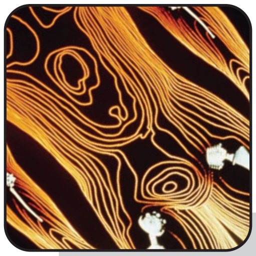


Biodex Multi-Joint System

Clinical Resource Manual

1) Integrated Rehabilitation

- PowerPoint Presentation
- Supporting Articles

INTEGRATED PHYSICAL REHABILITATION

How Does it All Fit

Achieving Goals

BIODEX

Overview

Integrated Rehabilitation

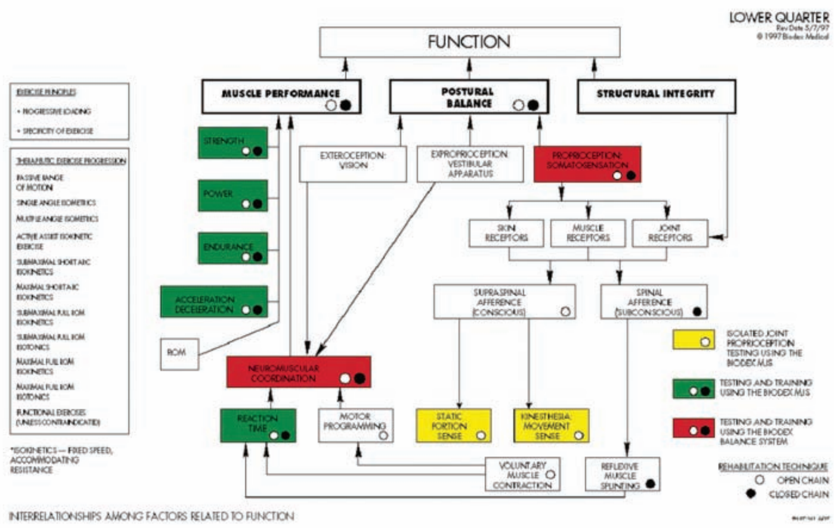
The right thing…
in the right place…
for the right reason.

BIODEX

Overview

Phases of Rehabilitation

- Phase 1 – Healing Constraints and Proving Need
- Phase 2 – Controlling Joint Effusion / Inflammation
- Phase 3 – Restoring Range of Motion
- Phase 4 – Restoring Strength and Proving Progress
- Phase 5 – Restoring Function
- Phase 6 – Proving Outcome



Function

Necessary Components:

- Muscle Performance
- Postural Balance
- Structural Integrity

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Muscle Performance

- Strength
- Power
- Endurance
- Acceleration/Deceleration
- Range of Motion
- Neuromuscular Coordination
  -important also for Balance

BIODEX

Overview

Muscle Performance

- Dynamic joint stabilizer
- All components of muscle function are important to prevent injury
- Works along with Postural Balance

BIODEX

Overview

Muscle Performance

- Measure Muscle Performance
- Determine deficit due to strength, power, acceleration, deceleration or endurance
- Test results allow clinician to focus on deficits improving treatment effectiveness and efficiency

BIODEX

Overview

Postural Balance

- Visual
- Vestibular
- Proprioception/Somatosensation
  - Skin receptors
  - Muscle receptors
  - Joint receptors

BIODEX

Overview

Postural Balance

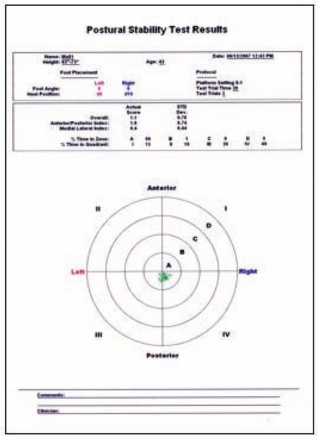
- Assessment of :
  - Proprioception / Somatonsensation
- Muscular Coordination
  - Ability to maintain COG over BOS

BIODEX

Overview

Postural Balance

- Document deficits and set goals
- Document progress
- Reduce risk of re-injury



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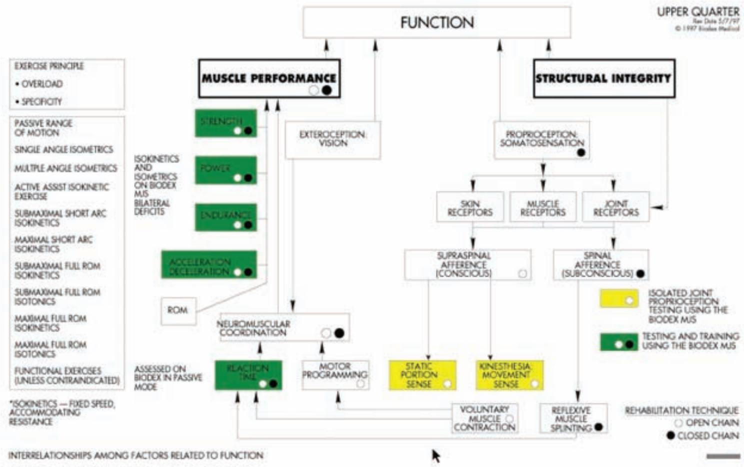
Overview

Structural Integrity

- Ligament, Tendon, Muscle or Bone
- Proprioception/Somatosensation Joint receptors
- Mother Nature and Physician

BIODEX



Overview

Range of Motion

Beneficial for

- Increasing Range of Motion
  - Passive Range of Motion
  - Active Range of Motion
  - Active Assist Range of Motion
- Reduction of Spasticity
- Improve Venous Return
- Improve Muscle Tone

BIODEX

Overview

Strength Evaluation and Treatment

BIODEX

Overview

Strength Evaluation

Isokinetic Testing

- Valid reliable measure
- Identify Neuromuscular control problems
- Track progress

The fastest way to identify, treat and document the physical impairments that cause functional limitations

BIODEX

Overview

Improving Strength

Isokinetics	**Isotonics**
Improve neuromuscular control	Develop strength production
Accommodating resistance	Constant resistance

BIODEX

Overview

Strengthening Exercises

- Eccentric Contractions first
  - Initially better control
- Concentric Contractions
  - Once gain control

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Overview

Gait Training

- Initially work on:
  - Step Length
  - Right Left Time Distribution
- Secondary Focus:
  - Step Speed

- Visual Cues for Step Length
- Audio Cues for Step Speed

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Overview

Unweighing System

- Partial Weight Bearing Environment
- Patient and Clinician Safety
- Reduce Muscle Spasticity
- Reduce Cardiac Demand
- Weight Shifting Activity
- Motor Programming when used along with a treadmill
- Biomechanically Efficient

BIODEX

Balance Training

- Static First
- Dynamic Second
- Develop Neuromuscular Coordination and Control

ICD-9 Codes

- **728.9** Muscle weakness
- **780.79** Leg weakness
- **715.0(x)** Degenerative joint disease
- **715.2** Osteoarthritis as secondary condition
- **718.8(x)** Instability in joint walking
- **719.9(x)** Difficulty walking
- **719.4(x)** Pain in joint
- **719.5 (x)** Stiffness in joint

Overview

When accompanied by MD referral & ICD-9 Code

Reimbursement: CPT codes*

- 97110: Therapeutic activities one or more areas (strength, endurance, flexibility, ROM) each 15 minutes
- 97112: Neuromuscular reeducation, each 15 minutes
- 97116: Gait Training, each 15 minute area
- 97530: Functional activities, one area, each 15 minutes
- 97535: Self care/home management training, each 15 minutes
- 97750: Physical performance test and measurement with written report, each 15 minutes

***Reimbursement amounts vary among plans and states**

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FN# 07-131

BIODEX

DYNAMIC JOINT STABILITY: MECHANICAL AND NEUROMUSCULAR INTER-RELATIONSHIPS

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ABSTRACT

Proprioceptive training, along with surgical repair/-reconstruction, plays an important role in the restoration of functional stability of the knee and ankle. Many studies of the relationship between proprioceptive ability and functional stability have assessed the ability to perceive open-chain joint position or to actively reproduce a given open-chain joint position.

A serious limitation of balance assessment systems that use force plates is the relatively static nature of the task that is performed as data are collected. The cumulative effect of gravity, ground reaction forces, and inertia on ankle motion while standing on a force plate are not the same as that produced on a surface that is unstable, slanted, or irregular. Therefore, using the results of a static test to predict how an athlete will perform during dynamic function may have limited validity.

The Biodex Stability System is an instrumented tilting platform that provides an improved method for objectively quantifying dynamic postural stability and may facilitate further scientific investigation of the role of proprioception in the maintenance of dynamic joint stability.

JOINT INSTABILITY

Chronic knee and ankle dysfunction are typically associated with complaints of pain during activity, recurrent swelling, a feeling of giving way, and repetitive re-injury. Factors that may contribute to the development and progressive worsening of these problems include ligamentous laxity, muscle weakness and impaired neuromuscular mechanisms (ie, proprioceptively mediated reflexive muscle splinting).

Management of chronic joint instability has traditionally emphasized surgical repair/reconstruction of passive ligamentous restraints and restoration of muscle strength. Many practitioners, however, have recently begun to recognize the importance of proprioceptive training for enhancement of dynamic joint stabilization.

Proprioception. No widely accepted definition for the term proprioception exists, and the term is often poorly or vaguely defined in the literature (4). The term somatosensation is sometimes used synonymously with the term proprioception (16). Terms used to define closely related concepts, such as kinesthesia, reflexive muscle splinting, postural balance, reaction speed, and neuromuscular coordination are sometimes used synonymously with the term proprioception in the literature.

Although precise definitions vary, proprioception clearly relates to the cumulative afferent neural input to the central nervous system (CNS) from mechanoreceptors in the joint capsules, ligaments, muscles, tendons and skin (22). Thus, proprioception contributes to both conscious (kinesthetic) and subconscious (reflexive) neural functions.

The mechanoreceptors are specialized nerve endings embedded in connective tissue, which translate mechanical distortion of the tissue into a neural-impulse code that is conveyed to the CNS. Tissue distortion that results from elongation, compression, or fluid tension triggers an electrical change across the membrane of the receptor, which generates repetitive afferent neural impulses. This coded proprioceptive information conveyed to the spinal cord from the mechanoreceptors passes through multisynaptic interneuronal connections and results in the eventual reflex excitation or inhibition of motor neurons (20, 22).

Kinesthesia. Kinesthesia is the conscious awareness of the direction, amplitude and speed of joint movement as a result of proprioceptive input to the CNS (12). Conscious awareness of static joint position has sometimes been included in the definition of kinesthesia (20, 6), but the term is generally associated with joint movement. The term "position sense" has also been used to describe conscious awareness of either static or dynamic joint position.

The term kinesthesia is often used interchangeably with the term proprioception. Although kinesthesia requires proprioceptive input to the CNS, there is conflicting evidence concerning the role that joint mechanoreceptors play in the conscious awareness of joint position (6, 2, 1). Muscle spindle receptors are believed to be most suited for involvement in cognitive processes related to joint position sense (22).

The muscle spindle consists of specialized muscle fibers (intrafusal fibers) that are oriented parallel to the non-specialized extrafusal muscle fibers. Gamma efference results in contraction of intrafusal fibers, which generates tension within their non-contractile equatorial region. Tension development results in spindle afference to the spinal cord, which reflexively activates extrafusal fibers of the same muscle (alpha efference). When the extrafusal fibers contract, tension is relieved on the equatorial portion of the intrafusal fibers and spindle afference is diminished. Mechanical elongation of the muscle elicits the same type of response from the muscle spindle as that produced by gamma efference.

There appears to be a connection between joint and muscle proprioceptive function in relation to reflex coordination of the muscle tone surrounding a joint (15). Afference from joint mechanoreceptors is believed to directly influence muscle tension through synaptic connections to both alpha and gamma motoneurons in the spinal cord (9). In a synergistic manner, changes in muscle tension may modulate joint afference by means of tendinous insertions into joint capsules (22).

PROPRIOCEPTIVE ABILITY AND FUNCTIONAL INSTABILITY

Postural balance refers to the ability to maintain the body center of gravity (COG) within the area of support provided by the feet (9, 11). Within the CNS, proprioceptive input is integrated with afferent signals from vision and from the vestibular apparatus of the inner ear to monitor the position of the COG. Control of the position of the COG results from appropriate muscle activation patterns, which are coordinated by a highly complex integration of cerebral, cerebellar, spinal and peripheral afferent and efferent signals (11, 24, 22).

Impaired proprioception. Impairment of normal reflexive muscle splinting (RMS) has been theorized to result from traumatic damage to mechanoreceptors and the formation of post-traumatic scar tissue within the joint capsule (9, 22, 25). The term "articular deafferentation" was introduced by Freeman, Dean and Hanham (8) to designate the mechanism that they believed to be the cause of functional instability of the ankle.

Although the presence of a capsular lesion may interfere with the transmission of afferent impulses from the joint, a more important effect may be alteration of the afferent neural code that is conveyed to the CNS (15). Decreased reflex excitation of motor neurons may result from either, or a combination of the following events: 1) a decrease in proprioceptive input to the CNS, or 2) an increase in the activation of inhibitory interneurons within the spinal cord. The finding that fluid distention of a joint produces muscle inhibition, suggests the presence of an inhibitory reflexive mechanism involving capsule mechanoreceptors (20).

Many studies of the relationship between proprioceptive ability and functional instability have involved assessment of the ability to perceive open-chain joint position or to actively reproduce a given open-chain joint position. Both perception of passive joint positioning and active joint positioning involve cognitive processes. Although conscious awareness of joint position or joint movement may enhance joint stability by initiating voluntary muscular contraction, proprioceptively mediated RMS does not depend upon supraspinal cognitive processes.

Postural control. Postural control is a complex function of cerebral, cerebellar, spinal and peripheral afferent and efferent signals, as well as muscle function, all working together in order to keep the body COG over some portion of the base of support (11).

The vestibular apparatus supplies information that assists in maintaining the body upright against the force of gravity and in determining linear and angular acceleration (16).

Perception of one's orientation in relation to gravity, the support surface, and surrounding objects requires a combination of vision (exteroception), the vestibular system of the inner ear (exproprioception) and somatosensation (proprioception). No one sense directly measures the position of the body COG (19, 14).

ASSESSMENT SYSTEMS

A modified Romberg test has been used by some investigators to evaluate unilateral postural control (8, 12, 18). The test consists of a subjective evaluation of the ability to maintain a single-leg stance without excessive movement of body segments to maintain balance. A more objective method, referred to as stabilometry, involves the use of a force plate to analyze displacement of the body COG during single-leg stance. During stabilometric testing, the foot remains relatively stationary, while the weight-bearing leg moves above it. Small movements within the joints of the ankle create relatively large displacements of the COP, which is referred to as postural sway (24).

Electromyography (EMG) patterns have demonstrated that the primary mechanism for maintenance of postural equilibrium is coordinated activation of muscles that control ankle motion (24). So long as the COG is maintained within the limits of the base of support, its location within the transverse plane corresponds to the center of pressure (COP) beneath the foot, and postural balance is maintained. If the COG is displaced beyond the limits of the base of support, the plantar surface of the foot tends to lift off the surface and postural balance is lost.

Static-force systems. A serious limitation of balance assessment systems that use force plates is the relatively static nature of the task that is performed as data are collected (5). Because most joint receptors are active only near the end range of motion (6, 22), a more dynamic method may be required to achieve the minimal amplitude of ankle displacement necessary for neural discharge from joint mechanoreceptors (7). If the supporting surface beneath the foot is level and stable (eg, a stationary force plate), the cumulative effect of gravity, ground reaction forces, inertia, and muscle forces on ankle motion will not be the same as that produced on a surface that is unstable, slanted, or irregular.

Using the results of a static test to predict how an athlete will perform during dynamic function may have limited validity. Static and dynamic tests appear to examine different aspects of the complex balance system (16).

Dynamic-force systems. The variability in long-term functional outcomes among people having identical injuries may be due to the ability of certain individuals to compensate for impaired joint proprioception through enhancement of related sensory mechanisms (1). Tensing the muscles around a joint, which increases the stretch sensitivity of the muscle spindles, has been found to dramatically enhance awareness of joint position (13). Therefore, improvement in muscle tone may enhance kinesthetic ability, which helps to compensate for altered joint afference (20).

Proprioceptive training. The objectives of proprioceptive training should be stimulation of joint and muscle mechanoreceptors to encourage maximum afferent discharge to the CNS (17). Rotation toward the limit of joint motion results in progressively smaller length changes in the muscles and in progressively larger tension in the joint capsule (13). Capsule mechanoreceptors may increase their response to movement as the ability of the muscle spindles to signal angular displacement is diminished. Because joint receptors are most responsive as the limit of normal joint motion is approached, a proprioceptive training device should permit the greatest possible range of closed-chain joint motion that does not present a significant risk of injury.

The most common form of proprioception training is the performance of single-leg balancing exercises on a multi-axial tilting platform. The practical effect of a multi-axial tilting platform is to greatly reduce the area over which the vertical ground reaction force (VGRF) is applied to the supporting foot. As a result, a relatively small displacement of the COG from a central position beneath the foot creates a force moment that induces foot rotation around an axis that roughly corresponds to the axis of rotation of the tilting platform. A multi-axial platform can tilt in any vertical plane, which facilitates rotation of the foot around its functional axes and permits simultaneous biplanar foot movements (7).

CONCLUSIONS

Exercises performed on a multi-axial device may improve dynamic postural balance by increasing awareness of the location of the COG and by increasing ankle strength in a functional closed-chain mode. Such training may also enhance the sensitivity of the muscle spindle and thereby increase proprioceptive input to the spinal cord, which may provide compensation for altered joint afference. Initiation of reflexive and/or voluntary muscle splinting before the joint has become displaced beyond a critical point may decrease the occurrence of joint subluxation during functional activities (17).

The Biodex Stability System is an instrumented tilting platform that provides an improved method for objective assessment of dynamic postural stability, and may facilitate further scientific investigation of the role of proprioception in the maintenance of dynamic joint stability.

DEFINITIONS OF PROPRIOCEPTION

Sherrington (1911): Awareness of posture, movement, changes in equilibrium and mechanical inertia, which generate pressures and strains at the joints (23).

Higgins (1991): The extraction of information regarding the position and movement of the body (14).

Lephart (1993): A specialized variation of the sensory modality of touch that encompasses the sensations of joint movement (kinesthesia) and joint position (joint position sense) (17).

Grigg (1994): The sense of position and movement of the limbs (13).

Tropp (1985): The sense of position and movement of one part of the body relative to another (24).

Irrgang et al (1994): The ability to receive input from muscles, tendons and joints and to process that information in a meaningful way in the central nervous system (16).

DEFINITIONS OF KINESTHESIA

Newton (1982): The ability to discriminate joint position, relative weight of body parts and joint movement, including direction, amplitude and speed (20).

Bastian (1888): Recognition of position during active or passive movements (3).

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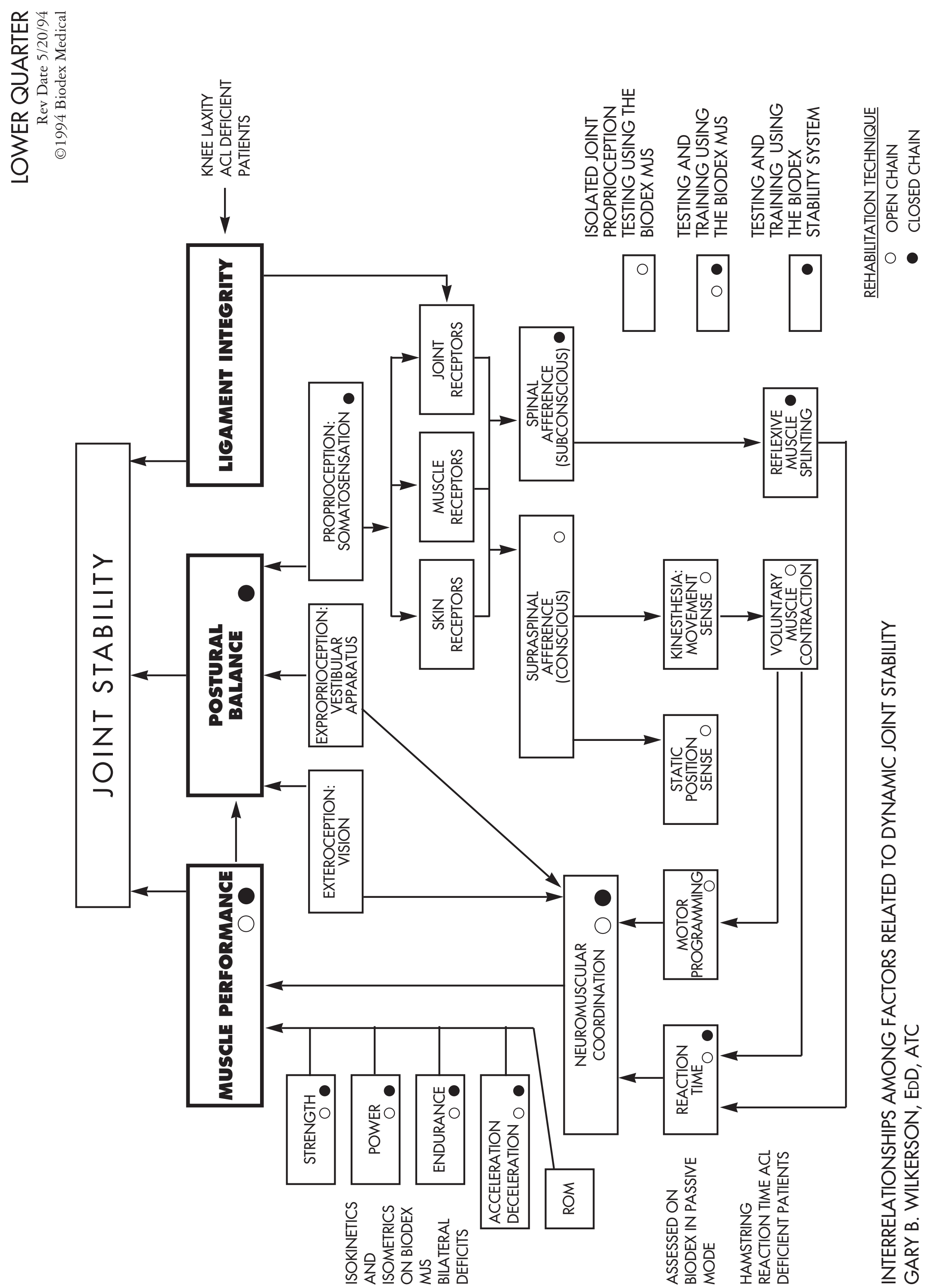
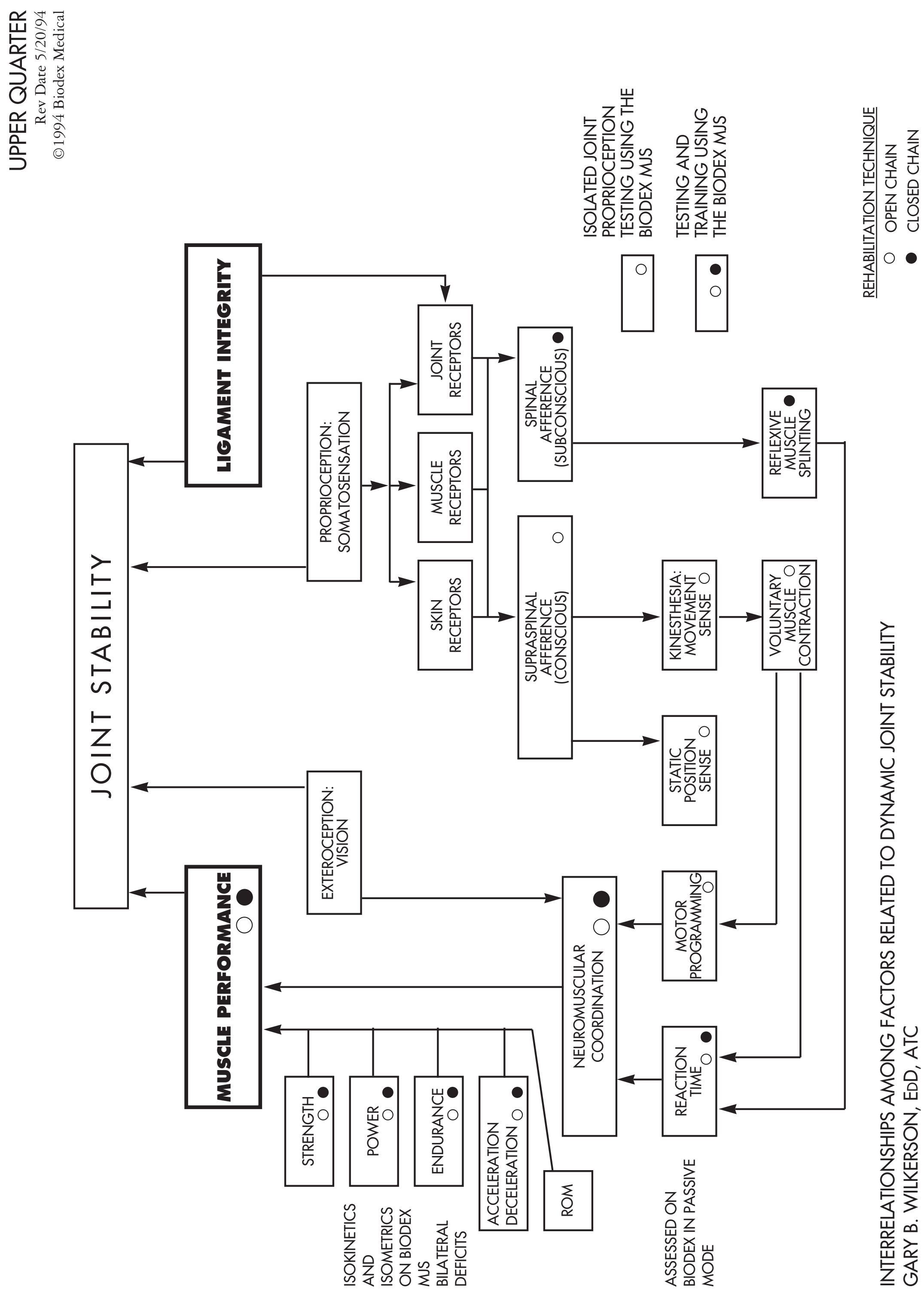
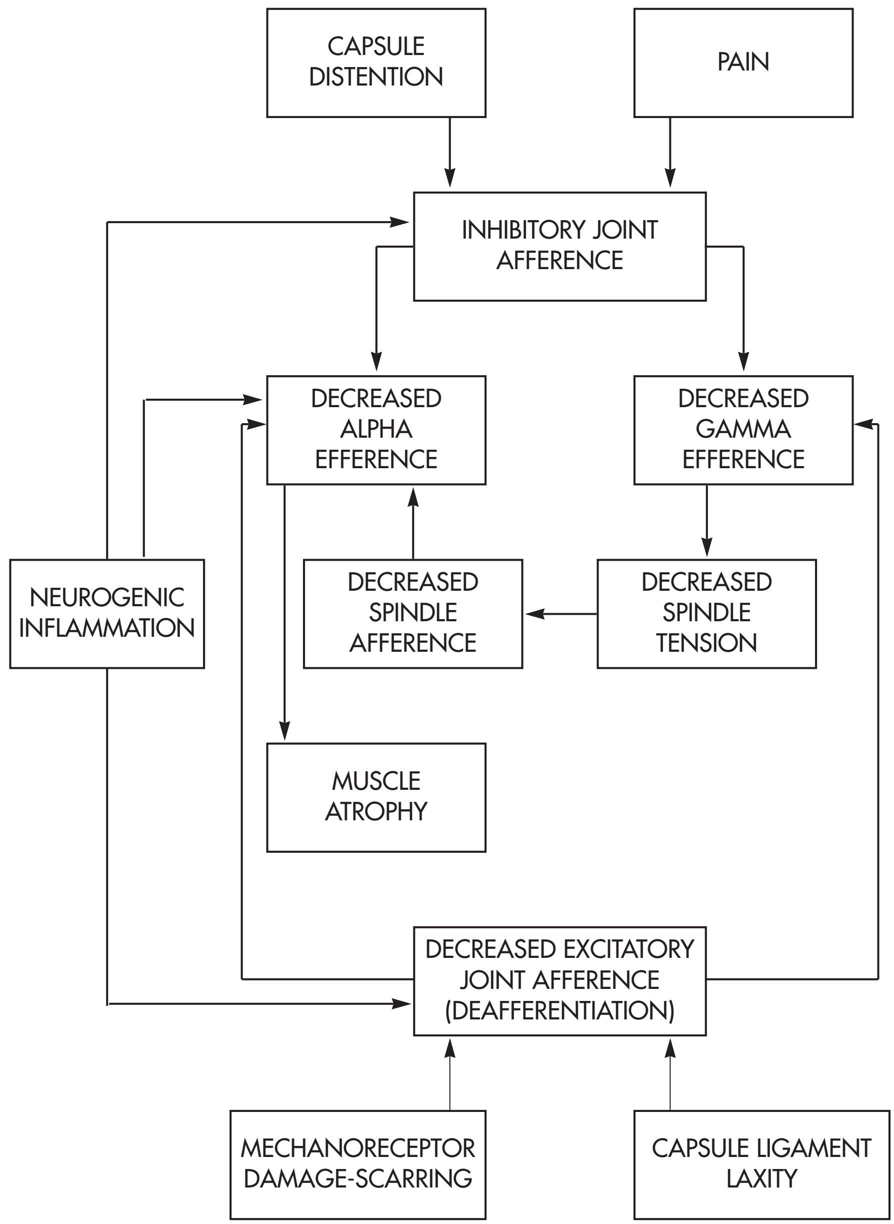
INTERRELATIONSHIPS AMONG FACTORS RELATED TO DYNAMIC JOINT STABILITY — LOWER QUARTER



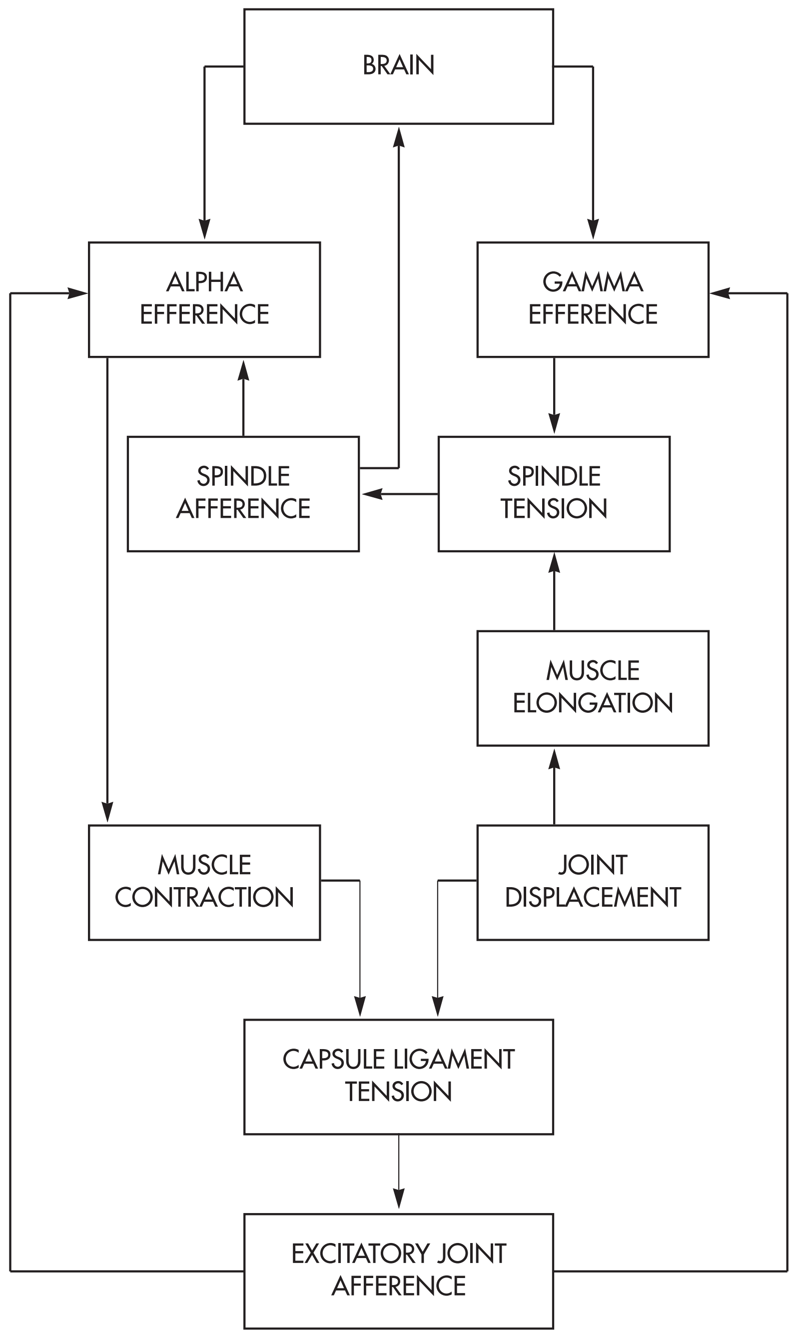
INTERRELATIONSHIPS AMONG FACTORS RELATED TO DYNAMIC JOINT STABILITY — UPPER QUARTER



THEORETICAL MECHANISMS OF PROPRIOCEPTION DEFICIENCY FOLLOWING JOINT INJURY



INTERRELATIONSHIPS AMONG FACTORS INFLUENCING PROPRIOCEPTIVELY-MEDIATED MUSCLE RESPONSE



BIODEX INTEGRATED PHYSICAL REHABILITATION

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INTRODUCTION

Traditional rehabilitation emphasizes restoration of ligament integrity, range of motion, muscular strength, muscular power and muscular endurance. However, simply restoring ligament integrity and strengthening the associated muscles neglects the coordinated neuromuscular controlling mechanism required for joint stability, especially during the sudden changes in joint position common to functional activities. Such a lag time in neuromuscular reaction time can result in recurrent joint subluxation and joint deterioration. (5)

Therefore, rehabilitation must focus on restoration of optimal joint function, which requires integrated rehabilitation of 1) healing passive mechanical restraints, 2) muscle function and 3) proprioceptive neuromuscular mechanisms. Neglect of any of these three components can result in a poor functional outcome and possibly re-injury.

OPEN- AND CLOSED-CHAIN FUNCTIONAL EXERCISE

Weight-bearing activities have been shown to stimulate the mechanoreceptors more readily than open-chain activities. (14) Therefore, numerous clinicians claim that the most efficient means to stimulate and rehabilitate joint mechanoreceptors is through closed-chain functional exercise.

A properly functioning muscle develops strength with the proper timing and sequence to allow smooth coordinated movement. (7) This ability to sense changes and respond appropriately is essential for safe return to functional activities. The key is to use safe and efficient rehabilitation techniques. This requires integration of open- and closed-chain exercises into a complete rehabilitation program.

Before initiating closed-chain activity, muscle must be healthy enough to meet the demands of closed-chain weight-bearing. Therefore, it is necessary to completely assess isolated muscle function to ensure that the essential performance levels of strength, power, endurance, acceleration/deceleration and range of motion have been developed to meet the demands of closed-chain activity. Jules Rothstein, PhD, put this very simply when he said, “If a muscle cannot function isolated, then it cannot function in a functional manner.”

ROLE OF ISOKINETICS

Isokinetics have been demonstrated to be the safest and most efficient means of increasing strength and rehabilitating musculoskeletal performance. (3, 12, 4, 11, 10, 6, 13)

Isokinetic resistance…

- Accommodates to the musculoskeletal leverage system, fatigue and pain
- Improves strength of bone-ligament-bone complex
- Increases muscle fiber cross-sectional area
- Promotes motor unit contraction synchrony
- Is equal to force applied, allowing the greatest safety
- Produces minimal muscle soreness
- Provides reliability and validates the rehabilitation process

In addition, isokinetics prepare the joint musculature for the progression to functional closed-chain activities. Specific to lower extremity rehabilitation, the objective isokinetic measurements of muscle function (strength, power, endurance, acceleration and deceleration), combined with the objective measurements of dynamic unilateral postural stability, can be used to establish performance criteria for advancement to functional activities.

With lower extremity involvement, it is recommended that the patient progress to closed-chain functional exercises after muscle function and dynamic unilateral postural stability have been restored.

- Isokinetic testing provides objective assessment of muscle function.
- Dynamic Unilateral Postural Stability testing provides assessment of central nervous system (CNS) response to afferent proprioceptive input.

Upper extremity rehabilitation requires successfully addressing muscular performance and neuromuscular control. Again isokinetic assessment and rehabilitation combined with proprioceptive testing and training.

PROPRIOCEPTION

Proprioception refers to afferent neural input that is conveyed to the CNS from mechanoreceptors in the joints, muscles and skin. This information plays a vital role in the control, organization and timing of functional actions. The CNS responds with efferent motor signals to contract the muscle(s) in response to stimulation. (1)

Proprioception is fundamental to musculoskeletal function. A proprioceptive deficiency manifests itself as a functional joint instability.

Proprioception is derived from the cumulative neural input to the CNS from mechanoreceptors, specialized nerve endings embedded in connective tissue, which transduce mechanical distortion of the tissue into a code that is conveyed to the CNS. Information transmitted in this fashion results in the eventual reflex excitation or inhibition of motor neurons. The mechanoreceptors are located in the joint capsules, ligaments, muscle tendons and skin.

The link between proprioceptive deficits and joint pathology has been well established in populations of athletes, individuals presenting acute traumatic joint pathology and people who have degenerative joint disease. In each of these populations, the lack of proper joint stability presents the potential for re-injury and progressive deterioration of articular structures. (2)

LOWER EXTREMITY REHABILITATION

INTEGRATION OF POSTURAL STABILITY ASSESSMENT AND TRAINING USING THE BIODEX STABILITY SYSTEM

Human balance is maintained through a complex process involving sensory detection of body motions, integration of sensorimotor information within the CNS and execution of the appropriate musculoskeletal responses.

Lewis M. Nashner, ScD

Three systems — visual, vestibular and proprioceptive — provide the major sensory inputs for the postural stabilizing reflexes that maintain and restore balance.

Susan Herdman, PhD, PT

A major portion of proprioceptive function appears to be reflexive. It does not occur at the conscious level. In response to this, Biodex Medical Systems developed the Biodex Stability System to identify and quantify proprioceptive deficiency. It can also serve as a training device to enhance kinesthetic abilities to provide compensation for reflexive insufficiency.

The Biodex system differs from a static force platform. Whereas static force plate systems measure deviations in the center of pressure (COP) beneath the foot (postural sway) within the limits of stability (defined as the sway envelope), the Biodex Stability System assesses dynamic muscular control of posture on an unstable support surface, rather than assessing movement of the body's center of gravity (COG) above a stationary foot. This makes the Biodex Stability System a more sensitive test of postural stability and more appropriate for orthopedic rehabilitation. (15)

BIODEX STABILITY SYSTEM THEORY

Any movement of the body's COG away from a perfectly balanced position (ie, directly over the central portion of the base of support) results in the creation of a force moment that must be counteracted by an appropriate muscle activation pattern and generation of sufficient muscular torque to prevent the support surface from tilting.

Postural training exercises enhance an individual's ability to perceive and to align gravitational and ground reaction forces through enhanced kinesthetic awareness and rapid activation of the appropriate muscle recruitment patterns. Since enhanced kinesthetic abilities provide compensation for impaired proprioceptive reflex mechanisms following joint injury, the Biodex Stability System has been designed to quantify neuromuscular control by assessing an individual's ability to maintain dynamic postural stability on an unstable surface.

If it is possible to enhance subconscious proprioceptive reflex mechanisms, then stimulation of joint mechanoreceptors is obviously necessary. Because these receptors are most stimulated by movement of a joint to the limit of its normal range, a relatively static balance system is probably an inadequate tool for enhancement of lower extremity proprioceptive mechanisms.

Because the Biodex Stability System permits up to 20 degrees of support surface tilt, the joints of the lower extremity are subjected to stress that is proportional to the COG displacement from the central portion of the support surface. This induced joint stress provides a stimulus for muscular response that trains the joint to handle functional situations.

Joint displacement also produces muscle elongation that stimulates the muscle spindle. Proprioceptive training on an unstable surface may enhance the sensitivity of the spindle and its ability to detect changes in its length more rapidly and more accurately. Stretch the muscle spindle to contract the muscle fiber; do this enough, and it increases muscle tone, which stabilizes the joint. This is the overall coordination of afferent and efferent neuro-information to provide appropriate muscular response.

The Biodex Multi-Joint System provides objective information concerning the ability of an isolated muscle group to produce force. This information is complemented by that derived from the Biodex Stability System, which provides objective information concerning neuromuscular mechanisms that enhance joint stability by monitoring and appropriately responding to 1) stresses imposed upon weight-bearing joints and 2) tension generated within muscles that cross the joints.

This combination helps determine when a patient is ready to return to function. Good neuromuscular postural coordination is required for functional activities.

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LOWER QUARTER

Rev Date 5/7/97

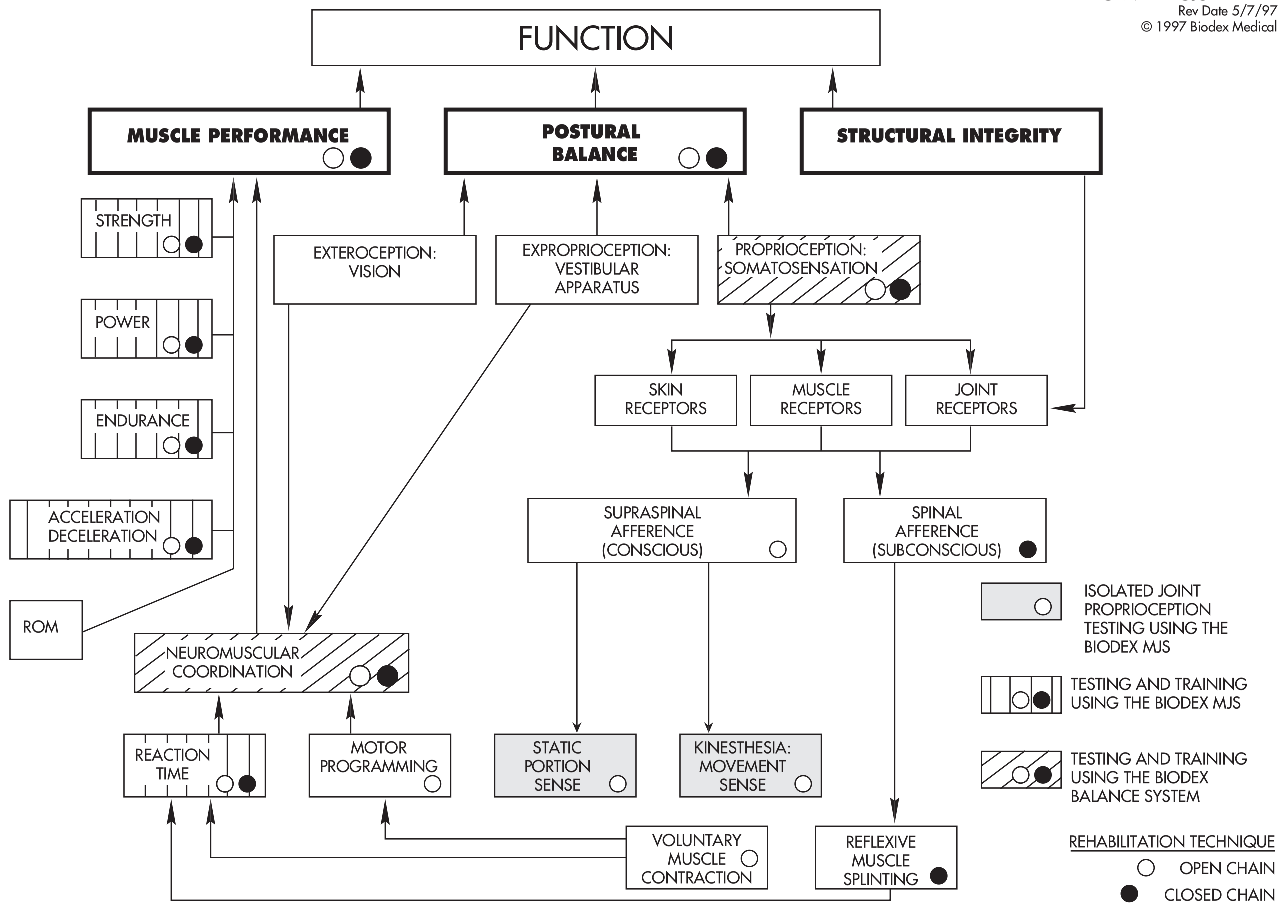
EXERCISE PRINCIPLES

- PROGRESSIVE LOADING
- SPECIFICITY OF EXERCISE

THERAPEUTIC EXERCISE PROGRESSION

- PASSIVE RANGE OF MOTION
- SINGLE ANGLE ISOMETRICS
- MULTPLE ANGLE ISOMETRICS
- ACTIVE ASSIST ISOKINETIC EXERCISE
- SUBMAXIMAL SHORT ARC ISOKINETICS
- MAXIMAL SHORT ARC ISOKINETICS
- SUBMAXIMAL FULL ROM ISOKINETICS
- SUBMAXIMAL FULL ROM ISOTONICS
- MAXIMAL FULL ROM ISOKINETICS
- MAXIMAL FULL ROM ISOTONICS
- FUNCTIONAL EXERCISES (UNLESS CONTRAINDICATED)

*ISOKINETICS — FIXED SPEED, ACCOMMODATING RESISTANCE



INTERRELATIONSHIPS AMONG FACTORS RELATED TO FUNCTION

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