ICSC
Manipulation Principles

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- **College of Graduate Studies**
- **University of Western States**
- **FICS International Federations Commission (Games Commission)**

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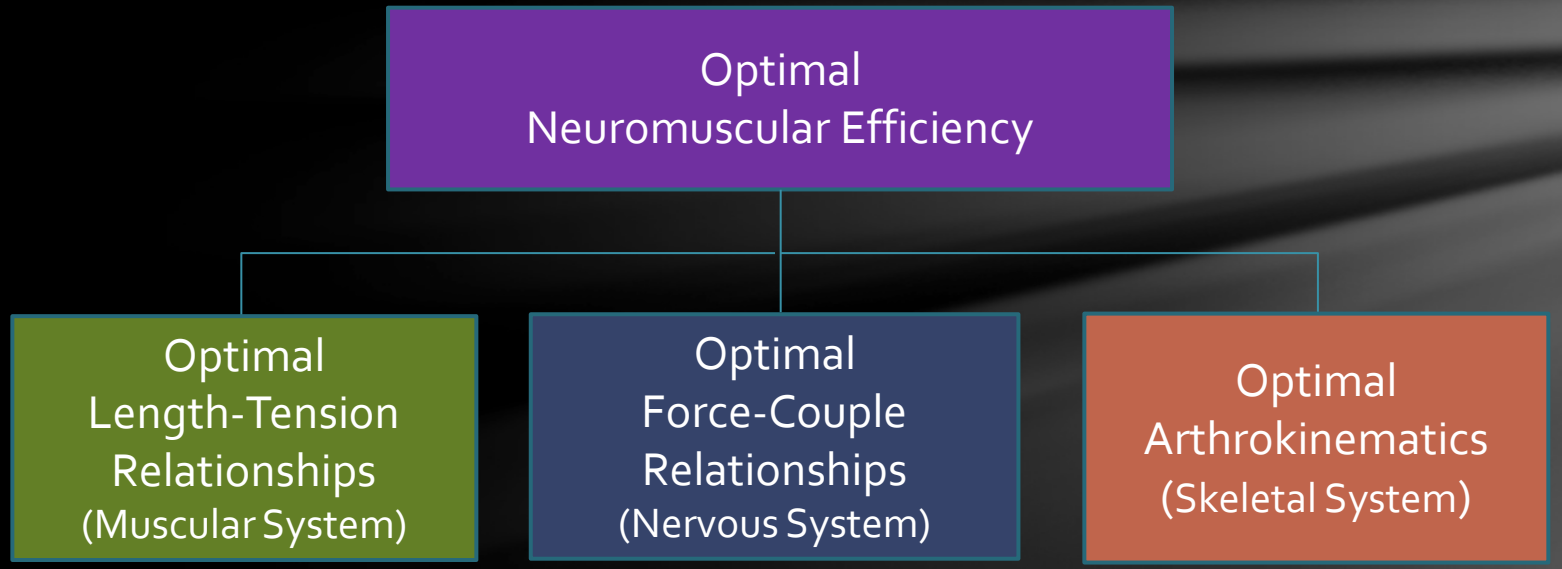
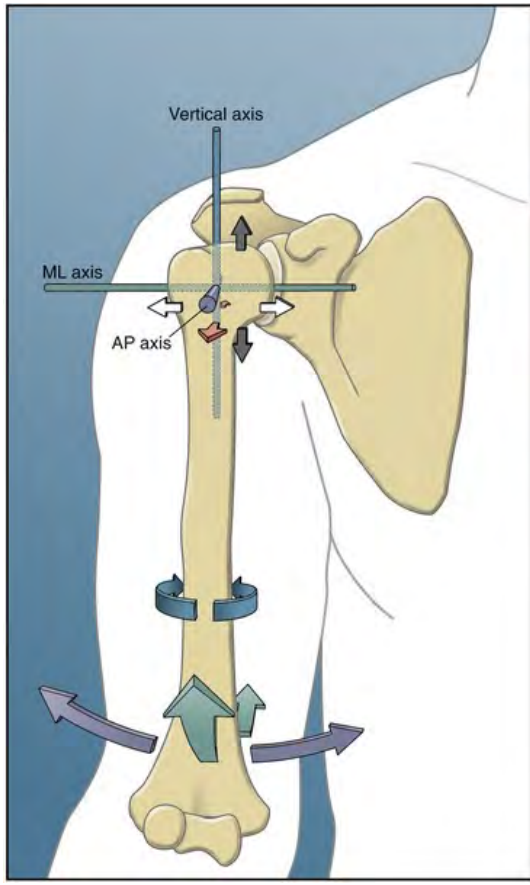
Optimal Neuromuscular Efficiency



Kinesiological Principles

Kinematics: Movement

- **Osteokinematics**: The way bones and joints move in relation to each other.
  - **Types of Motion**:
    - **Translation** (linear) all body parts move in the same direction. Has a center of mass.
    - **Rotation** (Angular) all body parts move in the same angle about an axis of rotation. Thigh and forearm.
    - **Combination**: Most body motions are multi-segmental combinations of translation and rotation.

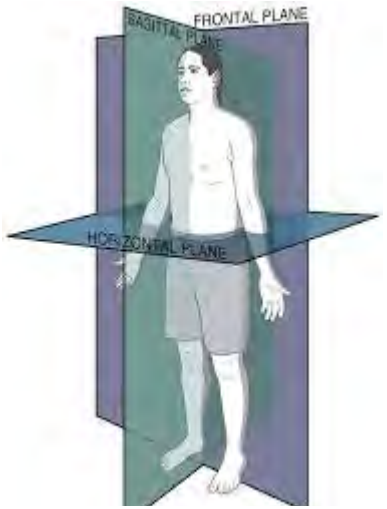


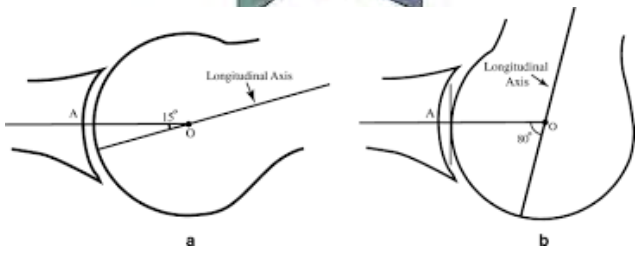
Wikimedia, Clinicalgate.com

Kinesiological Principles

Arthrokinematics

- **Planes of Motion**
  - Frontal
  - Sagittal
  - Transverse
- **Instantaneous Axis of Motion**: the point where the axis of rotation occurs.
- **Evolute**: A composite of multiple axis of rotation.





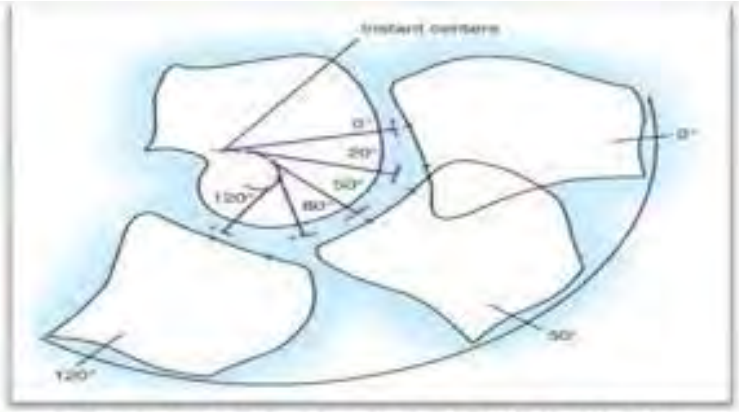


Fig. 14. Tibio-Femoral Joint Motion

Musculoskeletalkey.com, biomedcentral.com,

Joint – by – Joint Approach

- Boyle, M. (2010) Advances in Functional Training. Santa Cruz, CA: On Target Pub. pp 31-33.

Joint	Primary Function
Foot	Stability
Ankle	Mobility
Knee	Stability
Hip	Mobility
Lumbar Spine	Stability
Thoracic Spine	Mobility
Scapula	Stability
Glenohumeral Joint	Mobility

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Joint Stability

… ability of a joint to resist abnormal displacement of the articulation.

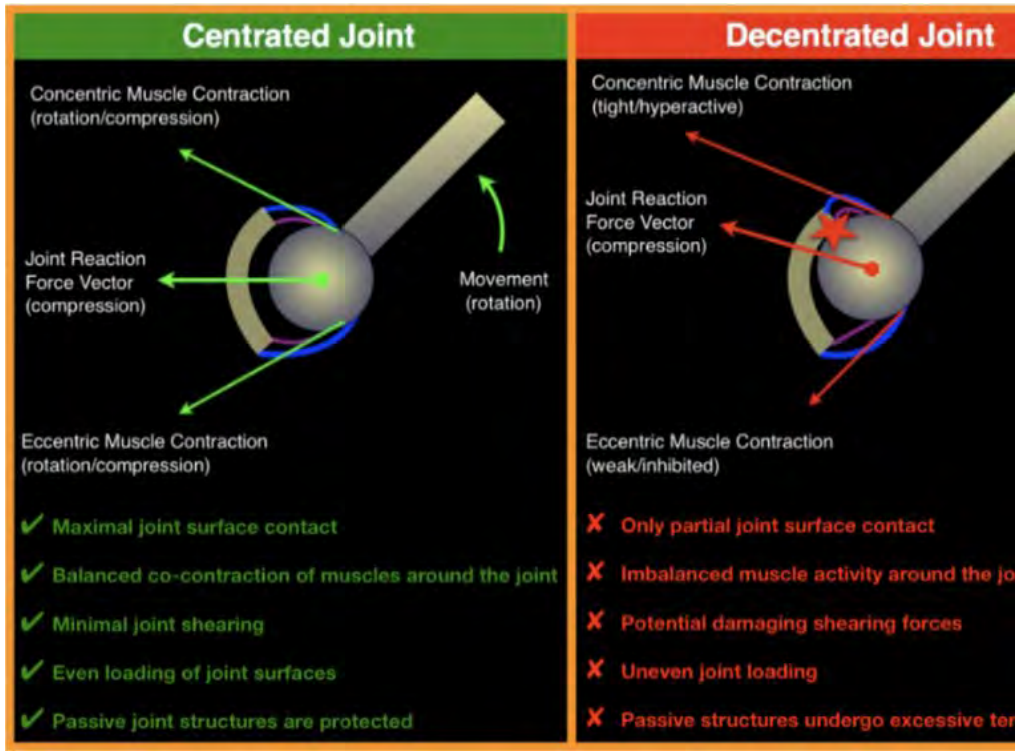
Joint Centration:

Closed packed position: maximum contact of articulating surfaces. (knee ext, ankle DF)

In a **closed chain exercise**, the distal aspect (hand or foot) is fixed, or stationary.

Open packed position: any other position.

In an **open chain exercise** the distal aspect, usually the hand or foot — is free and not fixed to an object. (Interphalangeal joint)



Hall, S. Basic Biomechanics, 5th ed. McGraw-Hill 2006. pp. 125.

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Kinematics

Arthokinematics: the way articulating surfaces of joints move in relation to each other.

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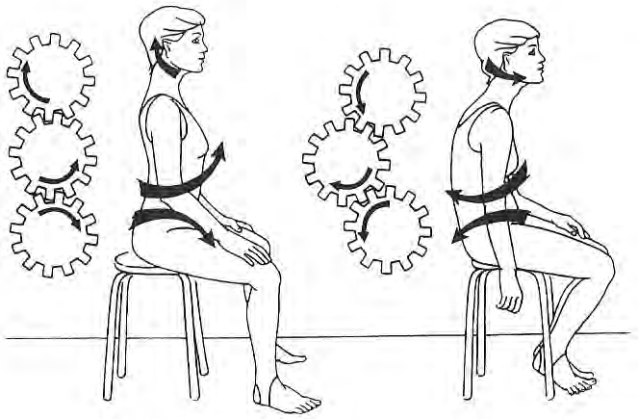
Kinetic Chains

Primary Chain	Secondary Chain	Type of Chain
Articular	Muscular, Neurological	Postural, Kinetic
Muscular	Articular, Neurological	Force Couples, Synergists, Slings, Myofascial
Neurological	Muscular, Articular	Protective, Sensorimotor, Neurodevelopmental



Postural

Kinetic

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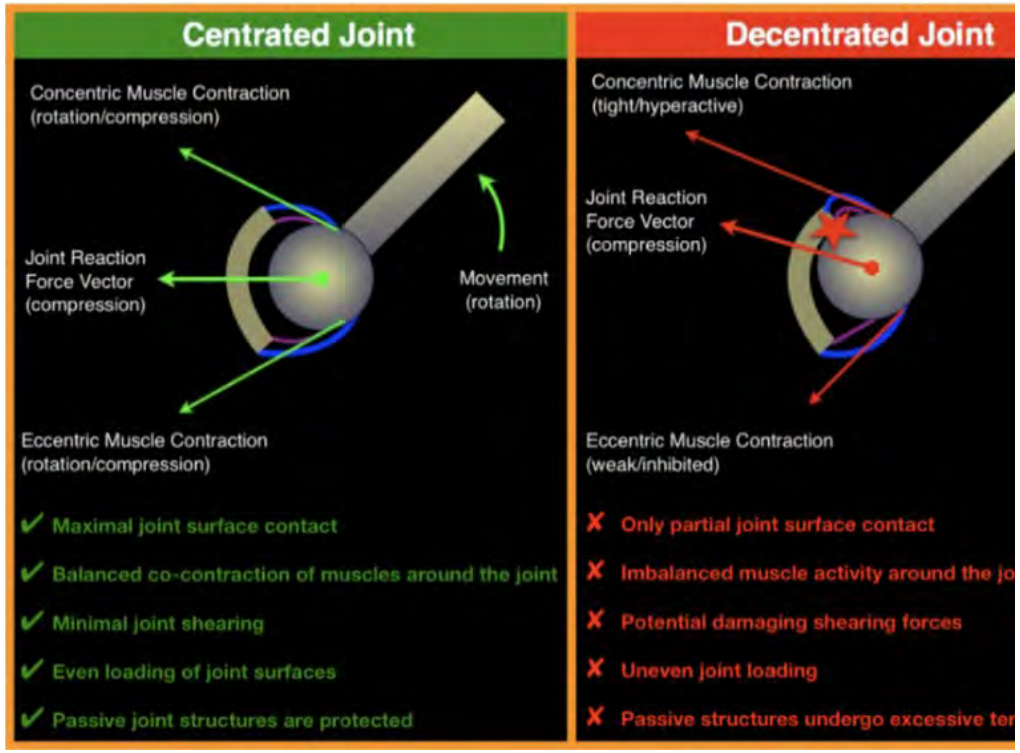
Kinesiology

Degrees of Freedom: A number of independent movements allowed in a joint.

Up to 3 degrees of motion

All synovial joints possess some translation (linear motion).

Accessory motion (Joint Play): movement relative to the articular surfaces. Or slight passive translation which may occur in 3 planes.



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Arthrokinematics:

Joint Play: Flexibility of the joint capsule.

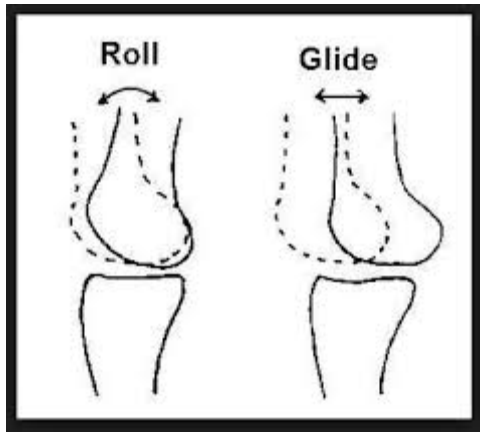
Fundamental Motions

-Roll

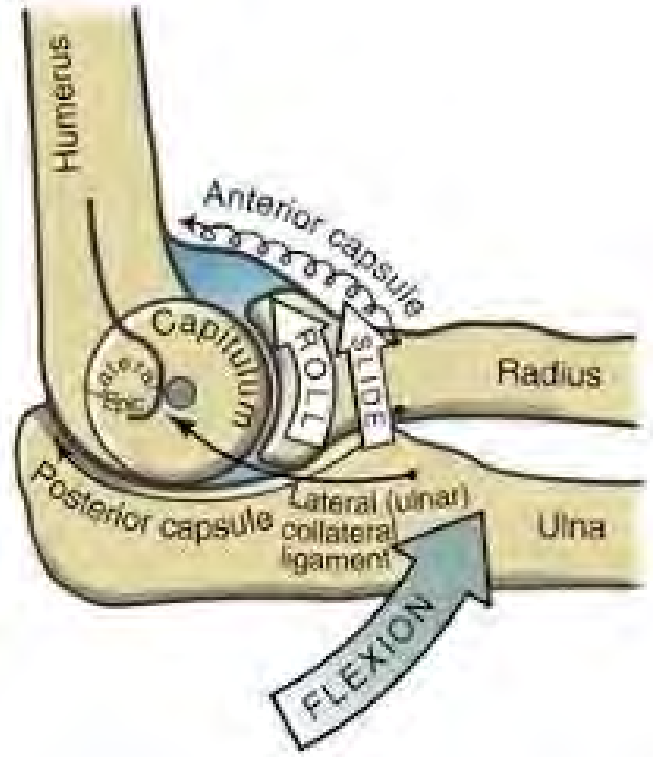
-Glide/Slide

-Spin/Swing

-Combinations



Quizlet.com, doctorlib.info,



Sites.google.com

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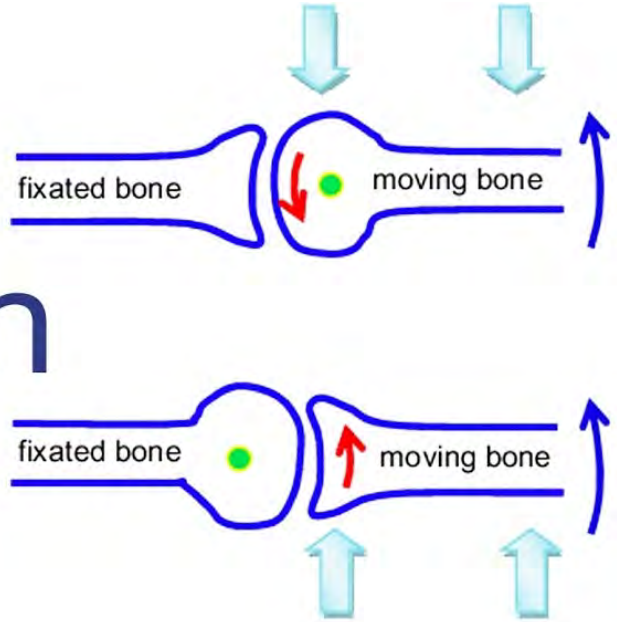
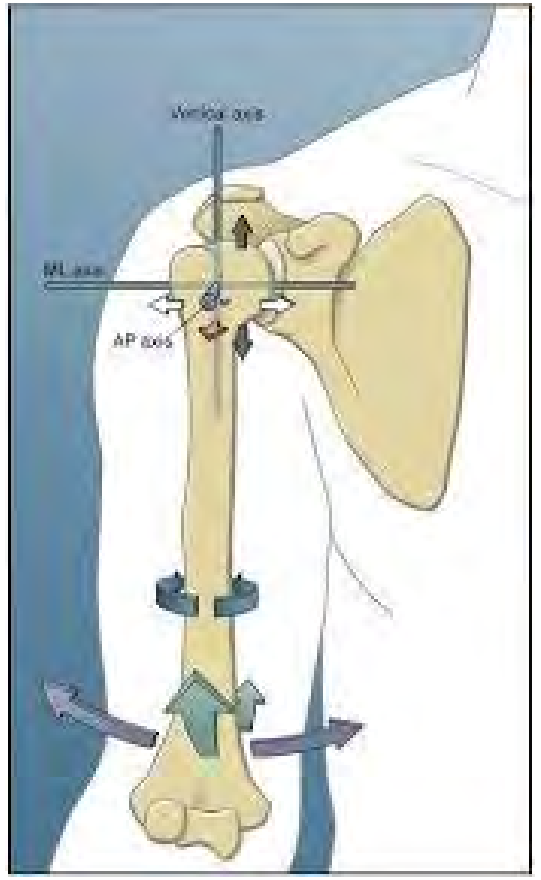
- **Convex-Concave Rule:** The fixed end of a joint determines the direction of accessory motion.
- **Instantaneous Axis of Motion**: the point where the axis of rotation occurs (green dot).
- **Evolute**: A composite of multiple axis of rotation.

The Kaltenborn Rule





clinicalgate.com

Physiotutors.com


Wikiwand.com


Gimnazijapg.me


Asu.edu

Body's Planes of Motion

- Like sports, most body motions are curvilinear.

A combination of translation and rotation.

- Allows for 3 translational and 3 rotational degrees of freedom of movement = 6 degrees of freedom of movement.

- Flexion, Extension, R/L-LF, R/L-Rot, AP, PA, LM, LM glide, Int/Ext Rotation, Compression, Distraction.

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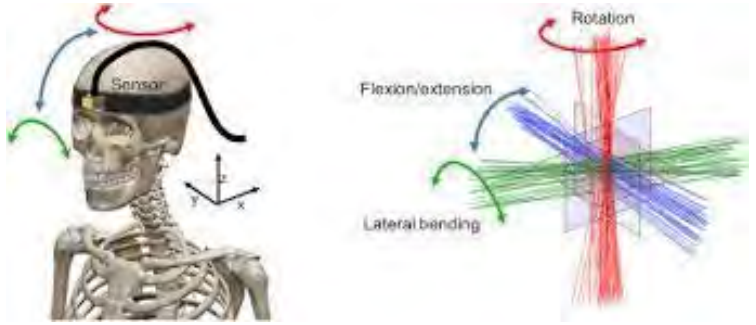
Arthrokinematics:

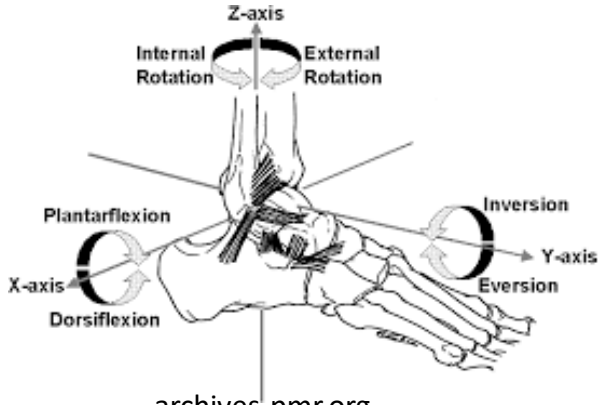
Helical Axis of Motion (HAM):

3-dimensional motion.

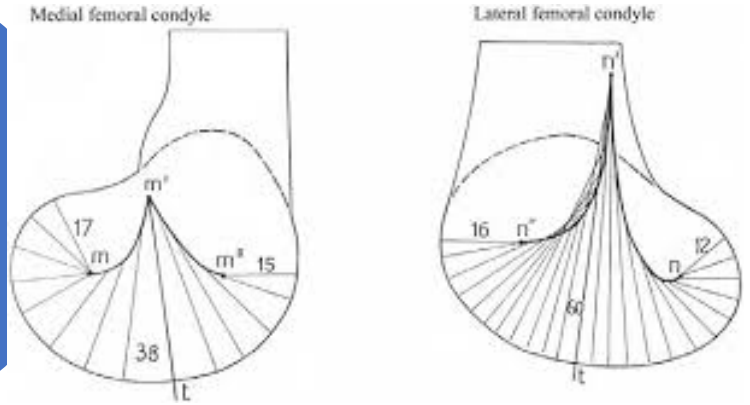
Most body motions are helical due to lack of pure planes of motion from multiple irregular articular surfaces.



Sciencedirect.com



archives-pmr.org



Journals.sagepub.com

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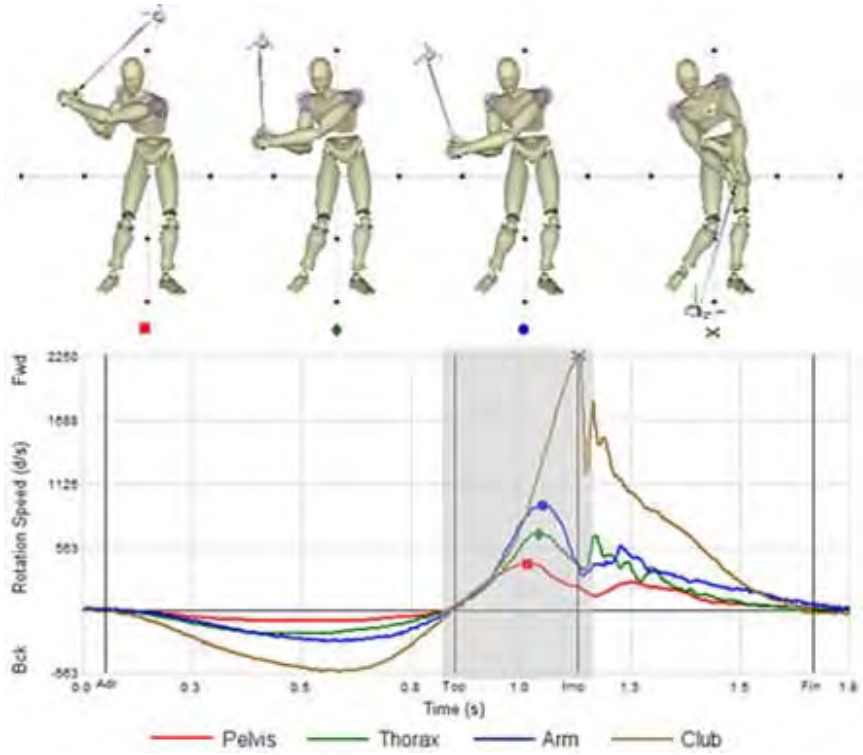
Kinetics: Study of forces that cause motion.

- **Newton's Second Law of Motion**: Acceleration of an object is dependent upon the force acting on it and the mass of the object.

Force = mass x acceleration



Singes.com

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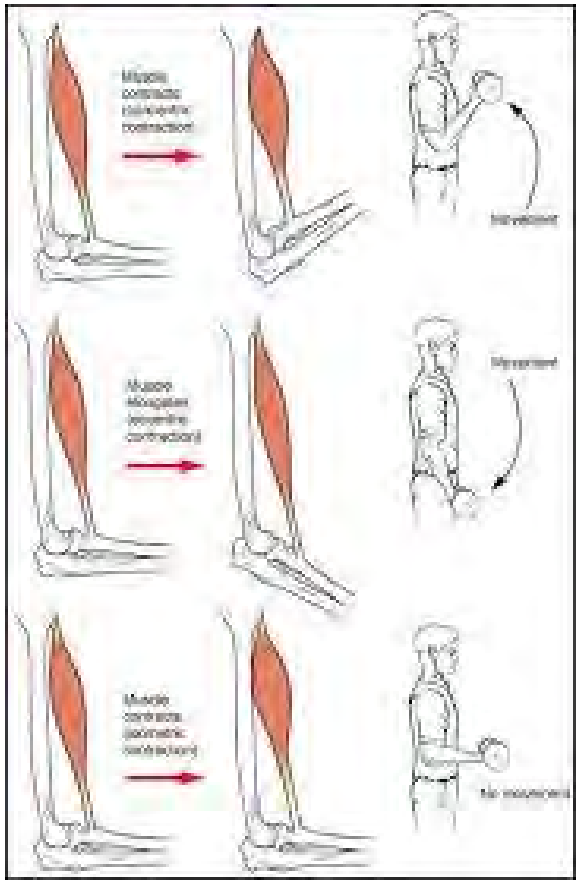
Kinetics: Study of forces that cause motion.

- **Types of Muscle Activation**
  - **Concentric**
  - **Eccentric**
  - **Isometric**



Theclimbingdoctor.com

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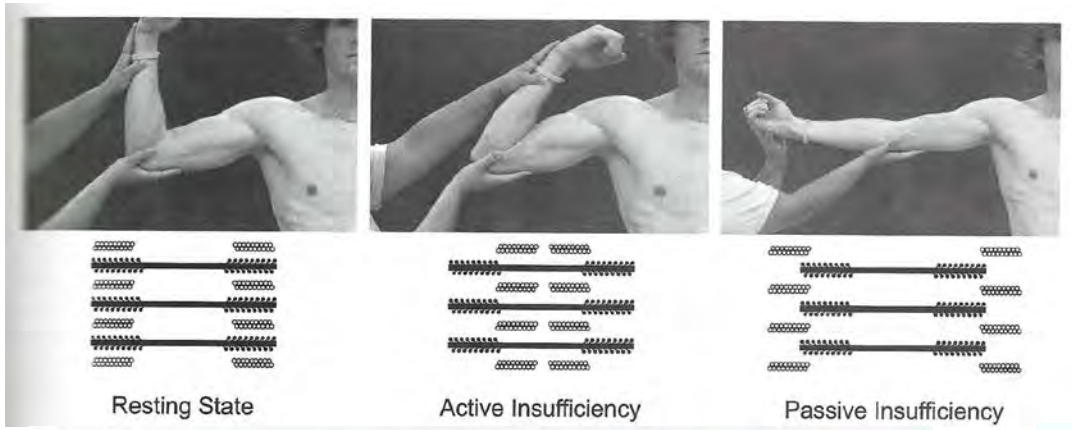
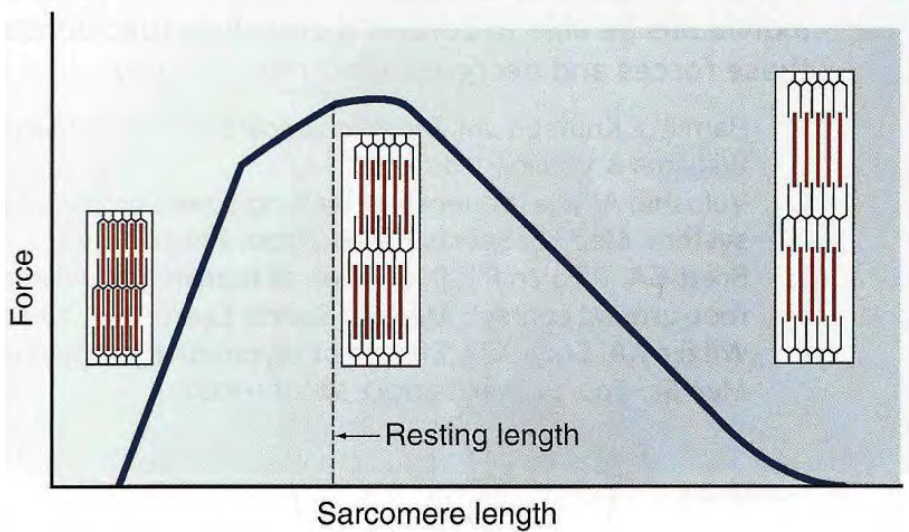
Kinetics: Study of forces that cause motion.

- **Agonist** – initiates and executes motion
- **Antagonist** – opposite action of agonist
- **Synergist** – aid in execution of agonist motion
- **Stabilizers** – isometric stabilization of body part
- **Force Couples** – synergistic action of muscles to produce movement.
- **Length-tension Relationship** – the tension a resting muscle can produce.





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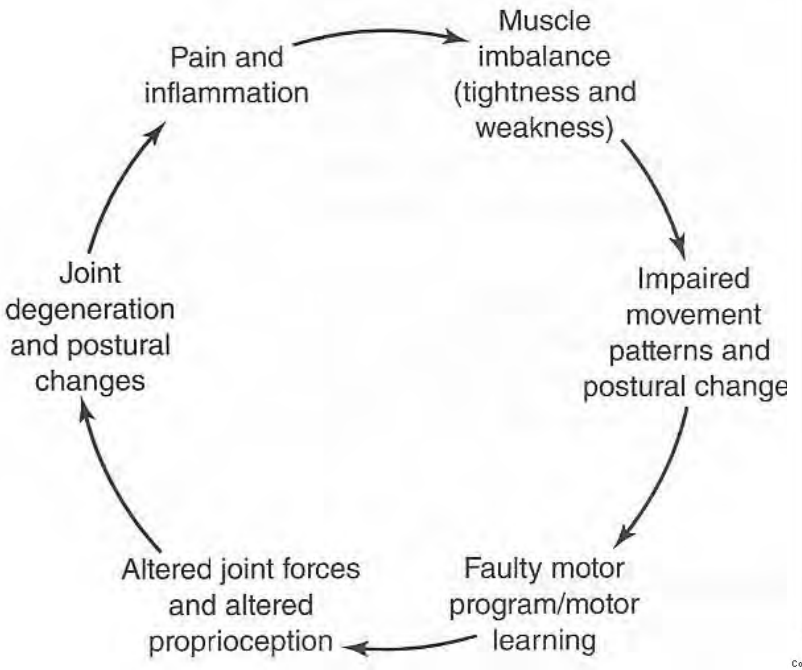
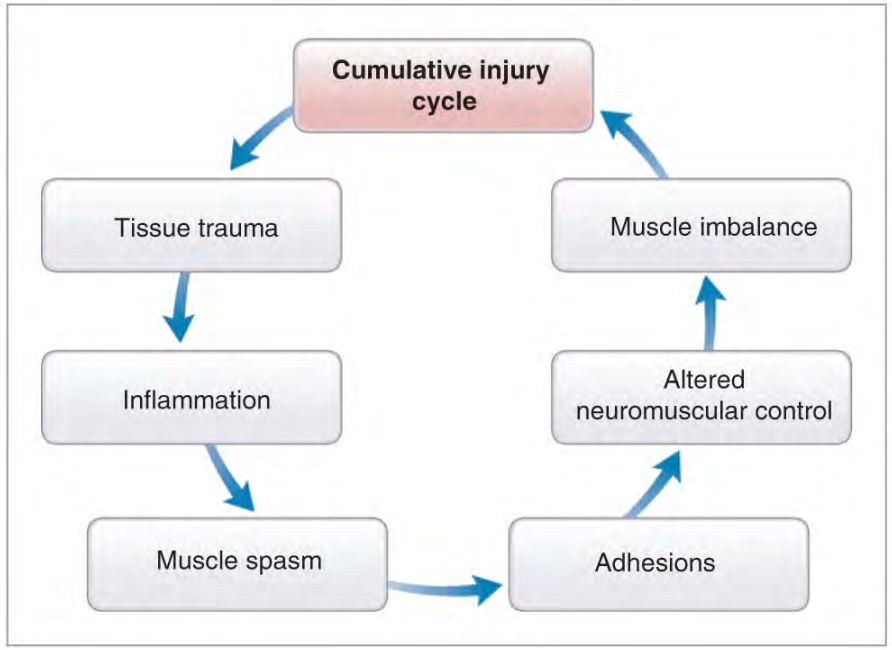
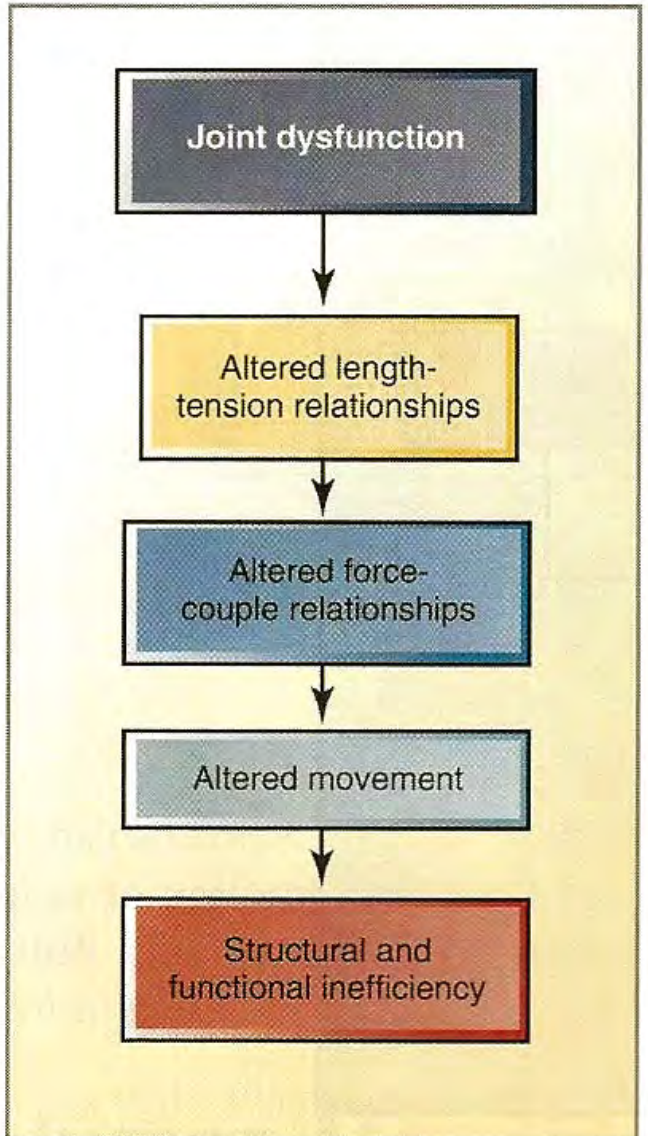
Genesis of Impairment in performance and Increased Risk of Injury







Kinetics: Study of forces that cause motion.

Muscular Forces

Tension

Compression

Bending

Shear

Torsion

Combinations

Journal.crossfit.com

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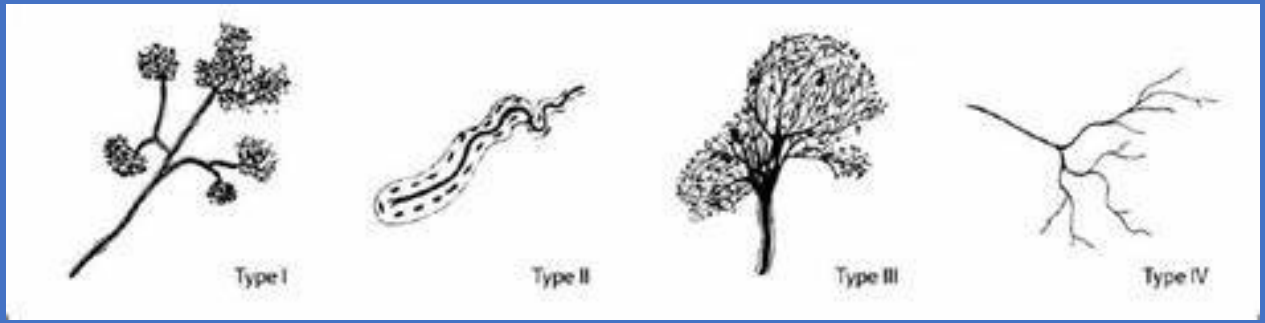
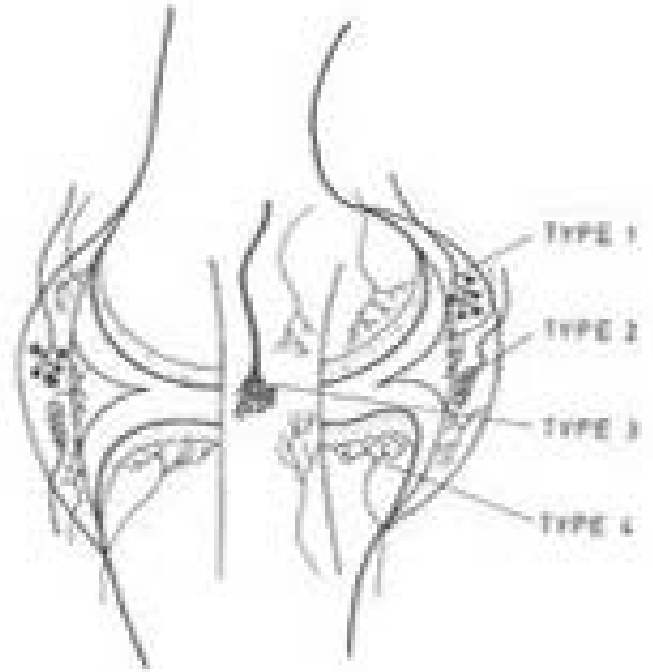
Articular Neurology

- Innervated by a variety of receptors
  - **Primary Articular** – independent branches of peripheral nerves.
  - **Accessory Articular** – branches of related muscles.
  - **Mechanoreceptors** – Types I-IV





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Articular Neurology

- Innervated by a variety of receptors
  - Mechanoreceptors
    - **Type I**
    - Capsules of all joints, but more numerous in proximal limb joints, apophyseal, and TMJ.
    - Low threshold, slow adapting,
    - always active even when joint is immobile.
    - Discharge rate 10-20/sec.
    - Discharge rate⬆⬇with man./mob., muscle contraction and intra-articular pressure gradient changes (Cavitation).
    - Supplement visual and cutaneous balance
    - Damage to joint capsule damages Type I leading to impairment of balance, posture.

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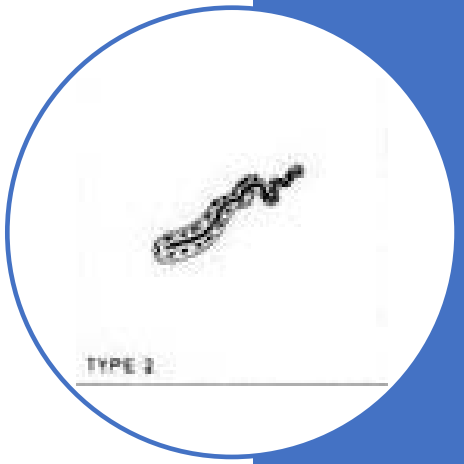
Articular Neurology

- Innervated by a variety of receptors
  - Mechanoreceptors
    - **Type II Pacinian**
    - Peri-articular tissue, Joint Capsule
    - More numerous in distal joints
    - Low threshold, rapidly adapting. Emit high frequency burst 20-40 m/sec before Type I.
    - Inactive in immobile joints
    - Signal joint acceleration/deceleration, reflex actions.



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Articular Neurology

- Innervated by a variety of receptors
  - Mechanoreceptors
    - **Type III** - like Golgi Tendon Organs
    - Intrinsic/Extrinsic joint ligaments
    - Collateral ligaments, Cruciates, Longitudinal, Interspinous lig. of spine
    - High threshold, slow adapting
    - Inactive in immobile joints
    - Only become active in end ranges of motion
    - Monitors Braking and direction of movement.

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Articular Neurology

- Innervated by a variety of receptors
  - Mechanoreceptors
    - **Type IV** Free Nerve Endings
    - High threshold
    - Mediate Pain
    - Stimulated by mechanical deformation, tension, mechanical and chemical irritation (inflammatory exudates)
    - Continuous firing = increased muscle tension, pain perception.

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Assessing Joint Function and Biomechanics

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Why do Synovial Joints Become Restricted?

Theories

- **Patterson – Steinmetz Model**
  - Created a cerebellar lesion in an anesthetized animal
  - Concluded spinal fixations were generated by peripheral inputs to segmental circuits
  - There were increased susceptibility for hours to months after acute problem was resolved.

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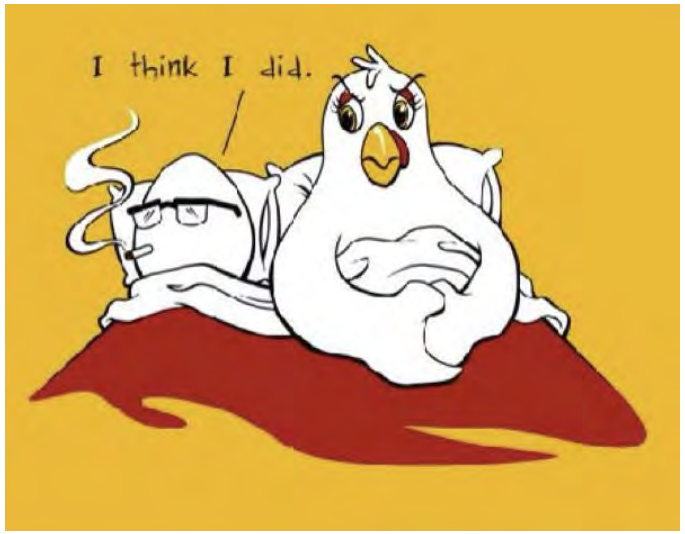
Theories



- **Gatterman-Goe Model**
  - Traumatic or Postural Strains create trigger points.
  - Tissue damage sensitizes nerve endings creating muscle tension and neurogenic inhibition.
  - Trigger points lead to muscle imbalance

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Theories

- **Triano's Biomedical Buckling Model**
  - Buckling is a local failure by deformation within the multi-segmental structure of the spinal column.
  - Single event. chronic loading, loading higher that 500lb/sec and chronic vibration are causative factors.
  - Mechanical irritation leads to altered movement, tone, pain, degenerative tissue changes.
  - Manipulation and exercise can alter the dynamics of the buckled region

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Theories

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Evaluation of Joint Play

Joint Play: Qualitative evaluation of the joint's resistance to movement when it is in a neutral or loose-packed position**.**

- Evaluated by small magnitude, springing of the joint.
- The discrete, short-range movement of a joint independent of the action of voluntary muscles, determined by springing the joint in the neutral position.

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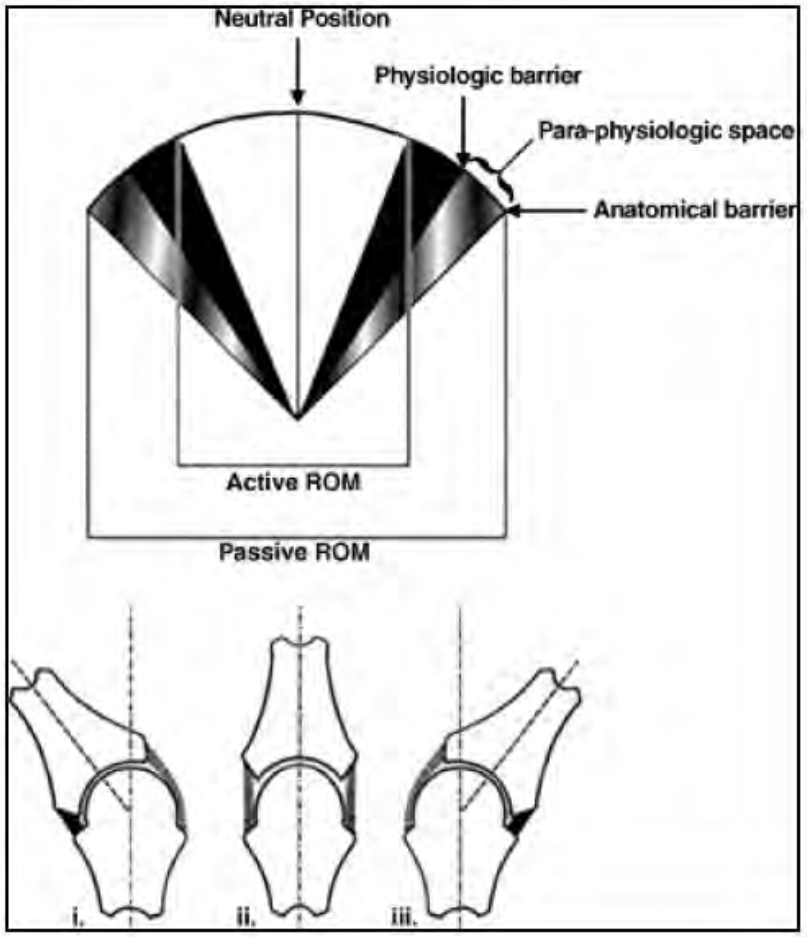
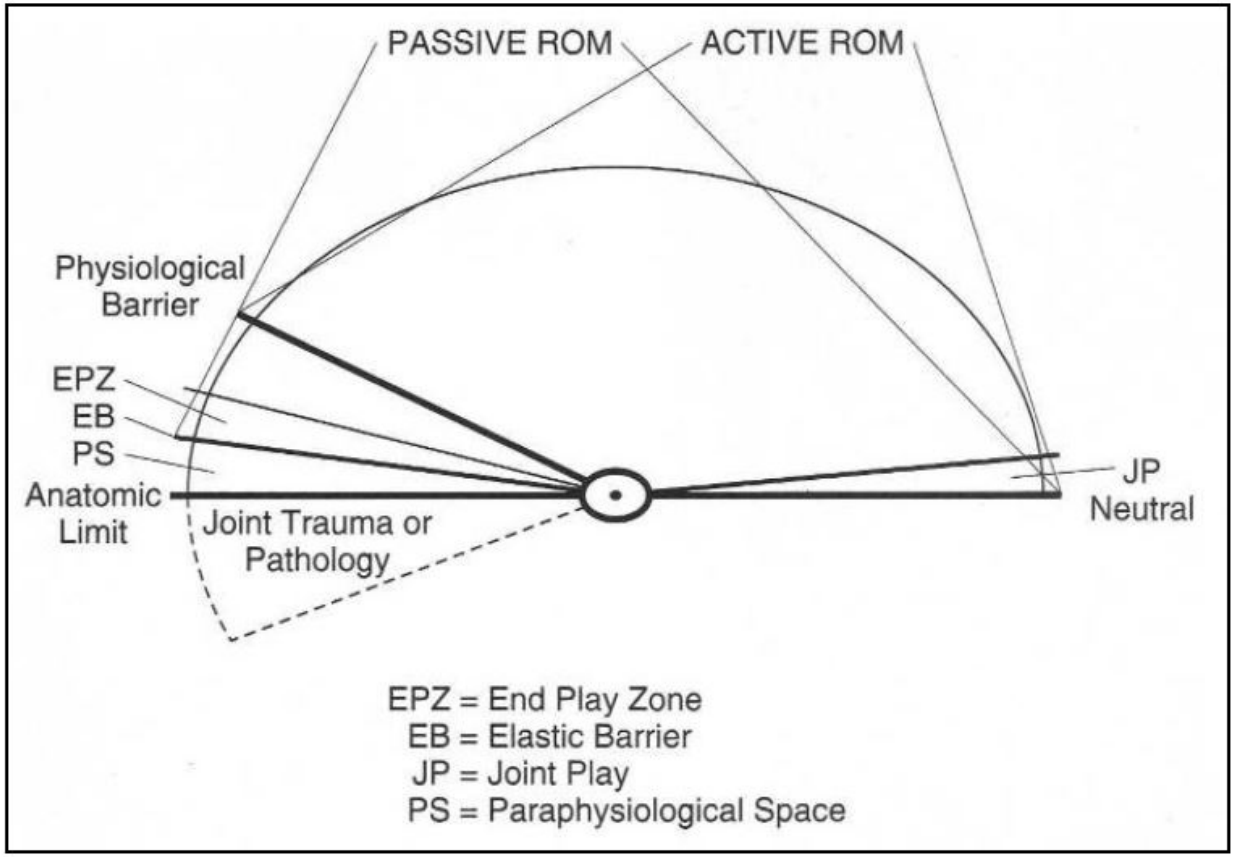
Intra-articular Ranges of Motion





End Feel

- **Normal End Feel**

1. **Bone-to-Bone**: A hard unyielding painless sensation exemplified by elbow extension.
2. **Soft Tissue Approximation**: Occurs when soft tissue stops further movement. For example, elbow, knee, or hip flexion, this is abnormal if less as a result of scar tissue, contracture, or arthrosis.
3. **Tissue Stretch**: A hard springy movement with little give to it, as in finger extension or glenohumeral lateral rotation.

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End Feel

Abnormal End Feel

1. **Bone-to-Bone**: Same as the normal end feel but occurs within or before the normal range of motion ends.

2. **Spasm**: A sudden dramatic arrest in movement often accompanied by pain.

3. **Springy Block**: Indicates an intra-articular pathology such as loss of knee extension due to a torn meniscus or loose body and is always abnormal; a spinal fixation would elicit a springy block.

4. **Empty Feeling**: Occurs when the examiner feels that more movement is possible, but the patient demands that the motion stop because of severe pain; may indicate anything from an acute bursitis to cancer and is always abnormal.

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End Feel

Abnormal End Feel

5. Capsular Patterns: Capsular: Normally the firm end feel of a normal shoulder, hip, or knee at the end of rotation; it is abnormal if the capsular feeling is firmer than usual or associated with a decreased range of motion.

Joint	Capsular Pattern
Cervical Spine	SF and rotation equally limited, ext
Glenohumeral jt.	ER, ABD, IR
Ulnohumeral	Flex, ext
Radiohumeral	Flexion, ext, sup, pro
Wrist	Flex and ext equally limited
Thoracic Spine	SF and rotation equally limited, ext
Lumbar Spine	SF and rotation equally limited, ext
Hip	Flex, ABD, IR (Variable)
Knee	Flexion, Extension
Talocrual	PF, DF

Assessing Joint Motion

- **Algometry**
  - **Excellent reliability, repeatability**
  - **Correlates well with psychometric outcomes.**

Points	Mean before	Mean after	Increase %
Right occipital	3.26	6.30	84%
Left occipital	2.94	5.76	98%
Right trapezius	4.18	5.80	70%
Left trapezius	4.14	6.16	74%
Right rhomboid	4.66	6.38	68%
Left rhomboid	4.20	7.00	83%
Right upper chest	2.78	3.40	61%
Left upper chest	2.34	3.36	71%
Right lateral Epicondyle	3.40	4.90	72%
Left lateral Epicondyle	2.98	4.94	83%

Researchgate.com

Assessing Joint Motion

- **Triano:** (2013) **PARTS**

Review of methods used by chiropractors to determine the site for applying manipulation

- **P**ain
- **A**symmetry
- **R**ange of Motion
- **T**issue Temperatures, Texture, Tone
- **S**pecial Tests

Chase (2009) **TART**
Tissue Texture abnormality
Asymmetry
Range of Motion
Tenderness.

Dowling (1998) **STAR**
Sensibility changes
Tissue Texture abnormality
Asymmetry
Restricted Range of Motion

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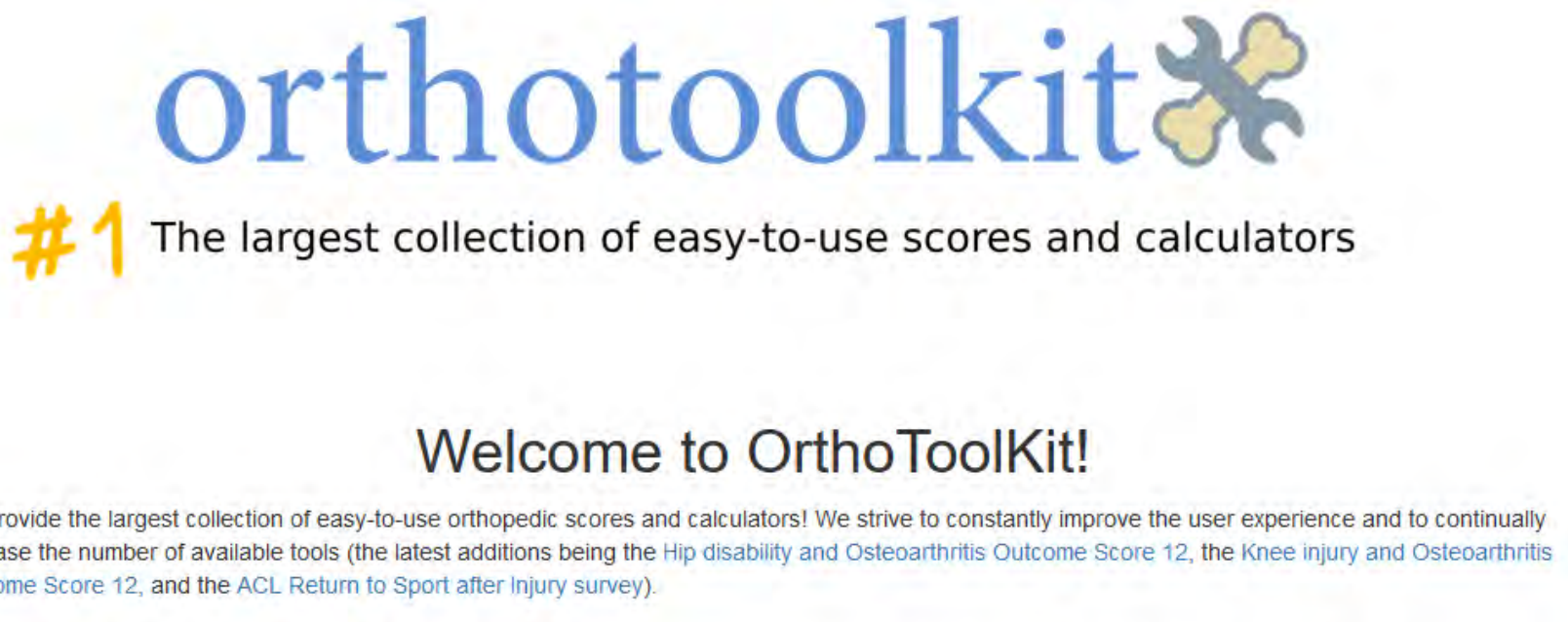
Assessing Joint Motion



https://orthotoolkit.com/

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Joint Mobilization

Classification

- **Grade 1:** Is a small amplitude movement at the beginning range of joint play. It is used when pain and spasm limit movements early in the range of motion.
- **Grade 2**: A large amplitude movement at the mi- range of joint play. It is used for pain control, spasm reduction which inhibits movement.
- **Grade 3**: A large amplitude movement at the end range of joint play. Reduces pain, increases periarticular extensibility, corrects positional faults, and releases meniscal tissue in the spine.
- **Grade 4**: small amplitude movement at the end range of joint play. Reduces pain, increases periarticular extensibility, correct positional false, and releases mensicoid tissue in the spine.
- **Grade 5**: manipulation of high velocity and low amplitude to the anatomical and point of a joint.

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References

Sahrmann S. 2002 Diagnosis and Treatment of Movement Impairment Syndromes. St. Louis, MO.

Cook G. 2010 Movement Screening, Assessment, Corrective Strategies. On Target Pub. Aptos, CA.

Boyle, M. 2010 Advances in Functional Training. On Target Pub. Santa Cruz, CA.

Page P., et. al. 2010 Assessment and Treatment of Muscle Imbalance. Human Kinetics Champaign IL.

Hall S. 2007 Basic Biomechanics 5th ed. McGraw Hill Boston, MA.

Clark M, et. al. 2014 NASM Essentials of Corrective Exercise Training. Jones Bartlett Burlington MA.

Chaitow L 2013 Muscle Energy Techniques 4th ed. Churchill Livingstone London, UK.

Liebenson, C ed. 2020 Rehabilitation of the Spine A Patient Centered Approach. Wolters Kluwer Philadelphia, PA.

Magee D. 2021 Orthopedic Physical Assessment 7th ed. Saunders St. Louis, Mo.

Triano J. et al. 2013. Review of Methods Used by Chiropractors to Determine the Site For Applying Manipulation. Chiropractic & Manipulative Therapies 2013,21:36.

Chase C. 2009 Glossary of Osteopathic Terminology. Educational Council on Osteopathic Principles

Dowling D. 1998 STAR A More Viable Alternative Description System of Somatic Dysfunction. AAAOJ 8 (2), 34-37.