

Shoulder: Internal/External Rotation in the Modified Neutral Position (Standing) (Double Chair)

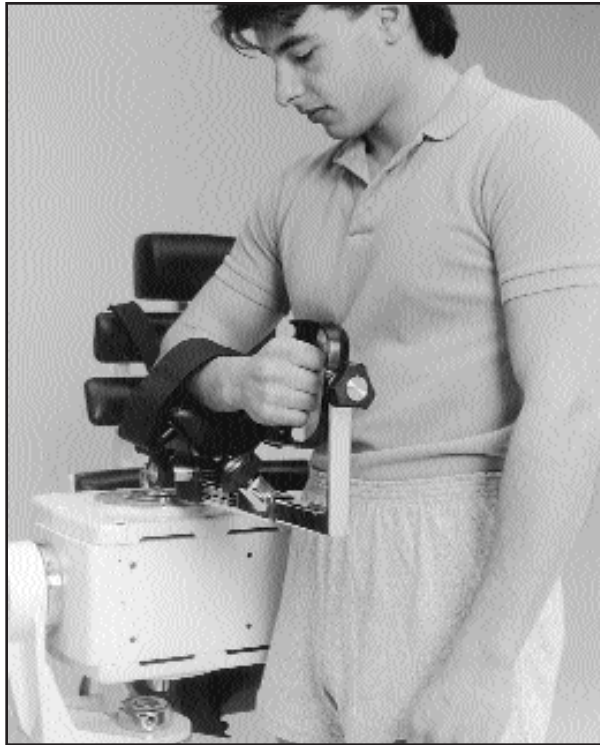


Figure 4.65

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Sensitivity:	B or C
Shoulder Abduction:	15°
Axis of Rotation:	Axis alignment is longitudinal through the head of the shaft of the humerus in a horizontal plane.
Ready Position:	Full Internal Rotation

Parts Needed

Powerhead:	Elbow/Shoulder Attachment
Accessory Chair:	Not used for this pattern.

Shoulder: Internal/External Rotation in the Modified Neutral Position (Seated) (Single Chair)

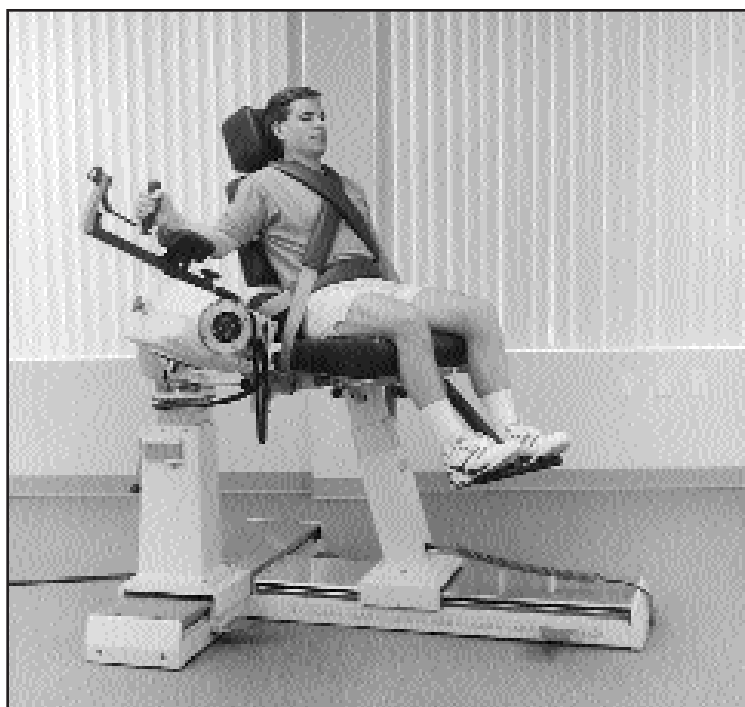


Figure 4.66

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	70°
Seat Orientation:	135°
Seatback Tilt:	15
Sensitivity:	B or C
Hip Flexion:	75°
Axis of Rotation:	Axis alignment is longitudinal through the head of the shaft of the humerus in a horizontal plane.
Ready Position:	Full Internal Rotation

Parts Needed

Powerhead:	Elbow/Shoulder Attachment
Positioning Chair:	Footrest (optional)

Shoulder: Internal/External Rotation in the Modified Neutral Position (Seated)

The rotator cuff is one of the most important structures in maintaining the integrity of the shoulder complex. The stability of the glenohumeral joint depends largely on an intact and functioning rotator cuff. A strong rotator cuff is especially important for a balanced and smooth movement of the upper extremity.

There are several different positions available to set up a subject for testing or rehabilitation of the internal/external rotation movement. Two are presented in this manual: the modified position (seated) and the modified position (standing).



Figure 4.67

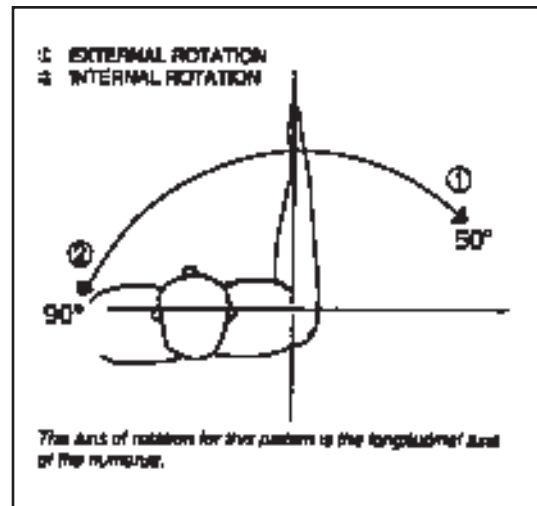


Figure 4.68

Setup and Positioning

1. Affix ELBOW / SHOULDER ATTACHMENT to powerhead shaft and secure with locking knob.
2. Affix FOREARM SUPPORT PAD to ELBOW / SHOULDER ATTACHMENT. To do this, loosen the FOREARM SUPPORT locking knob and slide the support over the attachment shaft. Slide the support down the attachment shaft until it is adjacent to, but not quite touching, the input shaft locking knob. The support pad groove should align with both the attachment shaft and HANDGRIP, the FOREARM SUPPORT shaft should be angled toward the HANDGRIP. See Figure 4.67.

-
3. Seat subject in positioning chair or stand subject alongside powerhead. Position powerhead (and chair) so that the powerhead shaft aligns with the axis of rotation at the shoulder. The axis of rotation for this pattern is the longitudinal axis of the humerus.
 4. With subject's elbow flexed to 90° and shoulder in 0° rotation and 15° to 45° abduction, instruct subject to grasp handgrip. Adjust handle length so that Handgrip slide assembly is in approximate middle of range. To do this, unscrew the locking knob and slide the assembly in the appropriate direction. Tighten the knob to secure.
 5. Place REMOTE COMFORT STOP in subject's free hand. Explain the purpose of the COMFORT STOP.
 6. Stabilize subject with pelvic and SHOULDER STRAPS.
 7. Set range of motion limits. Move limb through range of motion to check for proper alignment and subject comfort. Readjust ROM limits if necessary.
 8. Select mode and proceed as required by test/therapy protocol.

Ready Position

Full Internal Rotation

Clinical Applications of Biodex Operating Modes:

Passive Mode

1. The passive mode may be used initially for the benefits of continuous passive motion. This is especially important post-surgically. Many clinicians are using this mode one day post-op after arthroscopic surgery.
2. The passive mode may be used to work one muscle group both concentrically and eccentrically, (i.e., after an anterior shoulder dislocation, the internal rotators may be worked both concentrically and eccentrically through a limited range. With a tear in the posterior rotator cuff, the internal rotators may also be stressed initially in this way).

Eccentric Mode

1. The eccentric mode may be used to perform submaximal eccentrics for the diagnosis of tendonitis (i.e., this technique may be used in cases of supraspinatus tendonitis).

Isokinetic Mode

1. The isokinetic mode may be used at bi-directional velocities to stress either the internal rotators or the external rotators. This mode may also be used to replicate function (i.e., the athlete may work the external rotators at lower speeds and the internal rotators at higher speeds to replicate the throwing motion.)

Isometric Mode

1. Multi-angle isometrics may be performed early in the rehabilitation process or to work near painful points in the ROM. In this way, strength gains will be made through a portion of the unworked range.

Additional Comments

1. Subjects with impingement syndrome may best be worked in the modified neutral position and not 90 degrees of abduction.
2. A subject may be started in the modified neutral position and be worked into increasing degrees of abduction as tolerated.
3. Athletes, especially pitchers, may be worked at the 90 degree abduction position and full external rotation since this is a functional position for this group.
4. It has been found that the posterior cuff muscles act to decelerate the arm motion eccentrically during the follow-through phase of throwing. This eccentric motion may be simulated on the BIODEX System 2.
5. Some clinicians have thought of impingement syndrome as an ineffective action of the rotator cuff musculature. Use the eccentric mode to work on control.
6. As the glenohumeral joint is externally rotated, the anterior capsule undergoes a wringing which may cause an inflammatory response in the capsule. External rotation may initially be limited with ROM stop buttons or percent dials to prevent this.
7. The supraspinatus and infraspinatus tendons are considered avascular. Attention needs to be placed on the position the rotators are worked at.

Notes:

Shoulder: D1 (Standing) (Double Chair)

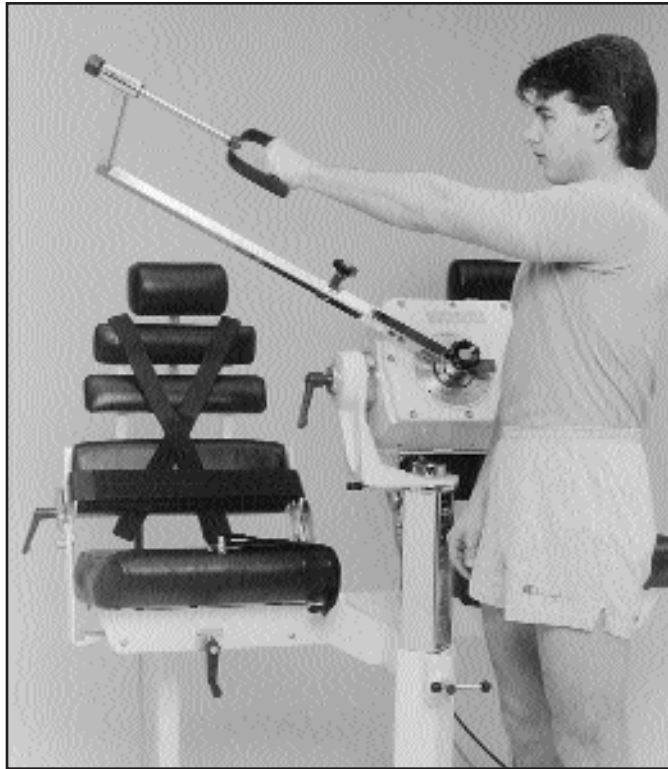


Figure 4.69

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	20 to 30°
Sensitivity:	A
Shoulder Abduction:	0°
Axis of Rotation:	
Ready Position:	Full Direction 2

Parts Needed

Powerhead:	Shoulder Attachment
Accessory Chair:	Not used for this pattern.

Shoulder: D1 (Standing) (Single Chair)

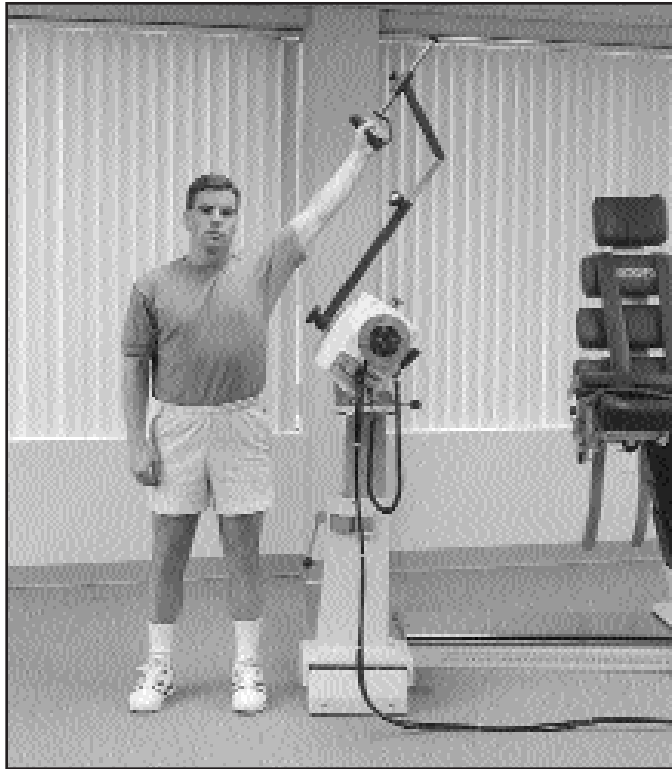


Figure 4.70

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	20 to 30°
Sensitivity:	B or C
Shoulder Abduction:	0°
Axis of Rotation:	Off axis through the glenohumeral joint.
Ready Position:	Full Direction 2

Parts Needed

Powerhead:	Shoulder Attachment
Positioning Chair:	Not used for this pattern.

Shoulder: D1 (Standing)

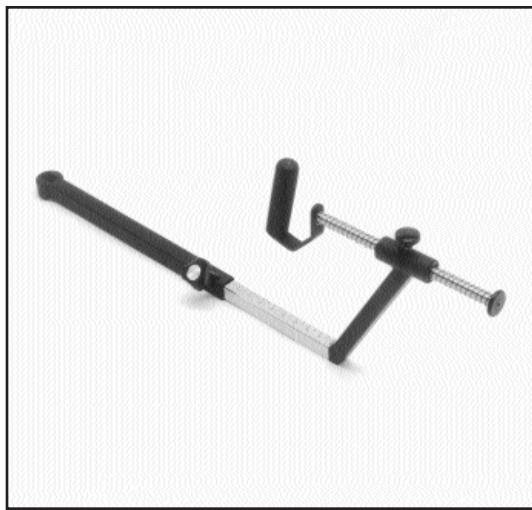


Figure 4.71

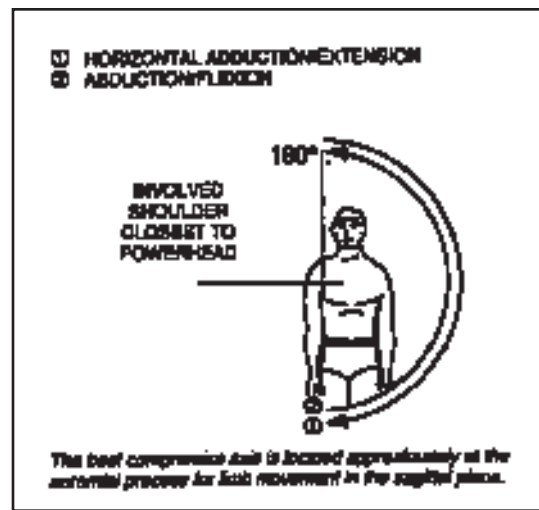


Figure 4.72

Setup and Positioning

1. Affix **SHOULDER ATTACHMENT** to powerhead shaft and secure with locking knob.
2. Position the subject standing perpendicular to the powerhead with the involved limb closest to the powerhead shaft. Adjust powerhead height so that the shaft aligns with axis of rotation for the involved shoulder.
3. Instruct subject to grasp handgrip. Adjust **SHOULDER ATTACHMENT** length as necessary. Loosen Handgrip locking knob so that **HANDGRIP** assembly is free to slide and rotate.
4. Set **ROM LIMITS**. Move subject through desired range of motion to check for comfort and proper axis alignment. Readjust ROM limits if necessary.
5. Place **REMOTE COMFORT STOP** in subject's free hand. Explain the purpose of the **COMFORT STOP**.

-
6. Select mode and proceed as required by test/therapy protocol.

Ready Position

Full Direction 2 Position

Notes:

Shoulder: D1 (Supine) (Double Chair)

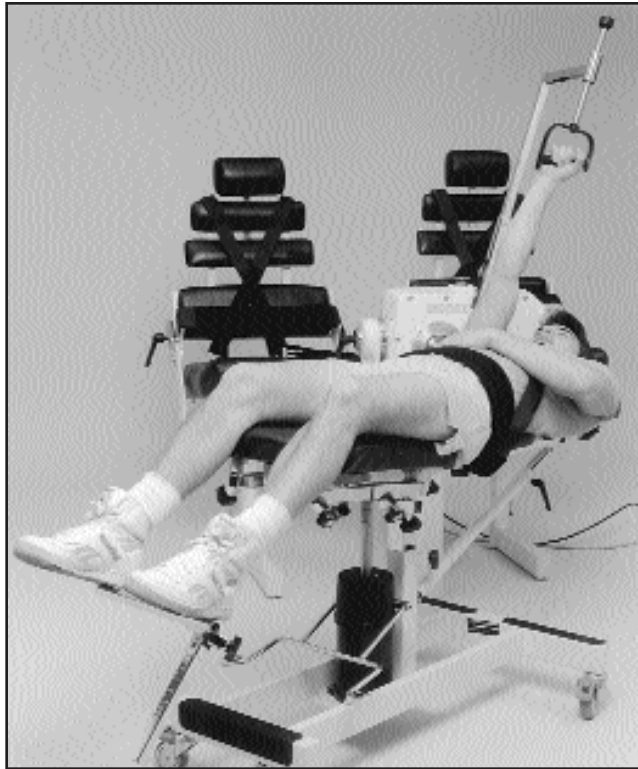


Figure 4.73

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	165° (Accessory Chair)
Seatback Tilt:	Fully reclined (Accessory Chair)
Sensitivity:	A
Shoulder Abduction:	0°
Axis of Rotation:	Off axis through the glenohumeral joint.
Ready Position:	Full Direction 2

Parts Needed

Powerhead:	Shoulder Attachment
Accessory Chair:	No additional parts needed for this pattern.

Shoulder D1 (Supine)



Figure 4.75

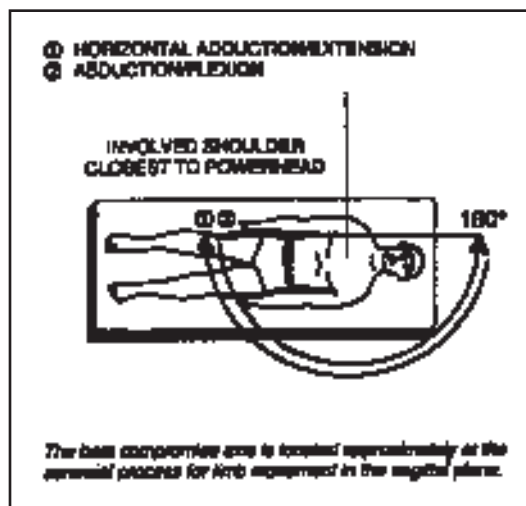


Figure 4.76

Setup and Positioning

1. Affix **SHOULDER ATTACHMENT** to powerhead shaft and secure with locking knob.
2. Instruct the subject to lie supine on the chair with the involved limb closest to the powerhead. Adjust the chair and powerhead so that the axis of rotation for the involved shoulder aligns with that of the input shaft.
3. Instruct subject to grasp handgrip. Adjust **SHOULDER ATTACHMENT** length as necessary. Loosen Handgrip locking knob so that **HANDGRIP** assembly is free to slide and rotate. Move subject through desired range of motion to check for comfort and proper axis alignment.
4. Place **REMOTE COMFORT STOP** in subject's free hand. Explain the purpose of the **COMFORT STOP**.
5. Set range of motion limits. Move limb through range of motion to check for proper positioning, axis alignment and subject comfort. Readjust ROM limits if necessary.
6. Select mode and proceed as required by test/therapy protocol.

Ready Position
Full Direction 2 Position

Notes:

Shoulder: D2 in the Standing Position (Double Chair)

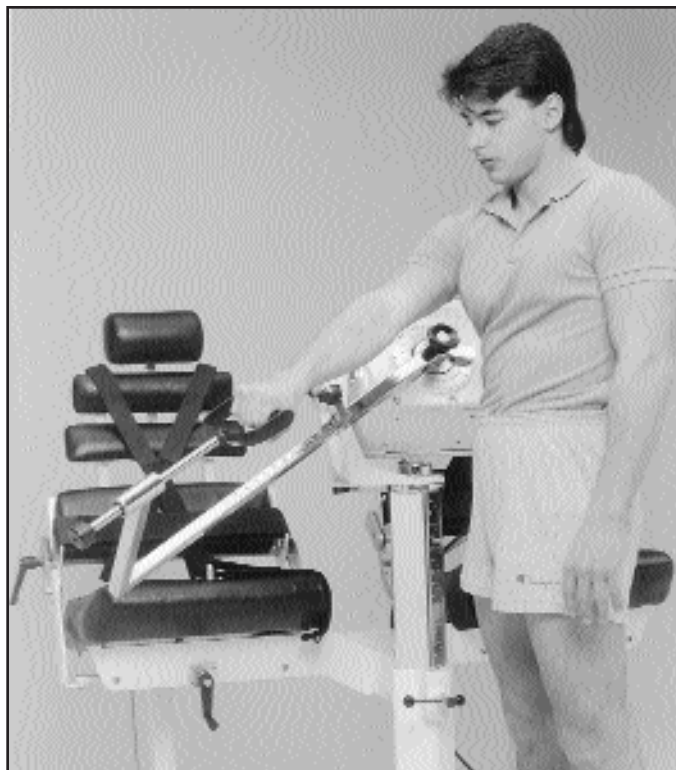


Figure 4.77

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	20 to 30°
Sensitivity:	A
Shoulder Abduction:	0°
Axis of Rotation:	
Ready Position:	Full Direction 2

Parts Needed

Powerhead:	Shoulder Attachment
Accessory Chair:	Not used for this pattern.

Shoulder: D2 in the Standing Position (Single Chair)

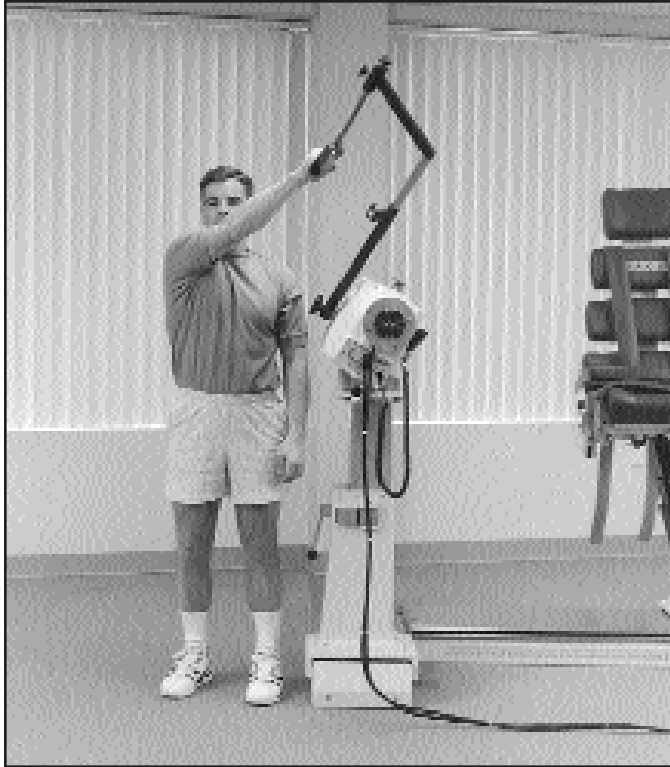


Figure 4.78

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	20 to 30°
Sensitivity:	B or C
Shoulder Abduction:	0°
Axis of Rotation:	Off axis through the glenohumeral joint.
Ready Position:	Full Direction 2

Parts Needed

Powerhead:	Shoulder Attachment
Positioning Chair:	Not used for this pattern.

Shoulder: D2 (Standing)



Figure 4.79

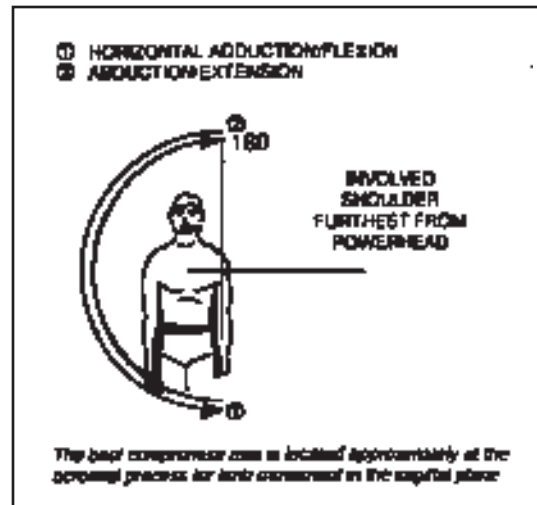


Figure 4.80

Setup and Positioning

1. Affix **SHOULDER ATTACHMENT** to powerhead shaft and secure with locking knob.
2. Position the subject standing perpendicular to the powerhead with the uninvolved limb closest to the powerhead shaft. Adjust powerhead height so that the shaft aligns with axis of rotation for the involved shoulder.
3. Instruct subject to grasp handgrip. Adjust **SHOULDER ATTACHMENT** length as necessary. Loosen Handgrip locking knob so that **HANDGRIP** assembly is free to slide and rotate.
4. Set **ROM LIMITS**. Move subject through desired range of motion to check for comfort and proper axis alignment. Readjust ROM limits if necessary.
5. Place **REMOTE COMFORT STOP** in subject's free hand. Explain the purpose of the **COMFORT STOP**.
6. Select mode and proceed as required by test/therapy protocol.

Ready Position

Full Direction 2 Position

Notes:

**Shoulder: D2 (Supine)
(Double Chair)**

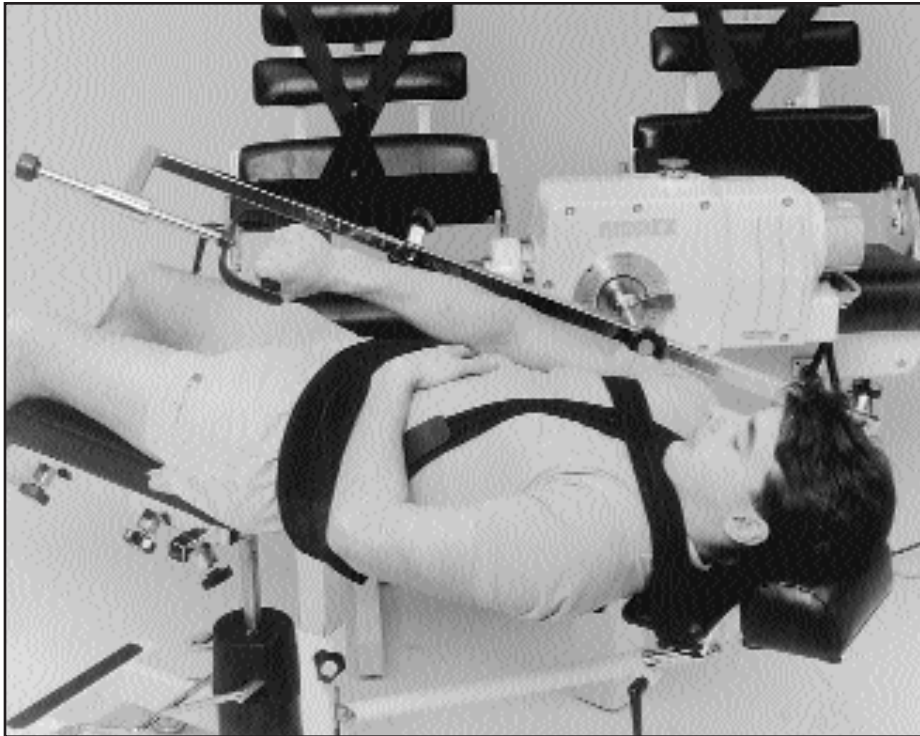


Figure 4.81

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	165° (Accessory Chair)
Seatback Tilt:	Fully reclined (Accessory Chair)
Sensitivity:	A
Shoulder Abduction:	0°
Axis of Rotation:	Off axis through the glenohumeral joint.
Ready Position:	Full Direction 2

Parts Needed

Powerhead:	Shoulder Attachment
Accessory Chair:	No additional parts needed for this pattern.

Shoulder: D2 (Supine) (Single Chair)

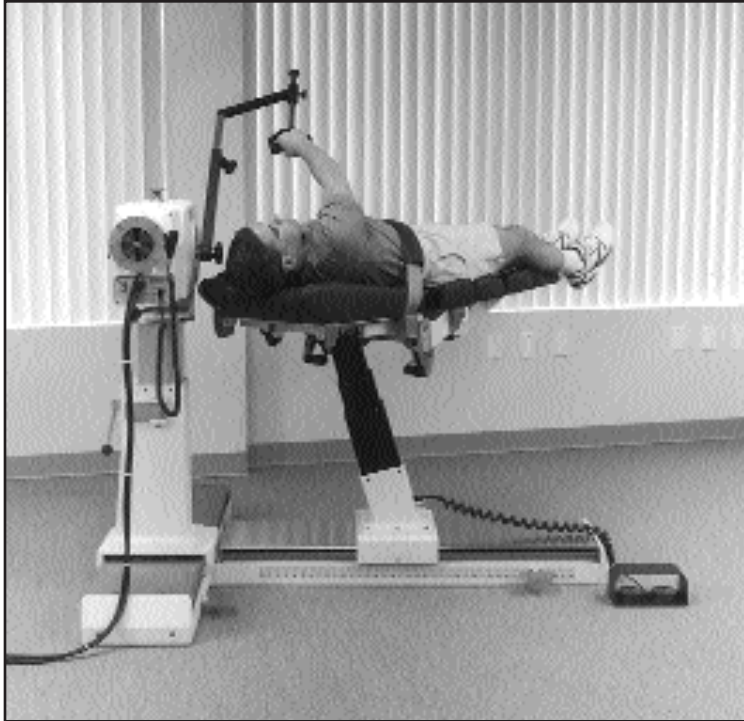


Figure 4.82

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	165°
Seatback Tilt:	Fully reclined
Sensitivity:	B or C
Shoulder Abduction:	0°
Axis of Rotation:	Off axis through the glenohumeral joint.
Ready Position:	Full Direction 2

Parts Needed

Powerhead:	Shoulder Attachment
Positioning Chair:	No additional parts needed for this pattern.

Shoulder D2 (Supine)

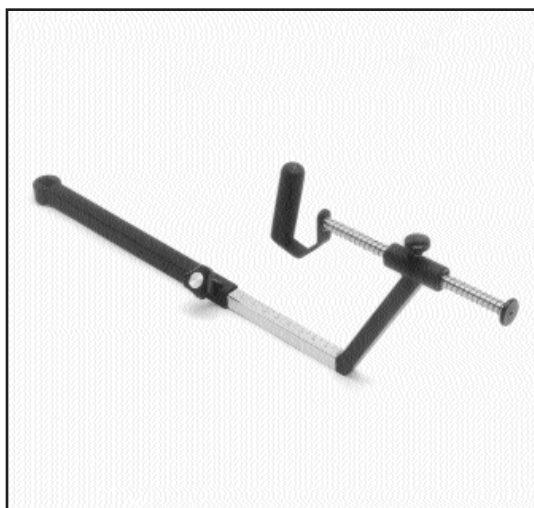


Figure 4.83

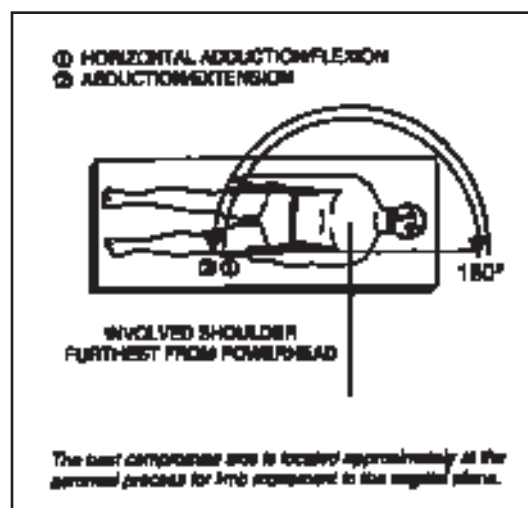


Figure 4.84

Setup and Positioning

1. Affix **SHOULDER ATTACHMENT** to powerhead shaft and secure with locking knob.
2. Instruct the subject to lie supine on the chair with the uninvolved limb closest to the powerhead. Adjust the chair and powerhead so that the axis of rotation for the involved shoulder aligns with that of the input shaft.
3. Instruct subject to grasp handgrip. Adjust **SHOULDER ATTACHMENT** length as necessary. Loosen Handgrip locking knob so that **HANDGRIP** assembly is free to slide and rotate. Move subject through desired range of motion to check for comfort and proper axis alignment.
4. Place **REMOTE COMFORT STOP** in subject's free hand. Explain the purpose of the **COMFORT STOP**.
5. Set range of motion limits. Move limb through range of motion to check for proper positioning, axis alignment and subject comfort. Readjust ROM limits if necessary.
6. Select mode and proceed as required by test/therapy protocol.

Ready Position
Full Direction 2 Position

Notes:

Elbow: Extension/Flexion (Seated) (Double Chair)

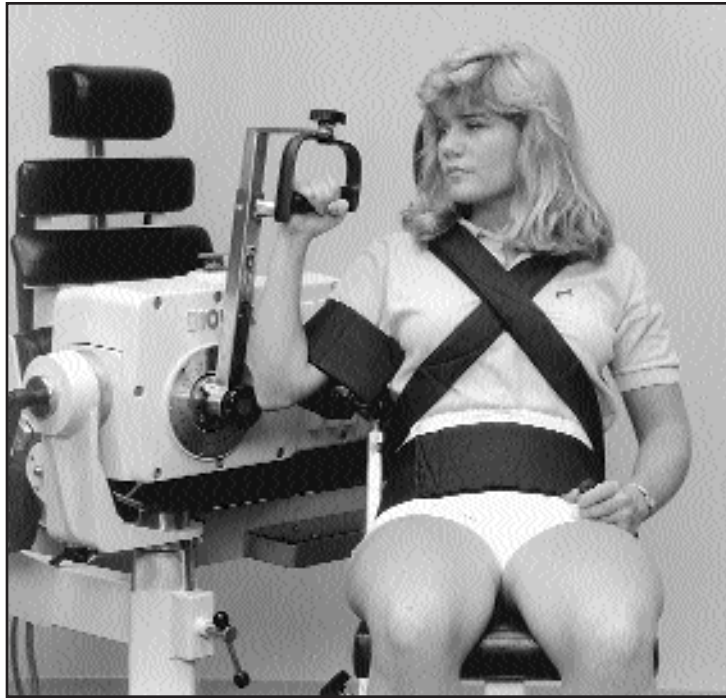


Figure 4.85

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	165° (Accessory Chair)
Seatback Tilt:	15° (Accessory Chair)
Sensitivity:	C or D
Hip Flexion:	90°
Shoulder Abduction:	25°
Axis of Rotation:	Passes through the center of the trochlea and the capitulum, bisecting the longitudinal axis of the shaft of the humerus.
Ready Position:	Full Extension

Parts Needed

Powerhead:	Elbow/Shoulder Attachment
Accessory Chair:	T-Bar Adapters (short and medium), Multi-Support Pad, Footrest (optional)

Elbow: Extension/Flexion (Seated) (Single Chair)



Figure 4.86

Quick Reference

Powerhead Orientation:	45°
Powerhead Tilt:	0°
Positioning Chair Orientation:	90°
Seatback Tilt:	15°
Sensitivity:	C or D
Hip Flexion:	90°
Axis of Rotation:	Passes through the center of the trochlea and the capitulum, bisecting the longitudinal axis of the shaft of the humerus.
Ready Position:	Full Extension

Parts Needed

Powerhead:	Elbow / Shoulder Attachment
Positioning Chair:	T-Bar Adapters (short and medium), Multi-Support Pad, Footrest (optional)

Elbow: Extension/Flexion

The elbow joint consists of the articulation between the trochlea of the humerus and the trochlear notch of the ulna, the capitulum of the humerus and the facet on the head of the radius and the circumference of the head of the radius and the radial notch of the ulna. Any bony malalignment (such as a fracture) interferes with the critical angles of these articulations making normal movement impossible.

Of special note at the elbow are the tendinous origins of the wrist musculature. The flexor/pronator muscles of the wrist originate at the medial epicondyle of the humerus and wrist extensor group at the lateral epicondyle. These are areas that frequently become inflamed with overuse.

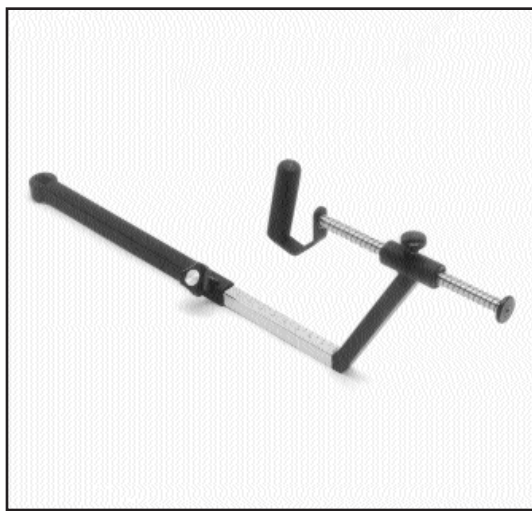


Figure 4.87

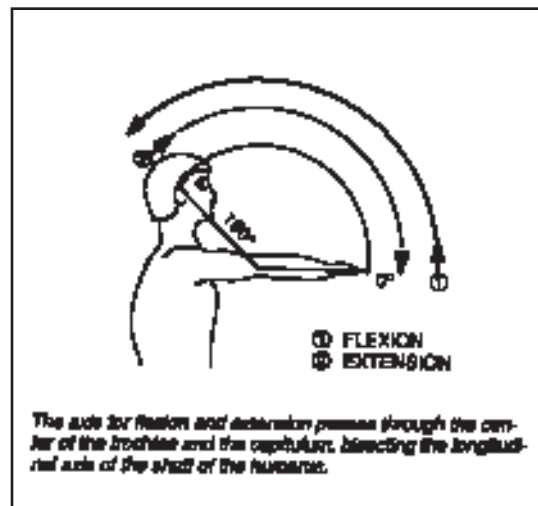


Figure 4.88

Setup and Positioning

1. Affix ELBOW / SHOULDER ATTACHMENT to powerhead shaft so that red dots align. Secure with locking knob.
2. Install FOOTREST in accessory or positioning chair, if desired.



Figure 4.89 Multi-Support Pad placement (Double Chair).



Figure 4.90 Multi-Support Pad placement (Single Chair).

3. Install MULTI-SUPPORT PAD on accessory or positioning chair as shown in Figures 4.89 and 4.90 to support the subject's upper arm, proximal to elbow (see Figures 4.85 and 4.86).
4. Seat subject in chair and with arm rested appropriately on MULTI-SUPPORT PAD. With subject's arm in the neutral position (0°) and shoulder abducted 25° , adjust powerhead and chair so that shaft is on same horizontal plane as elbow axis of rotation. The axis for flexion and extension of the elbow passes through the center of the trochlea and the capitulum.
5. Instruct subject to grasp handgrip. Adjust handle length so that handgrip sliding assembly is in approximate middle of range. To do this, unscrew the locking knob and slide the assembly in the appropriate direction. Tighten the knob to secure. Handgrip should be on same plane of movement as the subject's forearm. Readjust MULTI-SUPPORT PAD, if necessary, and secure by tightening pad adjust lever.
6. Readjust chair and powerhead, if necessary, to refine axis alignment.
7. Set range of motion limits. Move limb through range of motion to check for proper positioning and subject comfort. Readjust ROM limits if necessary.
8. Stabilize subject with pelvic and SHOULDER STRAPS.

-
-
9. Place remote comfort stop in subject's free hand. Explain the purpose of the Comfort Stop.
 10. Select mode and proceed as required by test/therapy protocol.

Ready Position

Full Extension (0°)

Clinical Applications of Biodex Operating Modes:

Passive Mode

1. The passive mode may be used to treat inflammatory conditions of the elbow. Many times when rest is recommended it does not mean total immobilization but the elimination of activities that cause pain. The passive mode may be used for the effects of continuous passive motion.
2. The passive mode may be used to perform non-reciprocal contractions, e.g., working the extensors at the end range of motion both concentrically and eccentrically, as it is not uncommon for elbow extension to be compromised after injury or fracture.

Eccentric Mode

1. The eccentric mode may be used to simulate job specific tasks, e.g., the eccentric mode may be used to work the elbow flexors, eccentrically as if the worker were lowering a heavy box.

Isokinetic Mode

1. The isokinetic mode may be used to work the elbow bi-directionally. In this way job specific tasks, functional tasks, or sports activities may be simulated.

Isometric Mode

1. Isometrics may be used when pain or inflammation is a concern. Multi-angle isometrics are recommended.

Additional Comments

1. It has been recommended by some clinicians that the dominant arm should be 5% stronger than the nondominant arm in recreational athletes and 10% stronger in competitive athletes.
2. Ice may be applied to the site of the lesion while the patient is in the passive mode for approximately fifteen minutes.

-
3. For cases of capsular tightness. Place the patient in the passive mode. Red range of motion limit set buttons may be set to encompass a slightly greater range of motion than the patient currently is capable of moving. The percent range dials should be turned down to 50% and the patient should be placed on the unit. Slowly and with caution, the percent ROM dials should be turned up. NEVER EXCEED A COMFORTABLE OR PHYSIOLOGICAL RANGE OF MOTION. ALWAYS HAVE THE COMFORT STOP AVAILABLE. The pause may also be used for a passive stretch at end range.
 4. The elbow is frequently injured by the repeated application of stresses. Throwing injuries commonly occur secondary to throwing too frequently and throwing repeatedly at maximum force. These injuries may be treated by working either passively, isokinetically, or eccentrically at submaximal levels.
 5. Position the handgrip to concentrate on specific muscle groups. If desired, keep the handgrip loose to obtain active supination or pronation.

Forearm: Pronation/Supination (Double Chair)



Figure 4.91

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	15° (shaft down)
Seat Orientation:	180° (Accessory Chair)
Seatback Tilt:	15° (Accessory Chair)
Sensitivity:	D or E
Elbow Flexion:	90°
Shoulder Abduction:	0°
Axis of Rotation:	Axis of rotation for this pattern is the longitudinal line through the center of the head of the radius proximally, and through the center of the head of the ulna distally.
Ready Position:	Full Pronation

Parts Needed

Powerhead:	Forearm/Wrist Attachment
Accessory Chair:	T-Bar Adapter, Multi-Support Pad, Footrest (optional)

Forearm: Pronation/Supination (Single Chair)

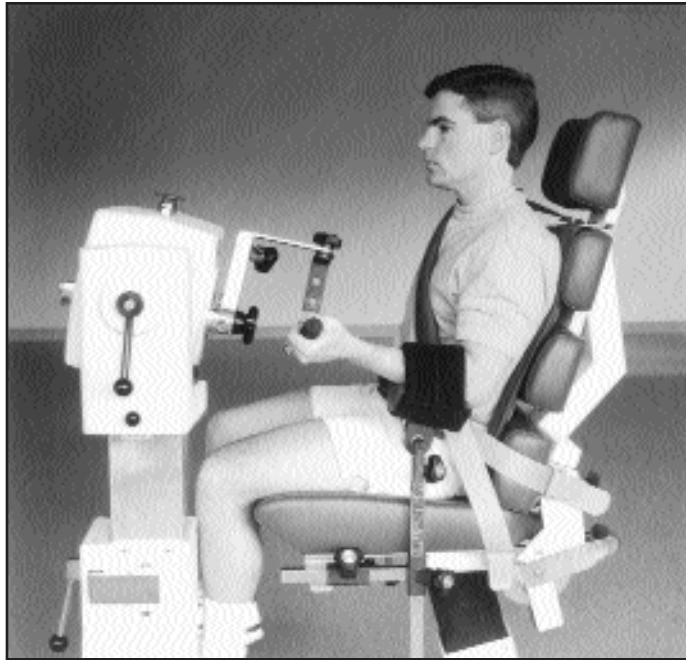


Figure 4.92

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	15° (shaft down)
Seat Orientation:	0°
Seatback Tilt:	15°
Sensitivity:	D or E
Elbow Flexion:	90°
Shoulder Abduction:	0°
Axis of Rotation:	Axis of rotation for this pattern is the longitudinal line through the center of the head of the radius proximally, and through the center of the head of the ulna distally.
Ready Position:	Full Pronation

Parts Needed

Powerhead:	Forearm/Wrist Attachment
Positioning Chair:	T-Bar Adapter (short and medium), Multi-Support Pad, Footrest (optional)

Forearm: Pronation/Supination

Pronation and supination occur when the forearm rotates around a longitudinal axis passing through the head of the radius and center of the distal ulna. During pronation/supination, the radial head articulates with the capitellum of the humerus and the radial notch of the ulna. Distally the radius and articular disc of the distal radioulnar joint articulates with the scaphoid, lunate and triquetrum. The radius carries the wrist about the ulna during pronation and supination. Pronation/supination may be a particularly difficult motion to fully achieve after injury secondary to the complex nature of the movement.



Figure 4.93

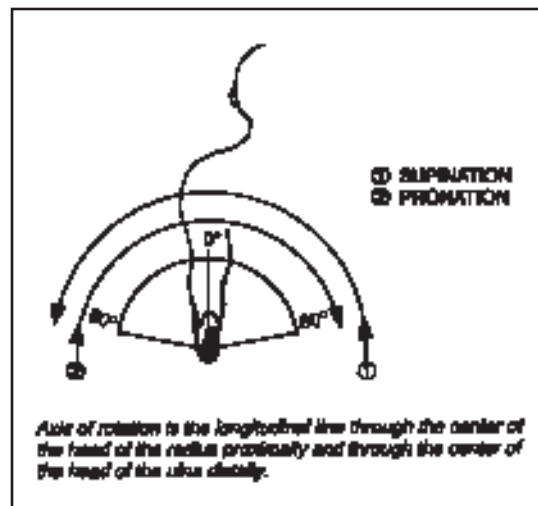


Figure 4.94

Setup and Positioning

1. Affix FOREARM/WRIST ATTACHMENT to powerhead shaft so that red dots align. Secure with locking knob. The fixture handle should point up when the red dots are aligned.
2. Install MULTI-SUPPORT PAD in accessory or positioning chair, as shown in Figures 4.95 and 4.96 to stabilize and support subject's forearm. Loosen the MULTI-SUPPORT PAD ADJUST LEVER and set pad tilt to 15°. Re-tighten the tilt lever to secure.
3. Install FOOTREST in accessory or positioning chair, if desired.



Figure 4.95 Multi-Support Pad placement (Double Chair).



Figure 4.96 Multi-Support Pad placement (Single Chair).

4. Instruct subject to sit on chair and grasp the HANDGRIP while resting mid-forearm on MULTI-SUPPORT PAD. Adjust Powerhead and chair to align forearm axis of rotation with powerhead shaft in sagittal plane. The axis of rotation for this pattern is a longitudinal line through the center of the head of the radius proximally and through the center of the head of the ulna distally.

Subject should be able to grasp handgrip with elbow in 90° flexion and shoulder in a comfortable neutral position (with no elevation). If necessary adjust height of MULTI-SUPPORT PAD. Secure pad strap to patient tolerance but not tight enough to inhibit the desired movement.

5. Set range of motion limits. Move limb through range of motion to check for proper positioning and subject comfort. Readjust ROM limits if necessary.
6. Stabilize subject with pelvic and SHOULDER STRAPS.
7. Place REMOTE COMFORT STOP in subject's free hand. Explain the purpose of the COMFORT STOP.
8. Select mode and proceed as required by test/therapy protocol.

READY POSITION
Full Pronation

Clinical Applications of Biodex Operating Modes:

Passive Mode

1. The passive mode is important for the effects of continuous passive motion. The passive mode may be used to initiate treatment of reflex sympathetic dystrophy.
2. The passive mode may be used to work a specific muscle group both concentrically and eccentrically, e.g., after a colles fracture, supination may be limited secondary to immobilization. The supinators may be worked both concentrically and eccentrically to gain motion and increase strength.

Eccentric Mode

1. The eccentric mode may be used to strengthen the musculotendinous junction. This may be important since the wrist is frequently used eccentrically during functional activities.

Isokinetic Mode

1. The isokinetic mode may be used at bidirectional velocities in order to simulate functional or sports activities.

Isometric Mode

1. The isometric mode may be used to strengthen musculature when pain, instability or surgery is a factor.

Additional Comments

1. At certain times, full range of motion may never be achieved, e.g., if in a colles fracture the distal radial fragment moves toward supination, there may be a permanent loss of pronation.
2. With involvement of the wrist, be careful of shoulder-hand syndrome. Be sure to mobilize the entire upper extremity.
3. If edema is a concern, the dynamometer and multi-support fixture may be raised during rehabilitation.



Notes:



Wrist: Extension/Flexion (Double Chair)

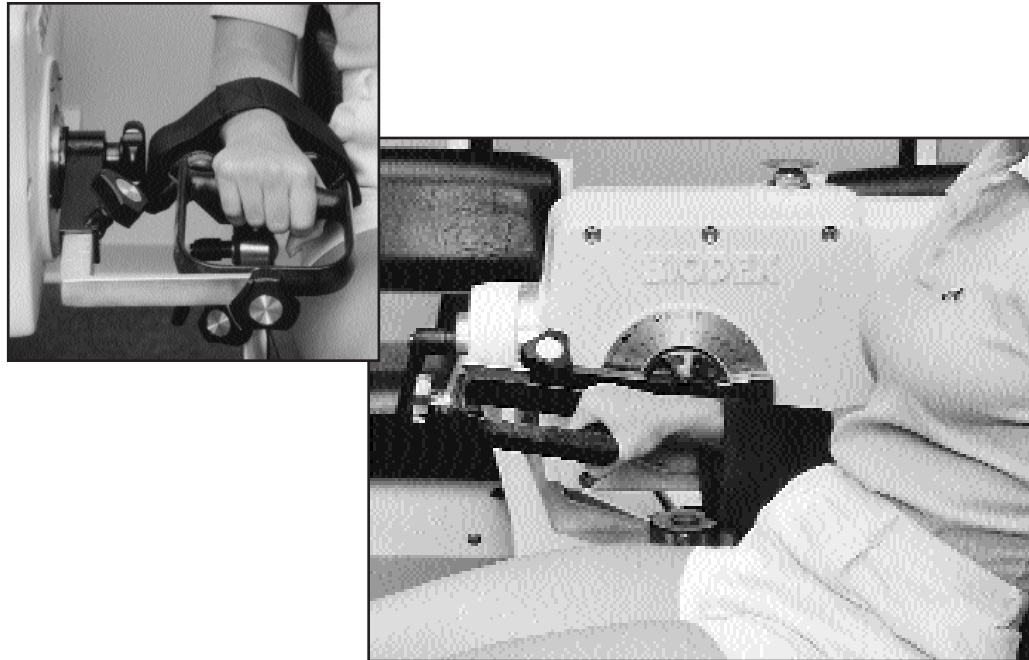


Figure 4.97

Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	90° (Accessory Chair)
Seatback Tilt:	15° (Accessory Chair)
Sensitivity:	D or E
Elbow Flexion:	90°
Shoulder Abduction:	0°
Axis of Rotation:	Axis of rotation for this pattern lies between the proximal row of the carpals, at the capitate bone, and the radius at the radiocarpal joint.
Ready Position:	Full Flexion

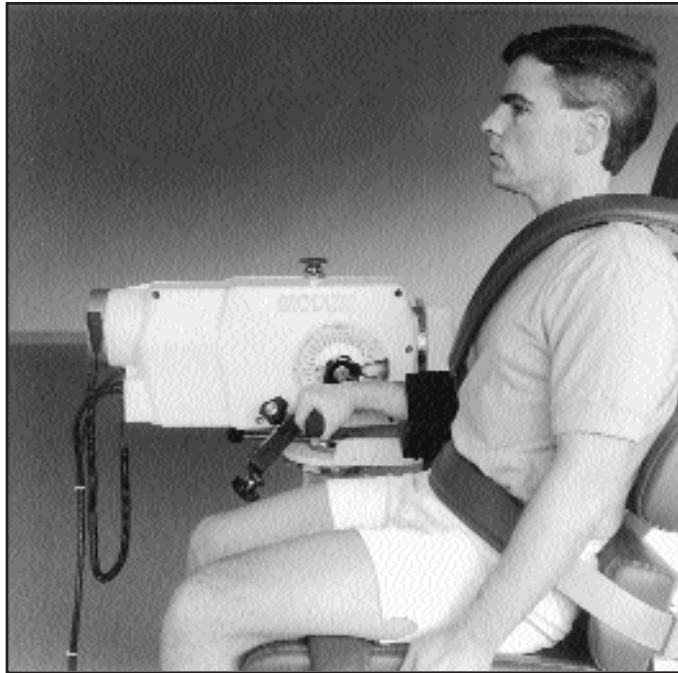
Parts Needed

Powerhead:	Forearm/Wrist Attachment
-------------------	--------------------------

Accessory Chair:

T-Bar Adapter (short and medium),
Multi-Support Pad, Footrest (optional)

Wrist: Extension/Flexion



(Single Chair)

Figure 4.98

Quick Reference

Powerhead Orientation:	0°
Powerhead Tilt:	0°
Seat Orientation:	0°
Seatback Tilt:	15°
Sensitivity:	D or E
Elbow Flexion:	90°
Shoulder Abduction:	0°
Axis of Rotation:	Axis of rotation for this pattern lies between the proximal row of the carpals, at the capitate bone, and the radius at the radiocarpal joint.
Ready Position:	Full Flexion

Parts Needed

Powerhead:
Positioning Chair:

Forearm/Wrist Attachment
T-Bar Adapters (short and medium),
Multi-Support Pad, Footrest (optional)

Wrist: Extension/Flexion

The wrist joint consists of the distal end of the radius and the articular disc of the distal radioulnar joint articulate with the proximal row of carpal bones (scaphoid, lunate, and triquetrum.) The carpal bones form a much larger surface than do the radius and the articular cartilage. This allows for adduction/abduction, flexion/extension and circumduction to occur.



Figure 4.99

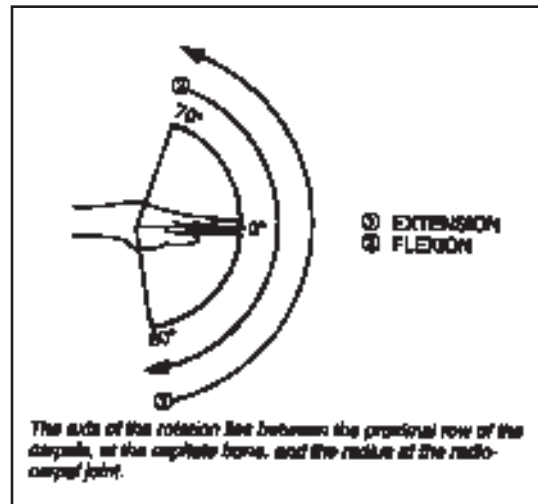


Figure 4.100

Movement also occurs between the proximal and distal row of carpal bones. The midcarpal joint adds considerably to flexion and extension of the wrist.

Setup and Positioning

1. Affix FOREARM/WRIST ATTACHMENT to powerhead shaft so that red dots align. Secure with locking knob.
2. Install MULTI-SUPPORT PAD in accessory or positioning chair, as shown in Figures 4.101 and 4.102 to stabilize and support subject's forearm. If necessary, loosen the MULTI-SUPPORT PAD TILT ADJUST LEVER and tilt the pad so that it will support the subjects arm in a horizontal position (parallel to the floor). Re-tighten the tilt lever to secure.
3. Install FOOTREST in accessory or positioning chair, if desired.



Figure 4.101 Multi-Support Pad placement (Double Chair).

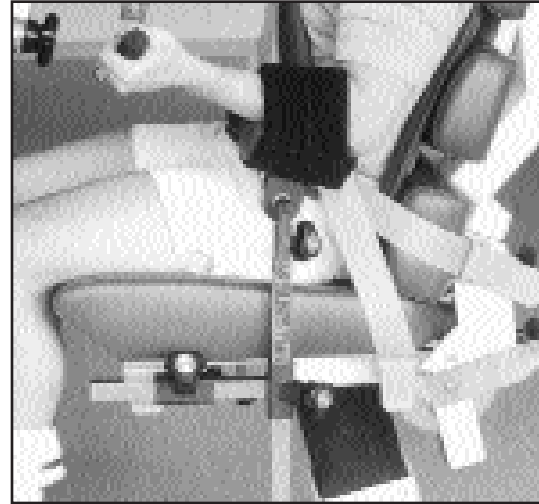


Figure 4.102 Multi-Support Pad placement (Single Chair).

4. Instruct subject to sit on chair and grasp the HANDGRIP while resting mid-forearm on MULTI-SUPPORT PAD. Adjust powerhead and chair to align the wrist axis with powerhead shaft. The axis of rotation for this pattern lies between the proximal row of carpals, at the capitate bone, and the radius at the radiocarpal joint. If necessary, loosen the locking knob on the shaft of the FOREARM/WRIST FIXTURE and adjust fixture length. Tighten the locking knob to secure.

Subject should be able to grasp handgrip with elbow in 90° flexion and shoulder in a comfortable neutral position (with no elevation). If necessary readjust height of MULTI-SUPPORT PAD. Secure support pad strap to stabilize forearm.

5. Set range of motion limits. Move limb through range of motion to check for proper positioning and subject comfort. Readjust ROM limits if necessary.
6. Stabilize subject with pelvic and SHOULDER STRAPS.
7. Place REMOTE COMFORT STOP in subject's free hand. Explain the purpose of the COMFORT STOP.
8. Select mode and proceed as required by test/therapy protocol.

READY POSITION

Full Flexion

Clinical Applications of Biodex Operating Modes:

Passive Mode

1. The passive mode may be used for continuous passive motion effects. It may also be used to maintain/increase range of motion, e.g., this is especially important in a colles fracture when regaining range of motion is most difficult.
2. The passive mode may be used in cases of reflex sympathetic dystrophy which frequently develops in conjunction with a colles fracture. These patients may receive sympathetic blocks followed by mobilization and range of motion. The patient may move passively at first and, as tolerated, begin to assist the motion in each direction.
3. The passive mode may be used to work non-reciprocally. In this way the wrist, both muscle groups or one muscle group may be exercised concentrically/eccentrically or vice versa, e.g., in cases of tennis elbow with involvement of the common extensor tendon at the elbow, the wrist extensors may be worked concentrically/eccentrically by having the patient assist wrist extension and resist wrist flexion.

Eccentric Mode

1. The eccentric mode may be used to simulate functional activities. Sub-maximal eccentrics have been used successfully to treat tendonitis.

Isokinetic Mode

1. The isokinetic mode may be used bi-directionally to emphasize one particular muscle group, e.g., in cases of golfer's elbow where there is involvement of the flexor tendon at the elbow, the wrist flexors may be worked at low speeds and the extensors at high speeds.

Isometric Mode

1. Isometrics may be used after periods of immobilization or surgery. Isometrics may be used to strengthen musculature after very delicate surgical procedures, e.g., isometrics may be the first step in treating a scapholunate advanced collapse wrist.

Additional Comments

1. Whenever there is wrist involvement, it is important to examine shoulder and elbow movements. If there is immobility in these areas, the passive mode on the BIODEx System 2 may be used to improve ROM.

-
2. Wrist flexion and extension exercises are frequently performed with the forearm pronated because tests have demonstrated that a greater mean torque can be produced than when in supination.
 3. Use of the work tools on the BIODEX System 2 may be an important adjunct in returning a patient to work.

Notes:



Wrist: Radial/Ulnar Deviation (Double Chair)

Figure 4.103

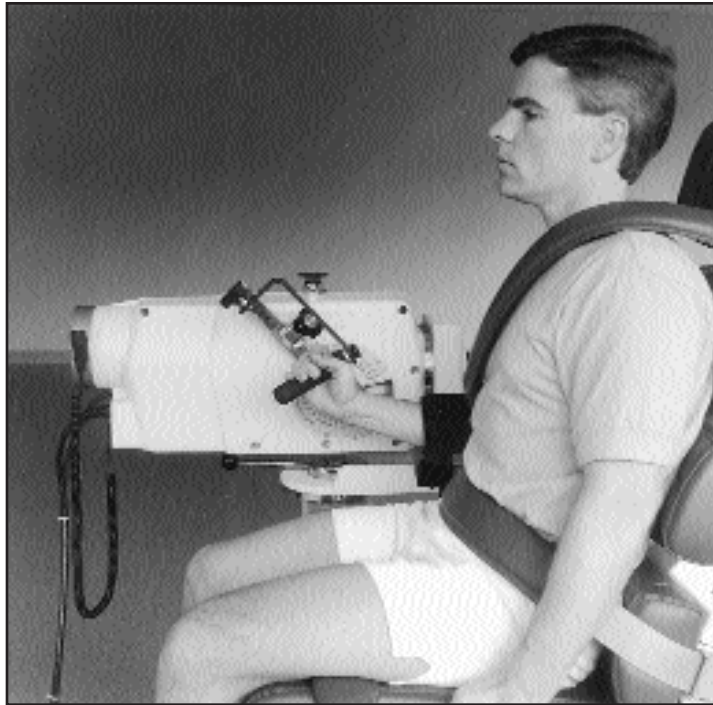
Quick Reference

Powerhead Orientation:	90°
Powerhead Tilt:	0°
Seat Orientation:	90° (Accessory Chair)
Seatback Tilt:	15° (Accessory Chair)
Sensitivity:	D or E
Elbow Flexion:	90°
Shoulder Abduction:	0°
Axis of Rotation:	Axis of rotation for this pattern is at approximate center of capitate bone if viewed from the palmar surface of the hand.
Ready Position:	Full Ulnar Deviation

Parts Needed

Powerhead:
Accessory Chair:

Forearm/Wrist Attachment
T-Bar Adapters (short and medium),
Multi-Support Pad, Footrest (optional)



**Wrist: Radial/Ulnar Deviation
(Single Chair)**

Figure 4.104

Quick Reference

Powerhead Orientation:	0°
Powerhead Tilt:	0°
Seat Orientation:	0°
Seatback Tilt:	15°
Sensitivity:	D or E
Elbow Flexion:	90°
Shoulder Abduction:	0°
Axis of Rotation:	Axis of rotation for this pattern is at approximate center of capitate bone if viewed from the palmar surface of the hand.
Ready Position:	Full Ulnar Deviation

Parts Needed

**Powerhead:
Positioning Chair:**

Forearm/ Wrist Attachment
T-Bar Adapters (short and medium),
Multi-Support Pad, Footrest (optional)
Wrist: Radial/Ulnar .

Radial/ Ulnar deviation involves radiocarpal and midcarpal movement. Ulnar deviation occurs over a greater ROM than radial deviation. Radial



Figure 4.105

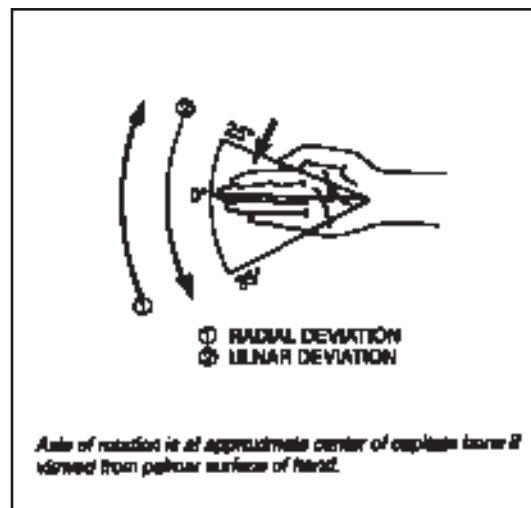


Figure 4.106

deviation is limited by bony contact of the scaphoid tubercle against the radial styloid.

Setup and Positioning

1. Affix FOREARM/WRIST ATTACHMENT to powerhead shaft so that red dots align. Secure with locking knob.
2. Install MULTI-SUPPORT PAD in accessory or positioning chair, as shown in Figures 4.107 and 4.108 to stabilize and support subject's forearm. If necessary, loosen the MULTI-SUPPORT PAD TILT ADJUST LEVER and tilt the pad so that it will support the subjects arm in a horizontal position (parallel to the floor). Re-tighten the tilt lever to secure.
3. Install FOOTREST in accessory or positioning chair, if desired.



Figure 4.107 Multi-Support Pad placement (Double Chair).

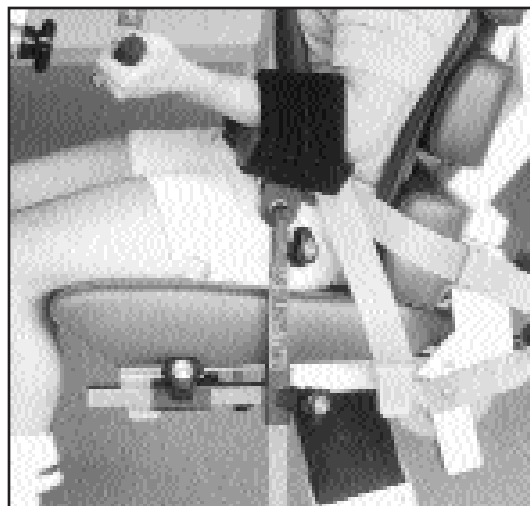


Figure 4.108 Multi-Support Pad placement (Single Chair).

4. Instruct subject to sit on chair and grasp the HANDGRIP while resting mid-forearm on MULTI-SUPPORT PAD. Adjust powerhead and chair to align the wrist axis with powerhead shaft. The axis of rotation for this pattern is located at the approximate center of the capitate bone if viewed from the palmer surface of the hand. If necessary, loosen the locking knob on the shaft of the FOREARM/WRIST FIXTURE and adjust fixture length. Tighten the locking knob to secure.

Subject should be able to grasp handgrip with elbow in 90° flexion and shoulder in a comfortable neutral position (with no elevation). If necessary readjust height of MULTI-SUPPORT PAD. Secure support pad strap to stabilize forearm.

5. Set range of motion limits. Move limb through range of motion to check for proper positioning and subject comfort. Readjust ROM limits if necessary.
6. Stabilize subject with pelvic and SHOULDER STRAPS.
7. Place REMOTE COMFORT STOP in subject's free hand. Explain the purpose of the COMFORT STOP.
8. Select mode and proceed as required by test/therapy protocol.

READY POSITION

Full Ulnar Deviation

Clinical Applications of Biodex Operating Modes:

Passive Mode

1. The passive mode may be used post-surgically in order to gain range of motion. e.g. After surgery to correct a scapholunate advanced collapse, place the patient in the passive mode at the range he/she has available and gradually increase as warranted.
2. The passive mode may be used to perform concentric/concentric, concentric/eccentric, eccentric/concentric, and eccentric/eccentric contraction types. It is important to perform multiple contraction types when rehabilitating the wrist since the hand performs such a wide variety of functional tasks.

Eccentric Mode

1. The eccentric mode may be used to perform submaximal eccentrics or to simulate functional activities.

Isokinetic Mode

1. The isokinetic mode may be used at bi-directional velocities to simulate function or to emphasize one particular muscle group.

Isometric Mode

1. Isometrics may be used after delicate surgical procedures or when instability is a concern. The physician and therapist's expertise and the type of surgery that has been performed must be taken into account when beginning any form of exercise.

Additional Comments

1. Swelling may be a concern when exercising the wrist and hand. If so, the multi-support fixture and dynamometer may be raised to keep the hand above the level of the heart.
2. At times, there may be situations where full range of motion cannot be achieved. In a colles fracture, secondary to malalignment during healing, there may be a permanent loss in ulnar deviation. In this case, it is important to work on motions that may have been limited during immobilization such as ulnar deviation.
3. Whenever the wrist is involved, it is important to evaluate the entire upper extremity for lack of mobility and then treat accordingly.

REFERENCE MATERIALS

Suggested Test Speeds

Joint	Pattern	Orthopedic Patient	Athlete
Knee	Extension/Flexion	(60), 180, 300	180, 300, 450
Knee	Tibial External/Internal Rotation	(60), 60, 120	120, 180, 240
Shoulder	Abduction/Adduction	(60), 180, 300	180, 300, 450
Shoulder	Flexion/Extension	(60), 180, 300	180, 300, 450
Shoulder	External/Internal Rotation	(60), 180, 300	180, 300, 450
Shoulder	D1, D2	(60), 180, 300	180, 300, 450
Shoulder	Horizontal Abduction/Adduction	(60), 180, 300	180, 300, 450
Elbow	Flexion/Extension	(60), 180, 300	180, 300
Wrist	Extension/Flexion	60, 120	120, 180
Wrist	Radial/Ulnar Deviation	60, 120	120, 180
Forearm	Supination/Pronation	60, 120	120, 180, 240
Ankle	Plantarflexion/Dorsiflexion	60, 120	(60), 120, 180
Ankle	Eversion/Inversion	60, 120	(60), 120, 180
Hip	Flexion/Extension	(120), 180, 300	180, 300, 450
Hip	Abduction/Adduction	(120), 180, 300	180, 300, 450
	Internal/External Rotation	60, 120	120, 180

NOTE: Test speeds in parenthesis may be approximate depending on pathology.

Research Articles and Abstracts

Physical Therapy Volume 68/Number 6/May 1988

R-089

RELIABILITY OF THE BIODEX B-2000 ISOKINETIC DYNAMOMETER.

Wilk KE, Johnson RD, Levine B (Chicagoland Orthopaedic Rehabilitation Services, Ltd. (7600 W. College Drive, Palos Heights, IL 60463)

The purpose of this paper was to determine the degree of test-retest repeatability of the Biodex B-2000 Isokinetic Dynamometer. This system is used clinically and in research to quantitatively measure muscular strength, power, and endurance as well as joint integrity. Four parameters were evaluated for reliability. These were: 1) peak torque (PT), 2) total work (TW), 3) angle of peak torque (APT), and 4) average power (AP).

Twenty-four adults (12 males) with a mean age of 32.2 participated in the study. Of the 24 subjects studied (18 healthy knees) six individuals reported a history of knee pathology (4 postoperatively). Testing was performed for knee extensors (E) and flexors (F) at isokinetic speeds of 60, 180, 300 and 450 o/s. Test procedures regarding positioning and stabilization followed the recommendations of the manufacturer. The machine was calibrated at the initiation of the study. The lever arm length, warm-up and test reps were constant throughout the study. Each subject was tested twice, with two days rest between tests.

Pearson Product moment correlation coefficients and paired t-tests were used to determine reliability at all test speeds.

The results regarding PT for knee E and F ranged from .93 to .99. Results for TW for knee E and F ranged from .73 to .93, and for AP from .95 to .99. Regarding APT the range was .01 to .59.

The results of this study support: the reliability of the Biodex B-2000 for PT, AP, and TW. This study is clinically relevant because isokinetic testing is a common test performed by clinicians, and a reliable device must be employed to determine muscular deficiencies and balances, and to chart and monitor progress.

Eccentric Contraction Research Conclusions

1. Eccentric contractions produce greater intramuscular tension than concentric contractions. (3,4)
2. Eccentric contractions exhibit different length-tension curves than concentric contractions. (1,3)
3. Eccentric contractions produce less motor-unit activation than concentric contractions. (3,5)
4. Eccentric contractions are required in a majority of daily sports and activities. (2)
5. The mechanical and physical aspects of eccentric contractions are currently under intensive study. (2)
6. Although eccentric exercise can produce delayed-onset muscle soreness (DOMS), many investigators see the eccentric component as a vital aspect of the muscular conditioning process. (6)
7. Submaximal eccentric isotonic and isokinetic training produce significant gains in maximal concentric isokinetic muscle performance ability. (7)
8. A physiological overflow effect is present for concentric velocities at least 100 deg/sec faster than the eccentric training speeds. (7)
9. Submaximal eccentric isotonic and isokinetic training produce significant gains in maximal eccentric isokinetic muscle performance ability. (7)
10. A physiological overflow effect is present from isotonic training to eccentric velocities at least 60 deg/sec faster. (7)
11. Eccentric isotonic training had a significantly greater effect on the enhancement of quadriceps muscle performance than did submaximal eccentric isokinetic training. (7)

² Duncan, P., et al. Mode and specificity of eccentric and concentric exercise training. *JOSPT*. 11(2):70-75, 1989.

³ Knuttgen, H.G., et al. O₂ uptake and HR response to exercise performed with concentric and eccentric and muscle contractions. *Med. Sci. Sport*. 3:1-5, 1971.

⁴ Komi, P.V. EMG activity of the leg extensor muscles with special reference to mechanical efficiency in concentric and eccentric exercise. *Int. J. Sports Med.* (suppl) 8:22-29, 1987.

⁵ Komi, P.V. Effects of eccentric and concentric muscle contraction on tension and electrical activity of human muscle. *Ergonomics*. 15:417-43, 1972.

⁶ Newhan, D.J., et al. Pain and fatigue after concentric and eccentric muscle contraction. *J. Appl. Physiol.* 63:1382-1386, 1987.

⁷ Timm, K., Malone, T. An investigation of submaximal isotonic versus submaximal isokinetic eccentric muscle training. Submitted for publication, *JOSPT*.

Legal Precedent for Biodex Evidence

In a recent Florida court decision, the BIODEX System was accepted into evidence as a measure of dynamic human function. This decision establishes a precedent with important medical/legal implications for all rehabilitation professionals. In the future, the testifying therapist need only cite the precedent case number for Biodex evidence to be accepted as valid.

Sue Chestnut, P.T., of Plantation Physical Therapy, testified as a witness for the plaintiff during the trial Larry Beard vs. State Paving Co. The trial convened the week of May 21, 1986 in Broward County Circuit Court, Fort Lauderdale, Florida. Case #81-12431 CH.

The plaintiff had sustained injuries in an automobile accident and was recommended to Sue's offices in Plantation, Florida for rehabilitation. Shortly before trial, a work-up on the patient was done on the BIODEX System. Evidence introduced indicated that the individual had a functional deficit on his affected side of 50%.

"BIODEX evidence was integral to the case," said Sue in a recent conversation. "The evidence was the only factual measure of his functional ability introduced during the trial."

Sue was able to explain to the jury exactly how the Biodex functioned and what it was used for. This included explaining the difference between the Biodex and one of the original Isokinetic devices. The attorney for the defense was familiar with the older system, but the Biodex was new to him.

After Sue had outlined the differences to the attorney, neither the presiding judge, Honorable Robert Andrews, nor the attorney had any further question or objection. The evidence as then legally admitted in a United States court of law for the first time.

Evidently, not only were the judge and attorneys the only ones impressed with Sue's testimony. The jury retired to consider its verdict and returned with a ruling in favor of Sue's client.

Biodex Data Admitted as Medical Evidence in Court

1. Larry Beard vs. State Paving Co.
Broward County Circuit Court
Ft. Lauderdale, FL
Docket No. 81-12431 CH
Judge: Hon. Robert Andrews
2. Gilbert Green vs. Delta Airlines
Federal Court
Ft. Lauderdale, FL
Docket No. 85-6656 CIVJAG
Attorney: David Kratlin, Esq.
3. Grace Monico vs. G.E. Credit Corp.
Broward County Court
Plantation, FL
Docket No. 87-000 75CA
Attorney: Jeffrey Fenster, Esq.

Bibliography

Ankle

1. Close JR, Inman VT, Poor PM, Todd FN: The Function of the Subtalar Joint. *Clinical Orthopaedics and Related Research* 50: 159-179, 1967.
2. Gross M: Effects of Recurrent Lateral Sprains if Active and Passive Judgments of Joint Position. *Physical Therapy* 67 (10): 1505-1509, 1987.
3. Oberg B, Bergman T, Tropp H: Testing of Isokinetic Muscle Strength in the Ankle. *Medicine and Science in Sports and Exercise* 19 (3): 318-322, 1987.
4. Smith RW, Reischl SF: Treatment of Ankles in Young Athletes. *The American Journal of Sports Medicine* 14 (6): 465-471, 1986.
5. Stormont DM, Morrey BF, Cass JR: Stability of the Loaded Ankle. *The American Journal of Sports Medicine* 13 (5): 295-300, 1985.

Eccentrics

1. Dean E: Physiology and Therapeutic Implications of Negative Work-A Review. *Physical Therapy* 68 (2): 233-237.
2. Ellenbecker TS, Davies GJ, Rowinski MJ: Concentric Versus Eccentric Strengthening of the Rotator Cuff. *The American Journal of Sports Medicine* 16(1): 64-69, 1988.
3. Friden J, Seger J, Sjostrom M, Ekblom B: Adaptive Response in Human Skeletal Muscle Subjected to Prolonged Eccentric Training. *International Journal of Sports Medicine* 4: 177-183, 1983.
4. Johnson BL, Adamczyk JW, Tennoe KO, Stromme SB: A Comparison of Concentric and Eccentric Muscle Training. *Medicine and Science in Sports* 8 (1): 35-38, 1976.
5. Johnson BL: Eccentric vs Concentric Muscle Training for Strength Development. *Medicine and Science in Sports* 4 (2): 111-115, 1972.
6. Newham DJ, Mills KR, Quigley BM, Edwards RHT: Pain and Fatigue after Concentric and Eccentric Muscle Contractions. *Clinical Sciences* 64: 55-62, 1983.
7. Walmsley RP, Pearson N, Stymiest P: Eccentric Wrist Extensor Contractions and the Force Velocity Relationship in Muscle. *The Journal of Orthopaedic and Sports Physical Therapy* 8 (6): 288-293, 1986.

Elbow

1. Goldberg VM, Figgie HE, Inglis AE, Figgie MP. Current Concepts Review: Total Elbow Arthroplasty. The Journal of Bone and Joint Surgery 70-A (5): 778-782,1988.
2. Griffin JW: Differences in Elbow Flexion Torque Measured Concentrically,Eccentrically, and Isometrically. Physical Therapy 67 (8): 1205-1208, 1987.
3. Nirschl RP, Sobel J: Conservative Treatment of Tennis Elbow. The Physician and Sportsmedicine 9 (6): 43-54, 1981.

Knee

1. Bennett JG, Stauber WT: Evaluation and Treatment of Anterior Knee Pain Using Eccentric Exercise . Medicine and Science in Sports and Exercise 18 (5): 526-530,1986.
2. Fowler PJ, Regan WD: The Patient with Symptomatic Chronic Anterior Cruciate Ligament Insufficiency. The American Journal of Sports Medicine 15 (4): 321-325, 1987.
3. Gose JC: Continuous Passive Motion in the Postoperative Treatment of Patients with Total Knee Replacement. Physical Therapy 67 (1): 39-42, 1987.
4. Inove M, McGurk-Burleson E, Hollis M, Woo S: Treatment of the Medial Collateral Ligament Injury. The American Journal of Sports Medicine 15 (1): 15-21, 1987.
5. **Johnson R, Wilk K: Lever Arm Length Relative to Peak Torque Production of Knee Musculature. Physical Therapy 68 (5): 779, 1988.**
6. King S, Butterwick DJ, Cuerrier J: The Anterior Cruciate Ligament: A Review of Recent Concepts. The Journal of Orthopaedic and Sports Physical Therapy 8 (3):110-121, 1986.
7. **Klopfer DA, Greij SD: Examining Quadriceps/Hamstrings Performance at High Velocity Isokinetics in Untrained Subjects. The Journal of Orthopaedic and Sports Physical Therapy 10 (1): 18-22, 1988.**
8. Lubell A: Artificial Ligaments: Promise or Panacea? The Physician and Sports Medicine 15 (3): 150-156, 1987.

-
9. Noyes FR, Mangine RE, Barber S: Early Knee Motion after Open and Arthroscopic Anterior Cruciate Reconstruction. *The American Journal of Sports Medicine* 15 (2): 149-160, 1987.
 10. Noyes FR, Matthews DS, Mooar PA, Grood ES: The Symptomatic Anterior Cruciate-Deficient Knee. *The Journal of Bone and Joint Surgery* 65-A (2): 163-174, 1983.
 11. Otis JC, Gould JD: The Effect of External Load on Torque Production by Knee Extensors. *The Journal of Bone and Joint Surgery* 68-A (1): 65-70, 1986.
 12. Roth JH, Brag RC, Best TM, Cunnig LA, Jacobson RP: Posterior Cruciate Ligament Reconstruction by Transfer of the Medial Gastocnemius Tendon. *The American Journal of Sports Medicine* 16 (1): 21-28, 1988.
 13. Solomonow M, Baratta R, Zhou BH, Shoji H, Bose W, Beck C, D'Ambrosia R: The Synergistic Action of the Anterior Cruciate Ligament and Thigh Muscles in Maintaining Joint Stability. *The American Journal of Sports Medicine* 15 (3): 207-213, 1987.

Miscellaneous

1. Ariki P, Davies GJ, Siewert MW, Rowinski MJ: Optimum Rest Interval Between Isokinetic Velocity Spectrum Rehabilitation Sets. *Physical Therapy* 65 (5): 733-734, 1985.
2. **Biodex Clinical Protocol Manual, Volume 1. Biodex Corporation, 1988.**
3. Curwin S, Stanish WD: *Tendonitis: Its Etiology and Treatment*. Lexington, MA: Collamore Press, 1984.
4. Davies GJ: *A Compendium of Isokinetics in Clinical Usage and Rehabilitation Techniques*. Onalaska, Wisconsin: S & S Publishers, 1987.
5. Frankel VH, Nordin M: *Basic Biomechanics of the Skeletal System*. Philadelphia: Lea & Febiger, 1980.
6. Halbach JW, Davies GJ, Gould JA, Kaufman WA, Ross DE: Effect of Limited ROM on Non-exercised ROM Strength. *Physical Therapy* 65 (5): 732-733, 1985.
7. Hart D, Strobbe T, Till C, Plummer R: Effect of Trunk Stabilization on Quadriceps Femoris Muscle Torque. *Physical Therapy* 64 (9): 766-770, 1984.

-
8. Johnson L: Suggestions from the Clinic: Hip and Trunk Stabilization During Quadriceps/Hamstring Evaluation. *The Journal of Orthopaedic and Sports Physical Therapy* 2 (4): 191-193, 1982.
 9. Moore KI: Clinically Oriented Anatomy. Baltimore: Williams & Wilkins Co., 1980.
 10. Rothstein JM, Lamb RL, Mayhew TP: Clinical Uses of Isokinetic Measurements. *Physical Therapy* 67 (12): 1840-1843, 1987.
 11. Wilk K, Johnson Rd, Levine B: Reliability of the Biodex B-2000 Isokinetic Dynamometer. *Physical Therapy* 68 (6): 792, 1988.
 12. Wilk K, Johnson RD, Levine B: Comparison of Knee Extensor and Flexor Muscle Group Strength Using the Biodex, Cybex, and Lido Isokinetic Dynamometers. *Physical Therapy* 68 (5): 792, 1988.

Shoulder

1. Andrews JR, Carson WG, Ortega K, Capt MC, Arthroscopy of the Shoulder: Technique and Normal Anatomy. *The American Journal of Sports Medicine* 12 (1):1-7, 1984.
2. Cain PR, Mutschler TA, Fu FH, Lee SK: Anterior Stability of the Glenohumeral Joint. *The American Journal of Sports Medicine* 15 (2) 144-148, 1987.
3. Galpin RD, Hawkins RJ, Grainger RW: A Comprehensive Analysis of Operative Versus Nonoperative Treatment of Grade III Acromioclavicular Separations. *Clinical Orthopaedics and Related Research* 193: 150-155, 1984.
4. Greipp JF: Swimmer's Shoulder: The Influence of Flexibility and Weight Training. *The Physician and Sportsmedicine* 13 (8): 92-105, 1985.
5. Hawkins RJ, Hobeika PE: Impingement Syndrome in the Athletic Shoulder. *Clinics in Sports Medicine* 2 (2): 391-405, 1983.
6. Hawkins RJ, Hobeika P: Physical Examination of the Shoulder. *Orthopedics* 6(10): 1270-1278, 1983.
7. Kent BE: Functional Anatomy of the Shoulder Complex. *Physical Therapy* 51 (8):867-887, 1971.

-
8. Nash HL: Rotator Cuff Damage: Reexamining the Causes and Treatments. *The Physician and Sportsmedicine* 16 (8) 129-135, 1988.
 9. Pappas AM, Zawicki RM, McCarthy CF: Rehabilitation of the Pitching Shoulder. *The American Journal of Sports Medicine* 13 (4): 223-235, 1985.
 10. Tibone JE, Jobe FW, Kerlan RK, Carter VS, Shields CL, Lombardo SJ, Yocum LA: Shoulder Impingement Syndrome in Athletes Treated by an Anterior Acromioplasty. *Clinical Orthopaedics and Related Research* 198: 134-140, 1985.

Wrist

1. Edgerton BW: Nerve Blocks in the Wrist. *Surgical Rounds for Orthopedics* Feb., 1988, 44-46.
2. Wadsworth CT: Clinical Anatomy and Mechanics of the Wrist and Hand. *The Journal of Orthopaedic and Sports Physical Therapy* 4 (4): 206-216, 1983.
3. Walmsley RP, Pearson N, Stymiest P: Eccentric Wrist Extensor Contractions and the Force Velocity Relationship in Muscle. *The Journal of Orthopaedic and Sports Physical Therapy* 8 (6): 288-293, 1986.

APPENDICES

BIODEX System 2 Parts and Components

Double Chair Configuration

Major Components:

870-115	Double Chair
820-200	Computer DataStation Cart (CDS)
820-240	Attachment Rack
900-801	Dynamometer and Controller

Powerhead Attachments:

875-174	Knee Attachment (left)
875-175	Knee Attachment (right)
820-321	Shoulder Attachment
875-157	Elbow/Shoulder Attachment
875-158	Wrist Attachment
875-167	Forearm Support Pad (v-pad and bracket)
820-350	Calibration Attachment
820-350-01	Calibration Weight
820-331	Common Ankle Attachment

Optional:

875-160	Sheer Reduction Attachment (left)
875-161	Sheer Reduction Attachment (right)
875-162	Anti-Compression Attachment (left)
875-163	Anti-Compression Attachment (right)

Positioning Chair Attachments:

820-154	Multi-Support Pad (arm and leg support)
X0558	Footrest Tube with Locking Knob
X0559	Footrest Support Post
820-153	Short T-Bar Adapter
820-151	Long T-Bar Adapter

Single Chair Configuration

Major Components:

820-110	S2 S Positioning Chair
820-200	S2 S Computer DataStation Cart (CDS)
820-240	S2 S Attachment Rack
900-800	Dynamometer and Controller

Powerhead Attachments:

875-174	Knee Attachment (left)
875-175	Knee Attachment (right)
820-321	Shoulder Attachment
875-157	Elbow/Shoulder Attachment
875-167	Forearm Support Pad (v-pad and bracket)
875-158	Wrist Attachment
820-331	Footplate Attachment
820-350	Calibration Attachment and weight
820-350-01	Calibration Weight alone

Optional:

875-160	Sheer Reduction Attachment (left)
875-161	Sheer Reduction Attachment (right)
875-162	Anti-Compression Attachment (left)
875-163	Anti-Compression Attachment (right)
820-460	Back Attachment

Positioning Chair Attachments:

820-154	Multi-Support Pad (arm and leg support)
820-155	Footrest
820-153	Short T-Bar Adapter
820-152	Medium T-Bar Adapter
820-151	Long T-Bar Adapter

General Product Warranty

A. Warranty

BIODEX MEDICAL SYSTEMS warrants that all products covered hereby shall be free from defects in workmanship and materials and shall conform to published specifications or other specifications accepted in writing by BIODEx for:

Description:	Parts:	Labor:
Controller	1 year	1 year
Powerhead	1 year	1 year
Clinical DataStation	1 year	1 year
Printer	1 year	1 year
Cables	1 year	1 year
Adjustable Positioning Chair	1 year	1 year
Attachments	1 year	1 year
Threads	1 year	1 year
Knobs	1 year	1 year
Upholstery	60 days	60 days
Straps	60 days	60 days
Pads	60 days	60 days

under normal use as prescribed in the operator's manual. The foregoing warranty does not apply to any products which have been subject to use other than as specified as standard operating procedure in the system manual, neglect, accident or modification. BIODEx's sole obligation to buyer hereunder for products failing to meet aforesaid warranty shall be, at BIODEx's discretion, to replace or repair the non-conforming product (parts and labor) or issue buyer credit for the purchase price of the non-conforming product where within warranty period:

1. BIODEx has received written notice of any nonconformity and
2. After BIODEx's attempts to remedy such nonconformity, BIODEx has determined that the nonconformity is not a result of improper use, accident, repair or other misuse by buyer.

Any replacement product shall carry the unexpired term of the warranty which was applicable to the replaced product or a period of 30 days, whichever is longest.

BIODEX MAY RETAIN THE RIGHT TO VOID ALL SYSTEM WARRANTIES IF PAYMENT IS NOT RECEIVED AS PRESCRIBED IN TERMS OF PURCHASE.

EXCEPT AS SPECIFICALLY PROVIDED HEREIN, THERE ARE NO OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

IN NO EVENT SHALL BIODEx BE LIABLE FOR LOSS OF PROFITS, INDIRECT, SPECIAL, CONSEQUENTIAL, OR OTHER SIMILAR DAMAGES ARISING OUT OF ANY BREACH HEREOF.

B. Warranty Period

Warranty time period stated in paragraph "A", is from date of invoice (shipment) unless otherwise specified in writing by BIODEx.

C. Repaired or Replacement Products (out of warranty)

BIODEx MEDICAL SYSTEMS, for a period of 60 days, warrants that its standard products repaired or replaced hereunder shall be free from defects in workmanship or materials under normal use as described in the system's Operator's Manual. Warranty period will begin upon shipment of repaired or replacement products. The sole responsibility of BIODEx under this warranty is, at its option, to repair or replace any defective component parts of such products. This warranty does not apply to:

1. Products which have been repaired or altered other than under specific instructions from BIODEx'S Service Department instruction as listed in system's manuals or procedures previously approved in writing by BIODEx Service Department, or
2. Products which have been subject to use other than described as standard use in the system's operator's manual, neglect or accident.

THIS WARRANTY IS NOT TRANSFERABLE (SITE, OWNERSHIP, ETC.) WITHOUT THE WRITTEN PERMISSION OF BIODEx MEDICAL SYSTEMS. WARRANTY IS VOID UNLESS EQUIPMENT IS INSTALLED BY BIODEx PERSONNEL.