PHYE 281 - Applied Kinesiology
Lecture 3
Biomechanical Fundamentals

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Objectives

Understand that the musculoskeletal system can be considered a mechanical system of levers

Understand the components of a lever system

Define the three classes of levers and give an example for each of these in the body

Identify the most common lever system in the body

Define angle of pull and how the forces applied to a bone vary as the angle changes during movement

Apply the concepts of human lever systems and angle of pull to certain movements and training techniques

The Body as a Machine

A machine is an apparatus that increases mechanical advantage

Musculosketal systems can be thought of as series of machines

Human movement is through a system of levers

Lever: rigid bar that turns about a fixed point of rotation - bones serve as levers

Fulcrum: axis of rotation - joints serve as fulcrums

Resistance: weight of body segment being moved, as in a limb with or without a dumbell

Force: The force (effort) applied to the lever causing movement - muscles apply this force

3

Types of Machines in the Body

Three classes of musculoskeletal lever-systems produce human movement

Each class of levers contains:

Resistance - R

Fulcrum - F

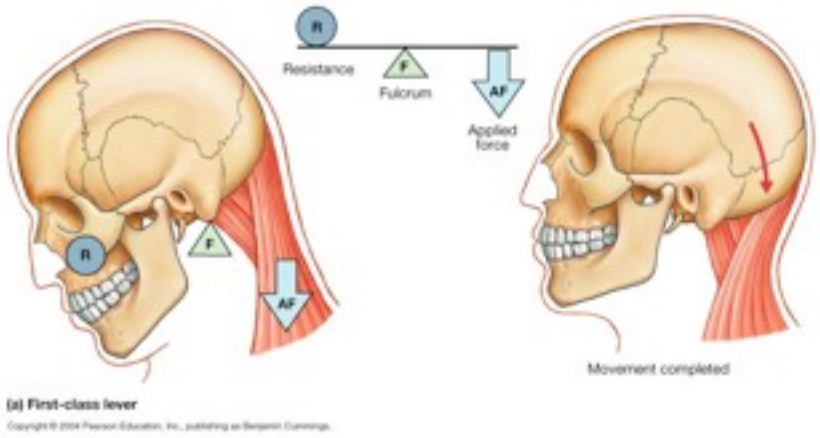
Applied Force - AF

4

First-class Lever

Few first-class levers in the body

Fulcrum lies between applied force and resistance



(a) First-class lever

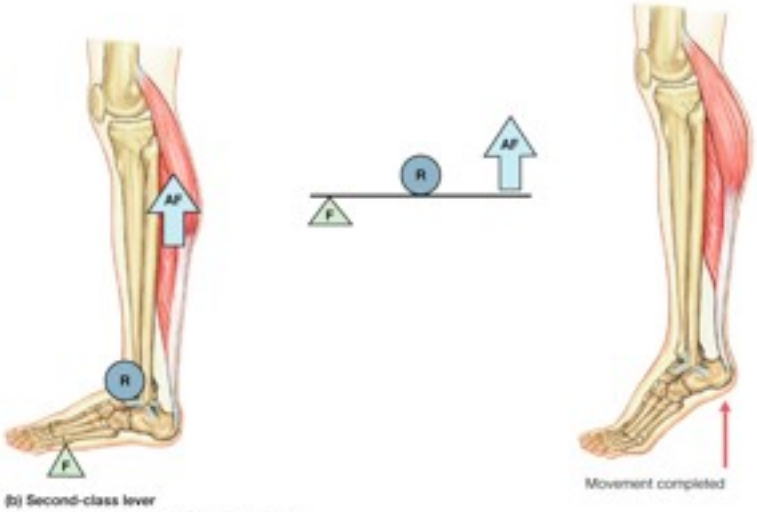
5

Second-class Levers

Few second-class levers in the body

Similar to a wheelbarrow

Resistance between applied force and fulcrum



(b) Second-class lever

6

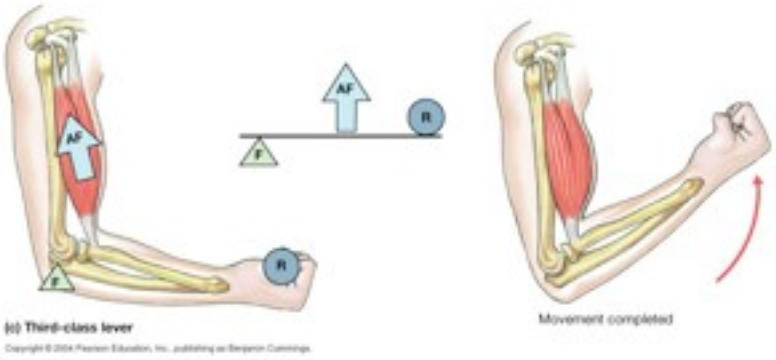
Third-class Levers

Most common in the body

Force between fulcrum and resistance

Maximizes speed and ROM

Requires significant applied force



Angle of Pull

Angle between the line of applied force by the muscle (pull) and the bone on which it inserts

With every degree of joint motion, angle of pull changes

Changes in angle of pull will direct the applied force to either rotary, stabilizing or dislocating forces

Angle of Pull

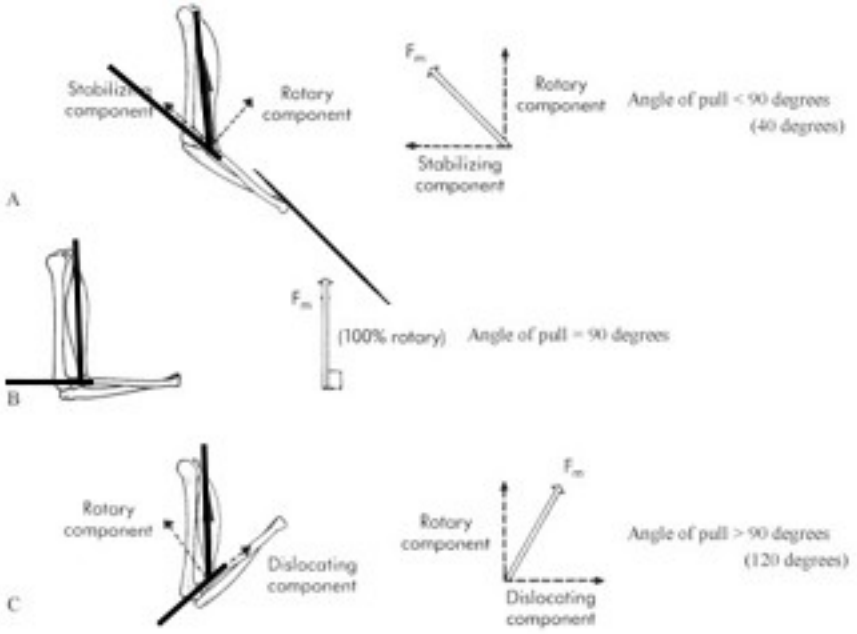
Three components of muscular force:

- Rotary Component
  - Acts perpendicular to bone and causes bone movement
  - Most efficient angle of pull is at 90 degrees (requires less force for bone movement)
- Stabilizing Component
  - Directs force toward joint (axis), pulling bones together
  - Occurs when angle of pull is less than 90 degrees
- Dislocating Component
  - Directs force away from joint, pulling bones apart
  - Occurs when angle of pull is more than 90 degrees

9

Angle of Pull

Angle is measured between joint and attachment



10

Angle of Pull and Exercise

How is angle of pull relevant during a pull up?

When is it hardest? When is it easiest?
How can you train to do pull up?

How is angle of pull relevant when training with free weights as opposed to machines that employ camming devices?

Is it beneficial to increase resistance with a weight machine when angle of pull is most advantageous?

11

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12