Osteokinematics, Arthrokinematics and Kinetics

Planes, Axes and Biomechanics
Osteokinematics

The manner in which bones move in space without regard for joint surfaces


**Osteokinematics**

- *Planes of Motion*
  - How do you divide the body in half?

- *Axis of rotation*
  - Where does the joint motion occur?

- *Degrees of freedom*
  - How many planes are allowed at a particular joint?
Planes of Motion

- Describes the motion of bones relative to the **three cardinal planes** of the body
  - Sagittal
  - Frontal (coronal)
  - Horizontal (transverse)
Axes (pleural of "axis") of Motion perpendicular to the plane of motion ($\perp$)

X, Y, Z Coordinates

- X - Left or Right
- Y - Up or Down
- Z - Forward or Back
Axes of Motion

- Traditionally we speak of the x, y & z axis for rotation; let’s give them more functional names or nomenclature:
  - **X-axis** is medial-lateral
    - (sagittal plane with flex/ext)
  - **Y-axis** is vertical or longitudinal
    - (horizontal plane with IR, ER, trunk rotation, supination/pronation)
  - **Z-axis** is anterior-posterior
    - (frontal plane with ABD/ADD)
Degrees of Freedom

- How many *planes of motion* can this joint work in?
Arthrokinematics

The manner in which adjoining joint surfaces move in relation to each other

Three fundamental movements [roll, slide & spin], and accessory motions [compression, distraction, shear, etc.]
Reminder: What is a joint?

- The intersection of two bones
  - A.k.a. an articulation
- The moving segments of the body
Joint Congruency

- Definition: the best fit!
- The relationship between two surfaces:
  - One concave – the catcher
  - One convex – the ball
- Closed-pack or close-packed position
- Opened-pack or loose-packed position
  - Position where joint play can occur
Joint Congruency

- This relationship provides a good fit and joint stability.
- Closed pack joint position
  - when all the structures holding the joint together are taut; the ligaments and capsule.
  - full knee extension
Joint Congruency

- Open pack joint position
  - any other position than closed packed
  - also known as the resting position
- Joint play = accessory motions
  - Motions necessary to achieve full ROM

The clinician is performing patellar glides, which are only possible in an open position where there is no tension on the quads.
Arthrokinematic Motion

- **Roll** – rolling of one joint surface on another
- **Slide or Glide** – linear movement of a joint surface parallel to the plane of the adjoining joint surface
- **Spin** – rotation of the movable joint surface on the fixed adjacent surface
Arthrokinematic Motion

- **Rolling** – multiple points along one rotating joint surface contact multiple points on another joint surface.
- **Slide** – a single point on one joint surface contacts multiple points on another joint surface. Like a skid across a surface.
- **Spin** – a single point on one joint surface rotates on a single point on another joint surface. Like a child’s top.
Convex on Concave rule

- Needed to establish joint **stability**
- A combination of rolling and sliding
  - The convex joint surface rolls on the concave surface, and simultaneously
  - The convex joint surface slides in the opposite direction of the roll on the concave surface
Concave on Convex rule

- This time the convex joint surface is fixed.
- The concave joint surface rolls in combination with a slide in the same direction.
Spins

- Spinning occurs about a central longitudinal axis of rotation
Kinetics - Biomechanics

- The effects of forces on the body.
- Mechanical principles applied to the human body (structure and function)
- Forces
  - Internal – forces from inside the body
    - Muscle contraction (active)
    - Ligamentous laxity or tautness (passive)
  - External – forces from outside the body
    - Gravity
    - Weights
    - Another person’s resistance
Mechanics

- **Force (F)**
  - Any action or influence that moves an object
    - Push or pull

- **Vector**
  - A quantity having both force and direction
    - Represents the line of pull
Torque

- The tendency of force to produce rotation about an axis
- Moment arm = the distance between the force and the axis of rotation

Force x Moment Arm = torque
Line of Pull & Axis of Rotation

This relationship determines the action or actions of a particular muscle:

- Anterior to medial/lateral axis = flexion
- Posterior to medial/lateral axis = extension
- Superior or lateral to anterior/posterior axis = ABDuction
- Inferior or medial to anterior/posterior axis = ADDuction
- Anterior to vertical axis = internal rotation
- Posterior to vertical axis = external rotation
Mechanical Advantage

- Ratio between the
  - force arm (FA)
    - Distance between the force and the axis

- and the
  - resistance arm (RA)
    - Distance between the resistance and the axis
Mechanical Advantage (MA)

- To determine
  - Length of force arm
  - Length of resistance arm

= MA
Mechanical Advantage (MA)

- When the FA is greater than the RA
  - The MA is greater than 1
  - The force arm has more force than the RA
Mechanical Advantage

- It takes less force on your part if you apply resistance distally rather than proximally.
Levers – 3 Classes

Used in the musculoskeletal system
Classes of Levers

- First Class Lever
  - F - A - R
  - Force, Axis, Resistance
  - Designed for balance
    - The head sitting on the cervical vertebrae
Classes of Levers

- Second Class Lever
  - A – R – F
    - Designed for power
    - Ankle plantar flexors when the individual stands on his or her toes
Classes of Levers

- Third Class lever
  - A – F – R
    - Designed for motion
      - The most common lever in the body because they favor large ranges of motion
      - Favor speed and distance