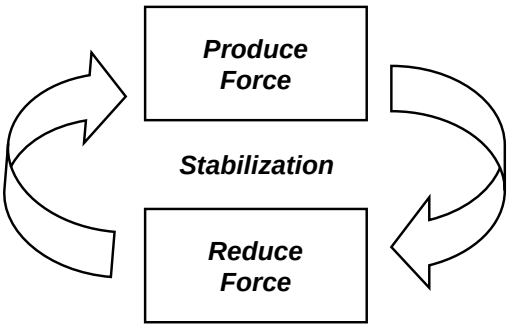
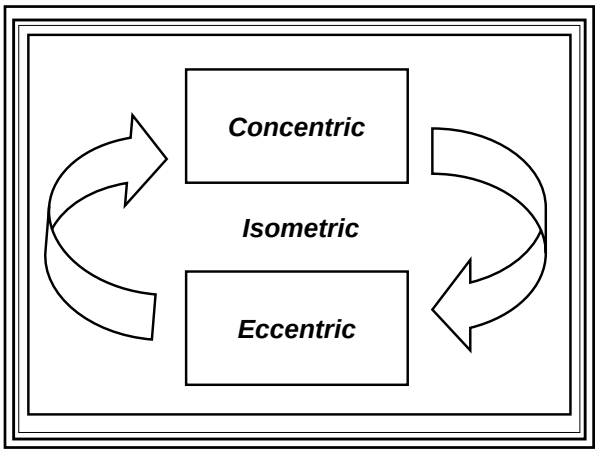
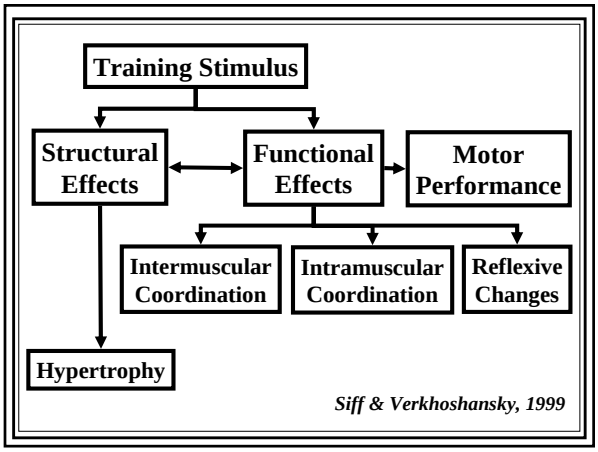
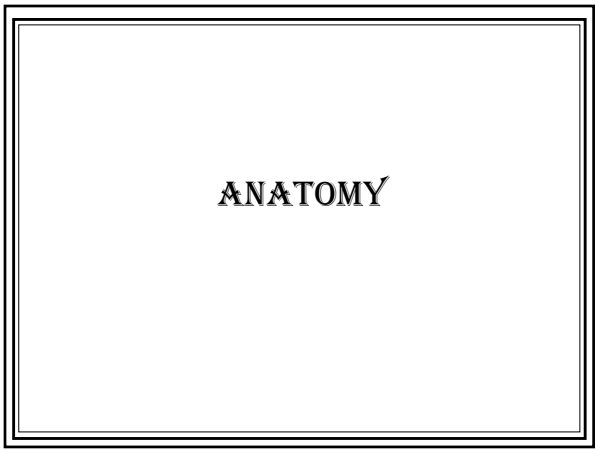
T e:
S d

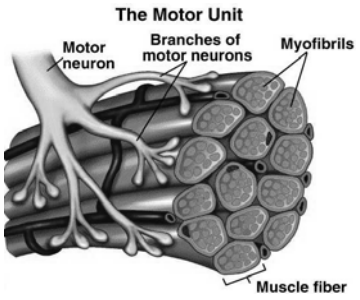
PART I: SCIENTIFIC FOUNDATIONS

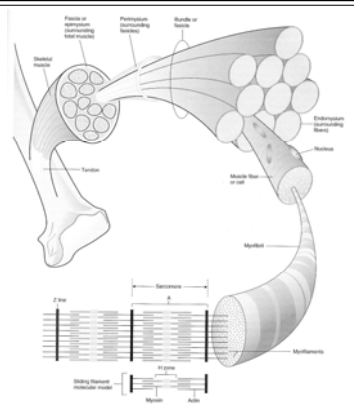



Concentric
Isometric
Eccentric


Training Stimulus
Structural Effects
Functional Effects
Motor Performance
Intermuscular Coordination
Intramuscular Coordination
Reflexive Changes
Hypertrophy
Siff & Verkhoshansky, 1999

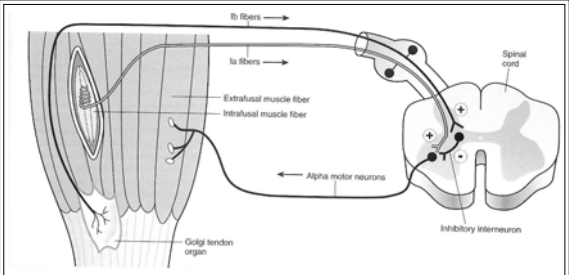

ANATOMY



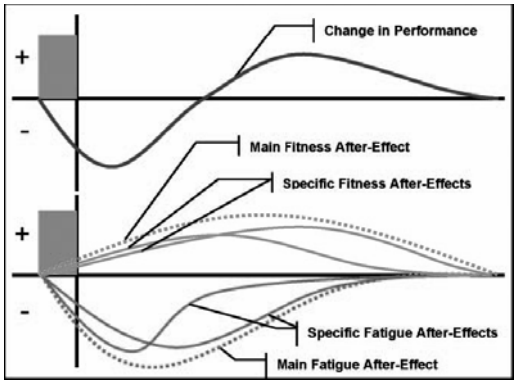


Sanders & Sanders, 2001

NEUROPHYSIOLOGY



Wilk & Reinhold, 2001



Chiu & Barnes, Strength & Conditioning, 2003

MECHANICS

Key Points

- Difference between strength, power, endurance
- Different types of endurance
- Torque vs. force
- Increasing muscle force
- Fitness-Fatigue Model
- Impulse - Momentum

PART II: TECHNIQUES

PART III: PROGRAM DESIGN

Indications

- ?

Contraindications

- Pain
- Increased edema
- Surgical / physician constraints

Acute Program Variables

- Choice of exercise
- Intensity
- Tempo
- Number of Repetitions
- Number of Sets
- Volume
- Rest Intervals
- Number of Sessions
- Frequency

Choice of Exercise

- Isometric vs. Dynamic
- Open vs. Closed Chain
- Machine vs. Free Weight
- Type of Resistance
  - Manual
  - Elastic
  - Isotonic – Body weight & Free weight
  - Isokinetic

C

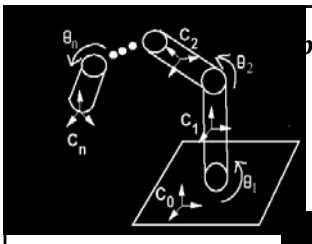
My cal

Presented APTA, 2005

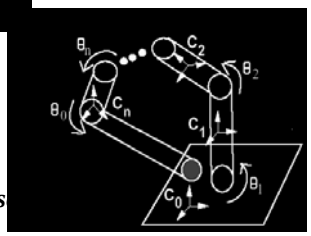
"Advantages" of Closed Chain Activities

- Stimulation of proprioceptors
- Increased joint congruency & stability
- Decreased shear forces
- Enhanced dynamic stability
- More "functional"

Prentice, 1999



pen Chain



Clos

Definitions

- **Steindler , 1955**
  - Open chain - a combination in which the terminal joint is free.
  - Closed chain - one in which the terminal joint meets with some "*considerable external resistance*" which prohibits or restrains free movement.

More definitions

- Closed chain – distal end is fixed (Zatsiorsky, 1998).
- Closed chain - motion of one [segment] at one joint will produce motion at all other joints in the system in a predictable manner (Levangie & Norkin, 2001).

Gary Mitchell

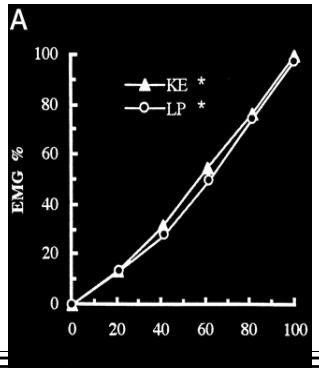
Alternate Classifications?

Dillman, Murray, & Hintermeister, J Sport Rehab, 1994

		Boundary	
		Fixed	Movable
External Load	External Load	FEL	MEL
	No Load	~~FNL~~	MNL

What does EMG tell us about movement classification?

EMG and Force

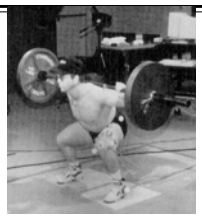


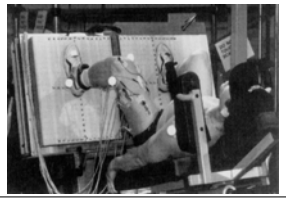
Alkner et al, MSSE 2000

No difference in integrated EMG between similarly- loaded push-ups and bench-press

Blackard, Jensnen, & Ebben, MSSE, 199

Biomechanical similarity between squat and leg press



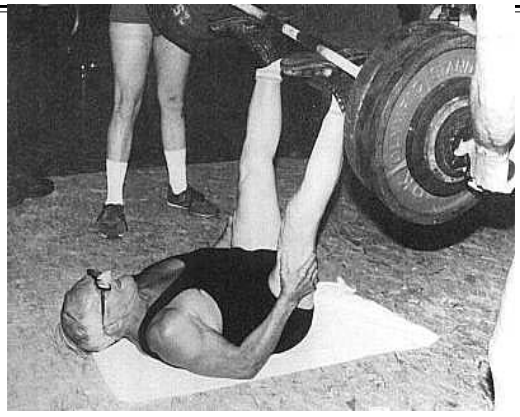


Escamilla et al, MSSE 1998

WEIGHT BEARING	Multiple Joints Linear Resistance
NON-WEIGHT BEARING	Single Joint Angular Resistance

No easy classification

- Distal vs. Proximal End Moving
- Single vs. Multiple Joints
- Angular vs. Linear Resistance
- Machine vs. Free Weight
- Seated vs. Standing vs. Prone



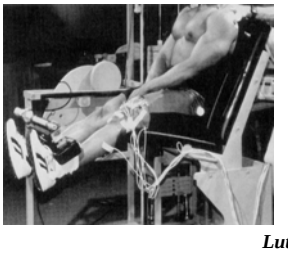
Ed Zercher

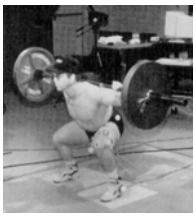
Rationale: CC & I. Safety

- Decreased Shear Force
- Increased Co-contraction
- CC movements are harder to control

Shear forces a function of…

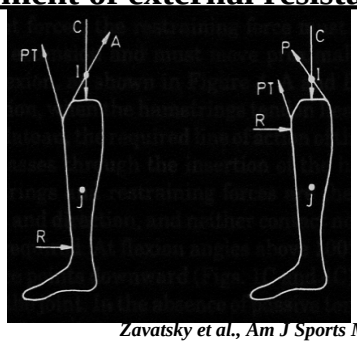
Type of loading





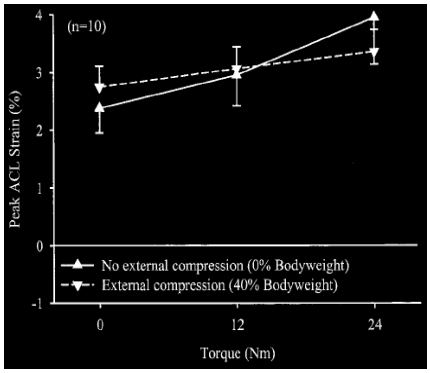
Lutz et al, JBJS-A, 1993
Wilk et al, Am J Sports Med, 1996
Escamilla et al, MSSE, 1998
Kvist et al, Am J Sports Med, 2001

Placement of external resistance



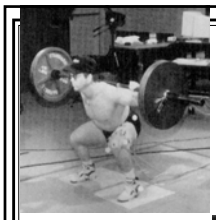
Zavatsky et al., Am J Sports Med, 1994

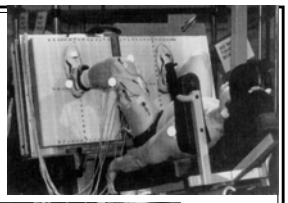
Amount of compressive force

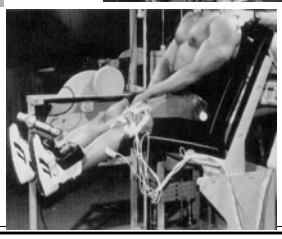


Fleming et al, Am J Sports Med, 2003

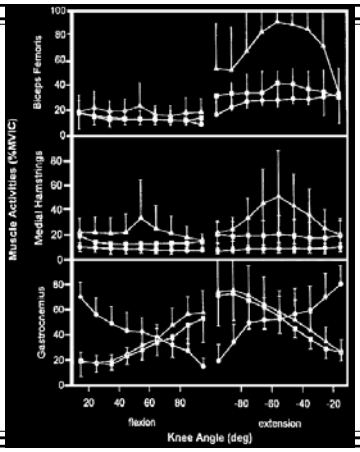
What about co-contraction?







Escamilla et al, MSSE 1998



Escamilla et al, MSSE 1998

Co-Contraction

- Function of free-weights vs. machines?
- Does not affect anterior shear forces at knee
- Over-rated?

No epidemiological evidence…

- Shear forces are pathologic
- Free weights are more injurious than machines

Comparisons across studies difficult…

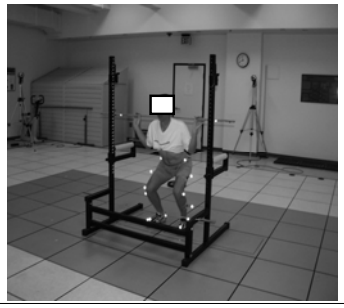
- Subject Population
- Intervention Duration
- Number of Exercises
- Amount and Type of Resistance
- Outcome Measures

Eight studies, no differences…

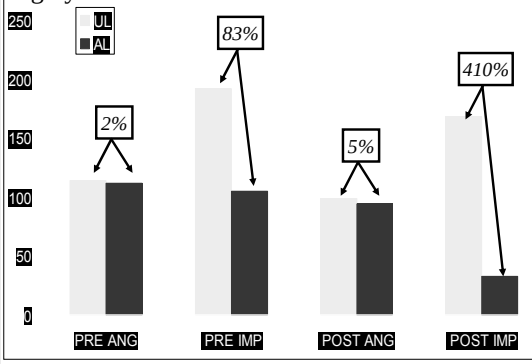
- Strength
- Pain
- Functional Performance
- Proprioception
- Joint Laxity?

Combined OC/CC appears superior to either one separately!

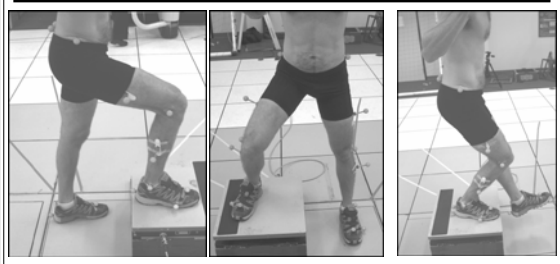
LE Kinetics Following ACL Surgery



Case Study: Bilateral Comparisons following ACL Surgery

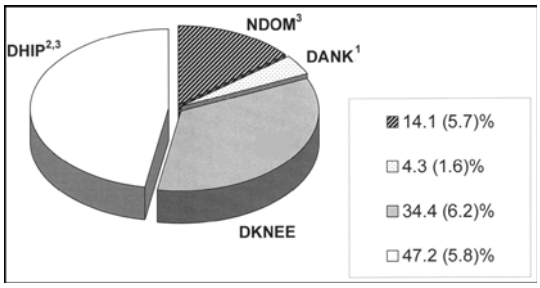


Three Variations of the Step Exercise

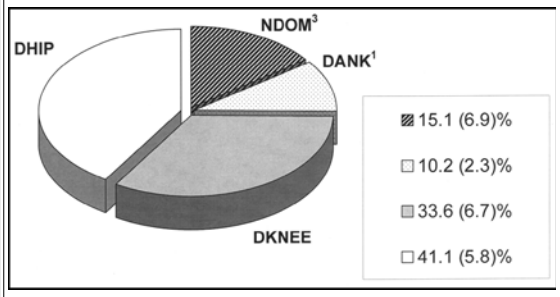


Flanagan, Kessans, & Salem, J Sport Rehabil, 2006

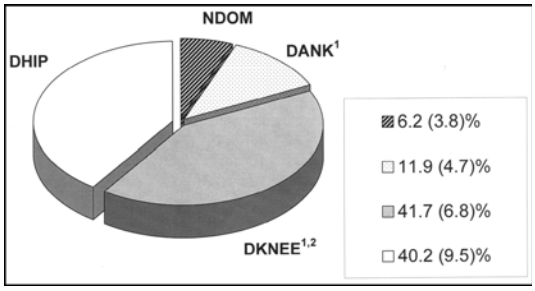
Forward Step Up



Lateral Step Up



Step Down



Intensity

- Dictates all other variables
- RM Continuum

Tempo

- Important to remember your biomechanics:
  - Force – velocity
  - Impulse – momentum

Tempo

Important to remember your biomechanics:
Force – velocity
Impulse – momentum

Bandy et al., Phys Ther, 1997

Speed Repetitions

Remember, impulse must be zero…

% RM	Movement	Deceleration	Source
50%	Squat	35%	Flanagan & Salem*
45%	Bench Press	40%	Newton et al, 1996
25%	Squat	45%	Flanagan & Salem*

* Preliminary unpublished data

Number of Reps / Sets

- DeLorme (DeLorme & Watkins)
- Oxford
- Aggressive Resistance Training Program
- DAPRE
- Performance-Based Periodization

DeLorme (DeLorme & Watkins, 1945)

Set	Load	Reps
1	50% of 10 RM	10
2	75% of 10 RM	10
3	100% of 10 RM	10

Oxford (Zinovieff, 1951)

Set	Load	Reps
1	100% of 10 RM	10
2	75% of 10 RM	10
3	50% of 10 RM	10

Aggressive Resistance Training Program (Stone and Kroll, 1982)

Set	Load	Reps
1	50% of 4 RM	8
2	80% of 4 RM	8
3	90% of 4 RM	6
4	95% of 4 RM	4
5	100% of 4 RM	4

DAPRE (Knight, 1985)

Set	Load	Reps
1	50% of Working	10
2	75% of Working	6
3	100% of Working	Max
4	Adjusted Working	Max

DAPRE Adjustments

Number of Reps / Set	Adjustments	
	4th Set	Next Day
0-2	↓ 5-10 lbs	↓ 5-10 lbs
3-4	↓ 0-5 lbs	Keep same
5-7	Keep same	↑ 5-10 lbs
8-12	↑ 5-10 lbs	↑ 5-15 lbs
13+	↑ 10-15 lbs	↑ 10-20 lbs

Performance-Based Periodization (Flanagan, 2001)

- Planned variables: load and rest periods
- Target: volume
- Performance variables: reps and sets
- Adjustments

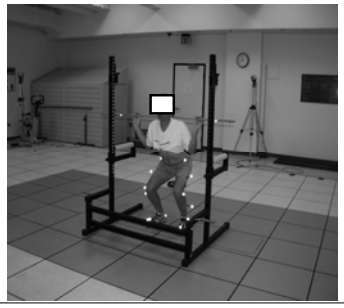
Rest Intervals

- 90 sec?

Frequency

- 2 – 3 times per week?

LE Kinetics Following ACL Surgery



Case Study: Bilateral Comparisons following ACL Surgery