Open- vs. Closed-Kinetic Chain Exercise

- Concept of the Kinetic Chain
- Adv and Disadv of OKC vs CKC Ex
- CKC Ex and NM Control
- Biomechanics of OKC vs CKC
  - Lower-Extremity Techniques
  - Upper-Extremity Techniques

Readings
- Chapter 12

Open and Closed Kinetic Chain

- Distal segment is fixed or stabilized relative to proximal segment
- Used more often in rehabilitation for lower extremity conditions

- Distal segment is mobile and not fixed

Both types of exercises used in the rehabilitation setting

Concept of the Kinetic Chain

Mechanical engineers

Closed link system: moveable segments affected by points at which they attach:
- Mts at differing joints becomes predictable
Muscle Action in the Kinetic Chain

Muscle actions that occur during OKC activities are often reversed during CKC

- OKC: muscle origin is fixed with insertion moving
- CKC: muscle insertion segment fixed, muscle work to move origin

Closed Kinetic Chain Exercises

- Increase joint compressive forces
- Functional and very sports specific
- Enhanced dynamic stability
- Co-activation and co-contraction
- Decrease shear forces

Open Kinetic Chain Exercises

- Increased deformation of mechanoreceptors
- OKC exercises allow for specific joint assessment
- COX acceleration and ECC deceleration forces
- Promotes functional activity
Using CKC Exercises to Regain Neuromuscular Control

- Functional weight-bearing activity requires coordinated muscle and joint function
  - CKC activities require integrated action of all segments,
    - facilitates proprioception and joint position sense
    - E-concentric loading to regain NM control
  - OKC activities used primarily to develop muscular strength

Requirements for normal function
- Series of well-timed muscle activation
  - Shock absorption
  - Foot flexibility
  - Foot stabilization
  - Acceleration and deceleration
  - Multi-planar motion
  - Joint stabilization
- Home-study: chapter 23

Biomechanics of OKC vs. CKC Activities in the Lower Extremity

The Knee Joint

directional along the longitudinal axis of the tibia. Weight bearing exercises increase joint compression, which enhances joint stability.

- Anterior displacement of tibia

In posterior direction would cause the tibia to translate anteriorly
- Not checked by constraints, primarily the ACL

• CKC Exercise
  1. Induce hamstring contraction
     • Flexion moment at knee and hip (hamstrings stabilise pelvis
       while quadriceps stabilise knee)
     • Helps to minimise shear force on tibia
     • Enhanced further with trunk anterior flexion (change in CoG due
       to shortened knee moment and shear)
  2. Minimize flexion moment at knee, ↑ flexion moment at hip
  3. Entire lower extremity kinetic chain (triple ext) is recruited via
     an axially directed force at the distal segment

• Open Kinetic Chain position (seated leg ext.)
  – Resistive force applied to distal tibia create flexion moment at knee
  – Negates hamstring co-contraction = maximal shear forces

  ![Figure 11-3](image)

  Figure 11-3  Resistive forces applied in different positions alter the magnitude of the shearing and compressive forces. A, Resistive force applied distally; B, Resistive force applied proximally; C, Resistive force applied distally with hamstring co-contraction.

• Patellofemoral Joint
  – as knee moves from 90° flexion to extension
  - Results in increased patellofemoral reaction force
  - Patellofemoral contact area decreases closer to extension = increased contact stress

  – as well, flexion moment increases as well
  - Patella has larger contact surface with respect to femur
  - Contact stress is minimized

  ![Patellofemoral Joint Diagram](image)

Closed Kinetic Chain Exercises for the Lower Extremity

- Mini-squat, Wall Slides and Lunges
- Leg Press - Train 0-60°
- Stair Climbing
- Step-Ups
- Terminal Knee Extensions with Surgical Tubing
- Stationary Bicycling
- BAPS Board and Mini-tramp
- Slide Boards and Fitter
**Biomechanics of OKC vs. CKC Activities in the Upper Extremity**

- Upper extremity generally operates as an OKC
  - High velocity, dynamic movements
  - Proximal segments stabilization role
  - Distal segments exhibit high degree of mobility
- CKC develop NM control in stabilizing musculature

- Less traditional approach (focus on segments)
- Incorporate legs and core

**Shoulder Joint**

- CKC exercises can promote and enhance joint stability
  - Rely on axial and rotational forces
  - Enhances force couples
    - Anterior deltoid: teres minor and infraspinatus
    - Subscapularis: infraspinatus teres minor


Function of scapula stabilizers:
- Lower Trapezius: Upper Trapezius and Levator Scapulae
- Rhomboids and middle Trapezius: Serratus Anterior

Elbow

- Elbow is highly involved in open kinetic chain activities
  - Propels objects at rapid velocities with accuracy
  - When hitting, must possess static stability and dynamic str
  - Swimming require to produce power, and stability
  - Gymnastics and wrestling rely on it as both an OKC/CKC link for both stability and propulsion

Closed Kinetic Chain Exercises for the Upper Extremity

- Used to train co-contractions in the shoulder early in the rehabilitation phase

- **Weight Shifting**
- **Push-Ups, Push-Ups with a Plus, Step-ups**
- **Slide Board**

Lecture Summary

1. Key concepts
   - hallmark of CKC exercises
2. Role of OKC and CKC in rehabilitative process
   - hallmark of CKC exercises
3. CKC exercises
   - lower extremity: decreased shear forces, reduced anterior tibial translation, and increased compressive forces resulting in increased ability
   - upper extremity: used for strengthening and establishing neuromuscular control of those muscles act to stabilize the shoulder joint