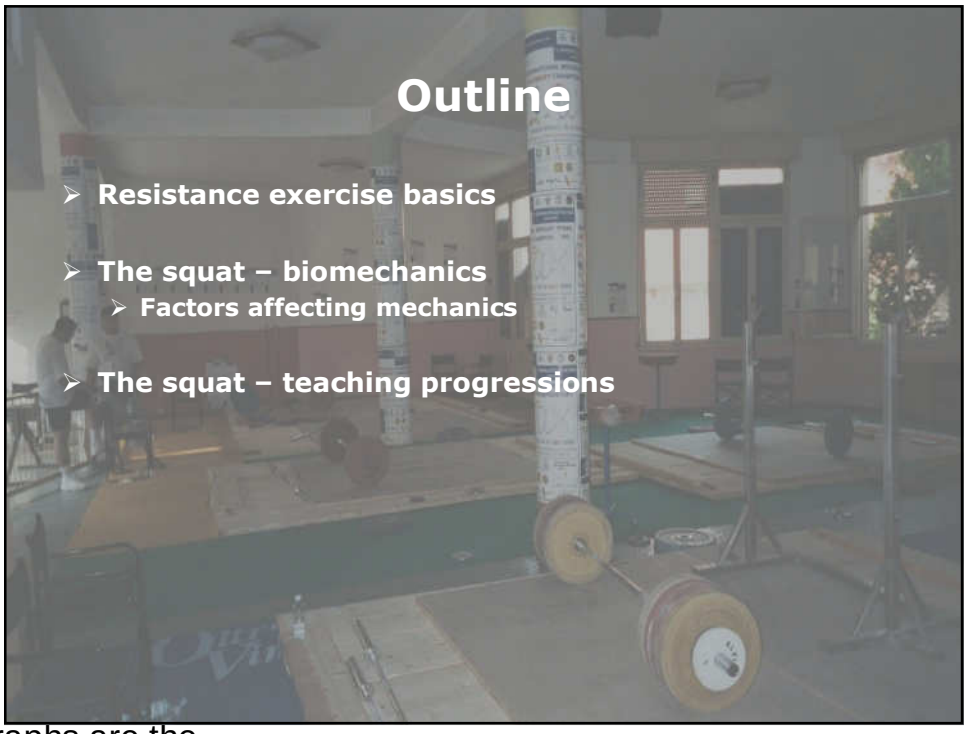
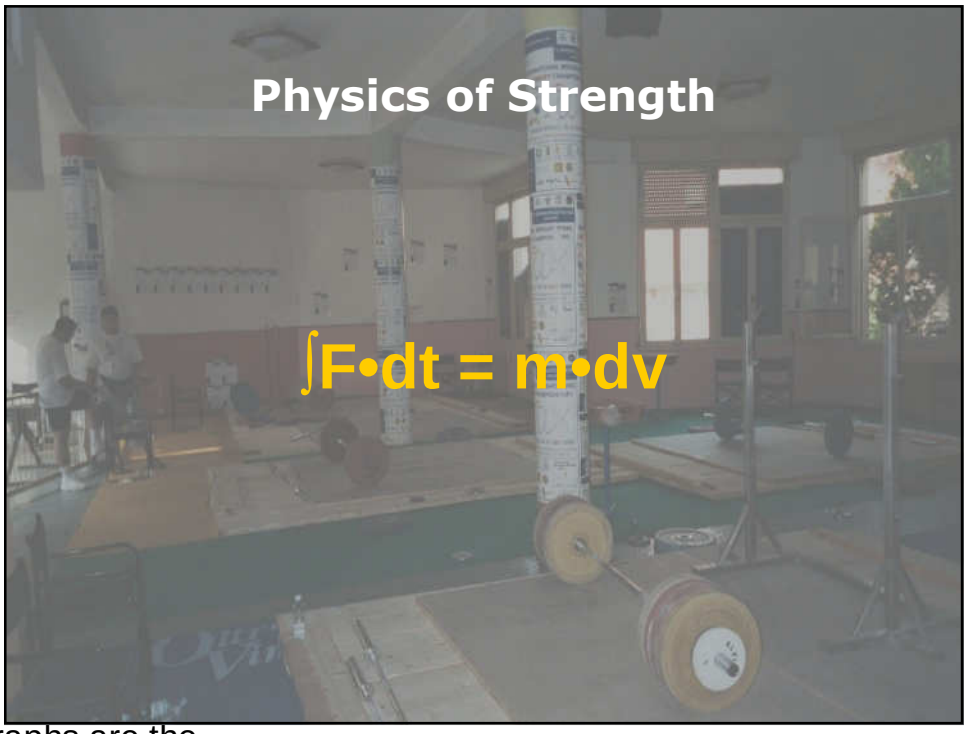
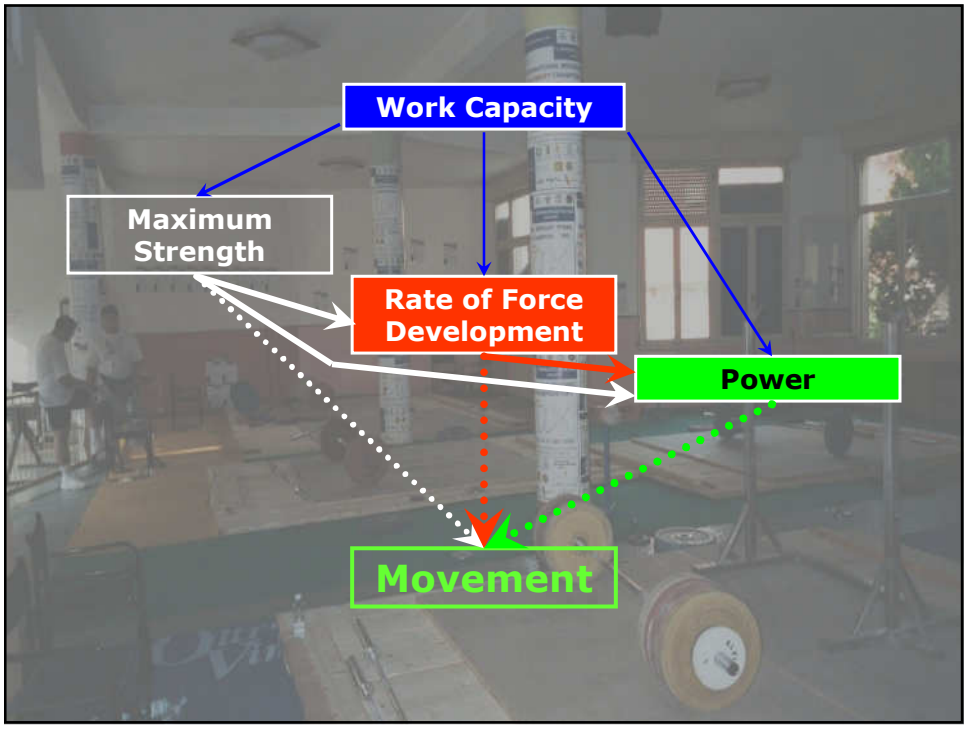
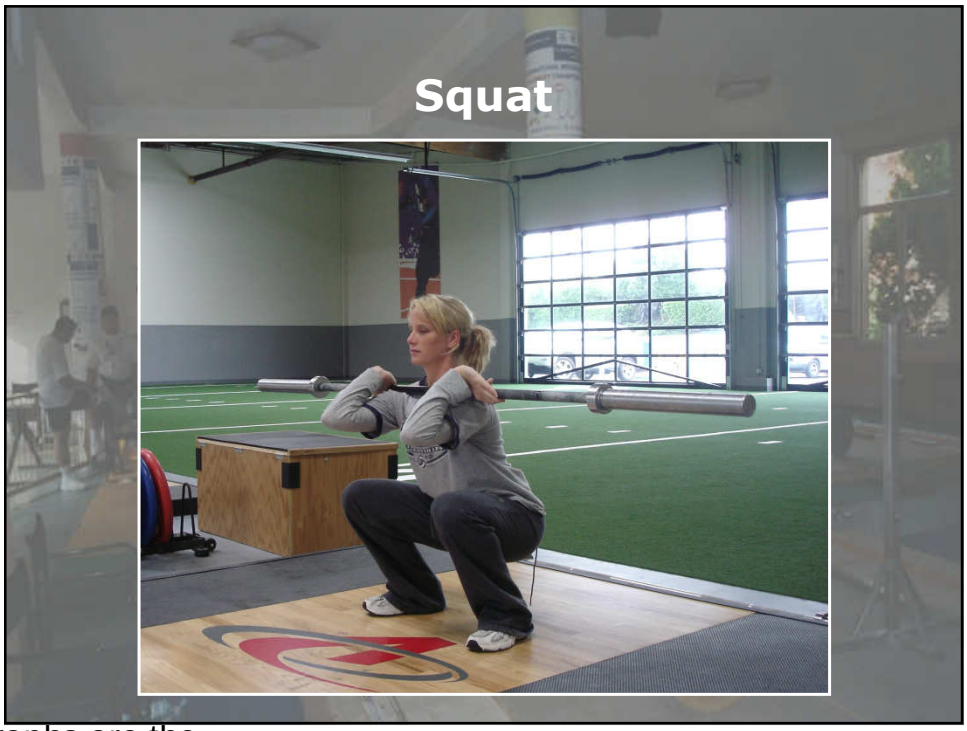
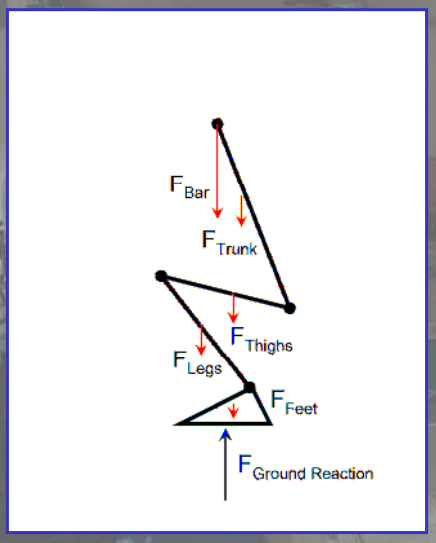








Segment Biomechanics



- Segment kinematics
- Net joint moments
- Muscle activity

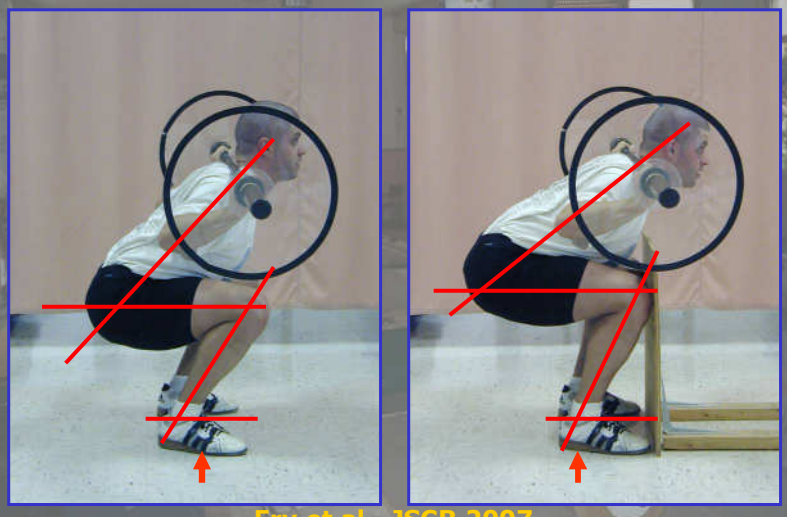
Net Joint Moments

	Hip Extensor (N•m)	Knee Extensor (N•m)	Ankle Plantar-Flexor (N•m)
Hay et al. 1983	320	400	200
Escamilla et al. 2001	547	573	51
Wretenberg et al. 1996	230	190	
Nisell & Ekholm 1986	400	220	150

Considerations

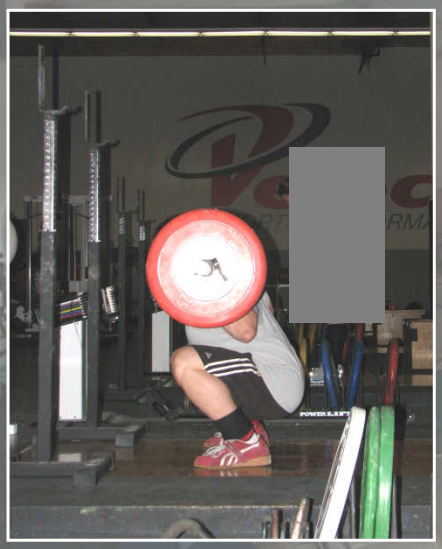
- Effect of stance width
- Effect of squat depth
- Effect of external load
- Single- vs. double-limb

Different Techniques



Fry et al., JSCR 2007

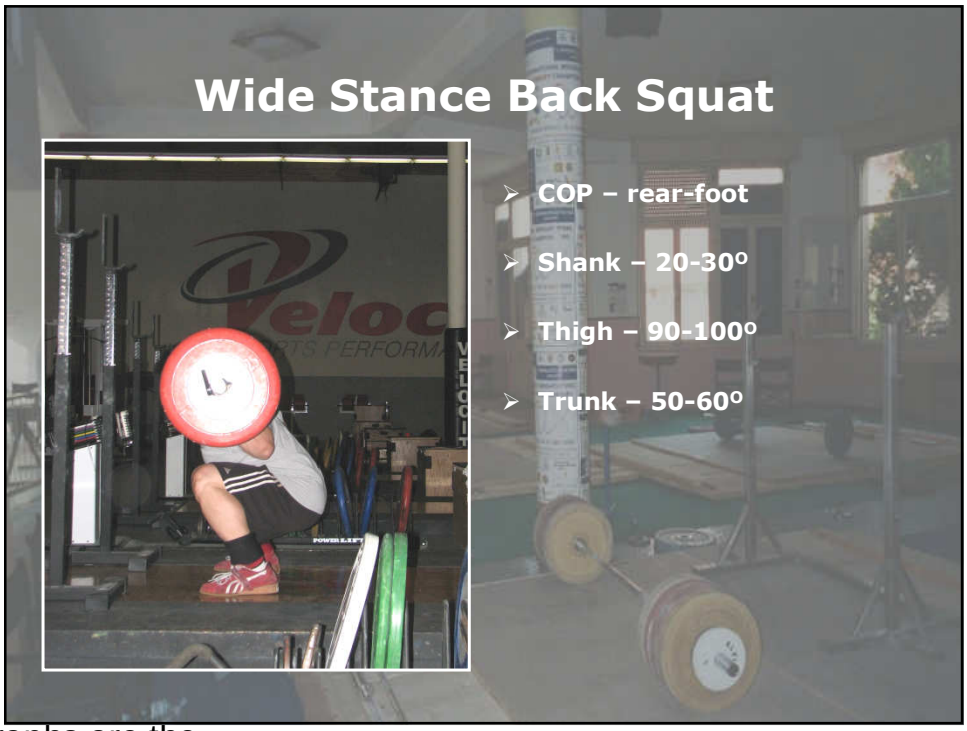
Back Squat



- COP – mid-foot
- Shank – 30-40º
- Thigh – 90-110º
- Trunk – 30-45º

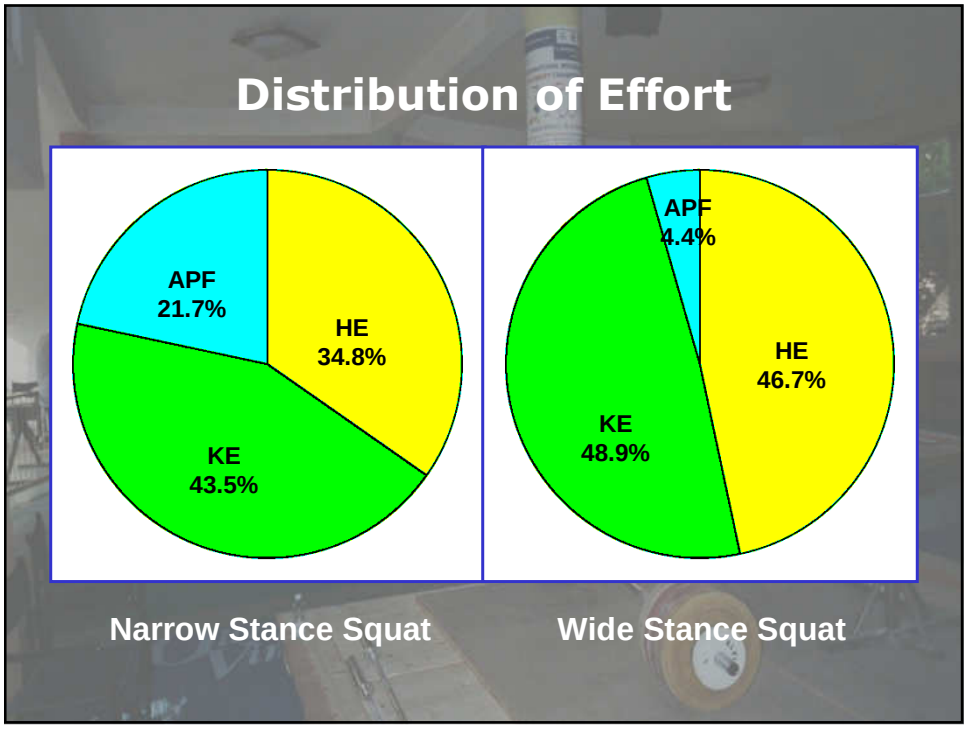
Front Squat

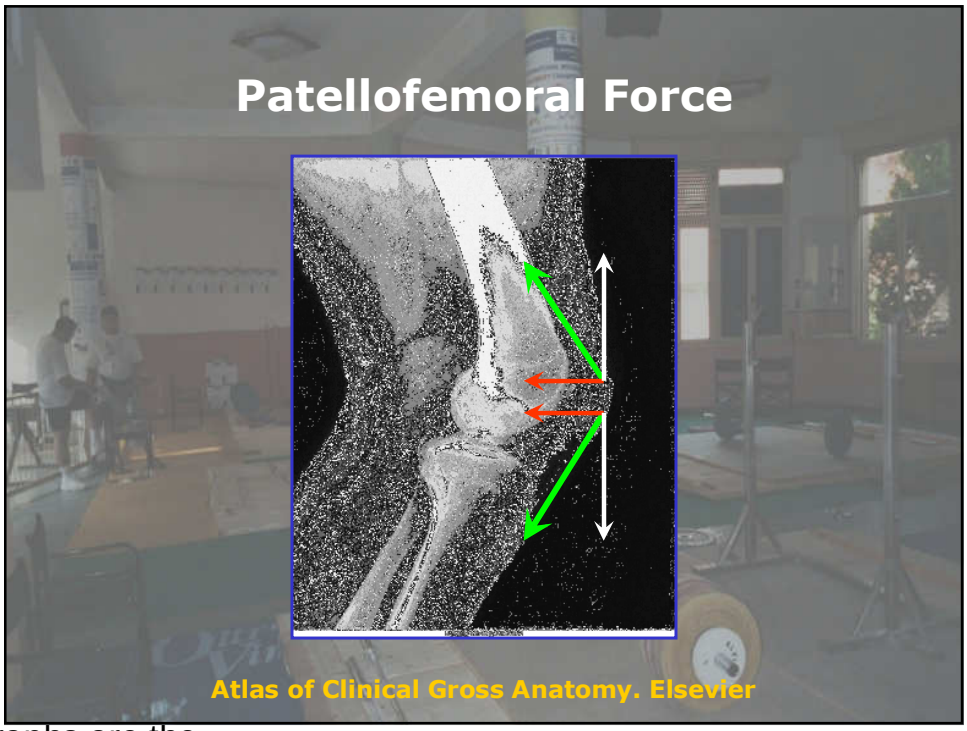
- COP – mid-foot
- Shank – 30-40º
- Thigh – 100-120º
- Trunk – 20-30º

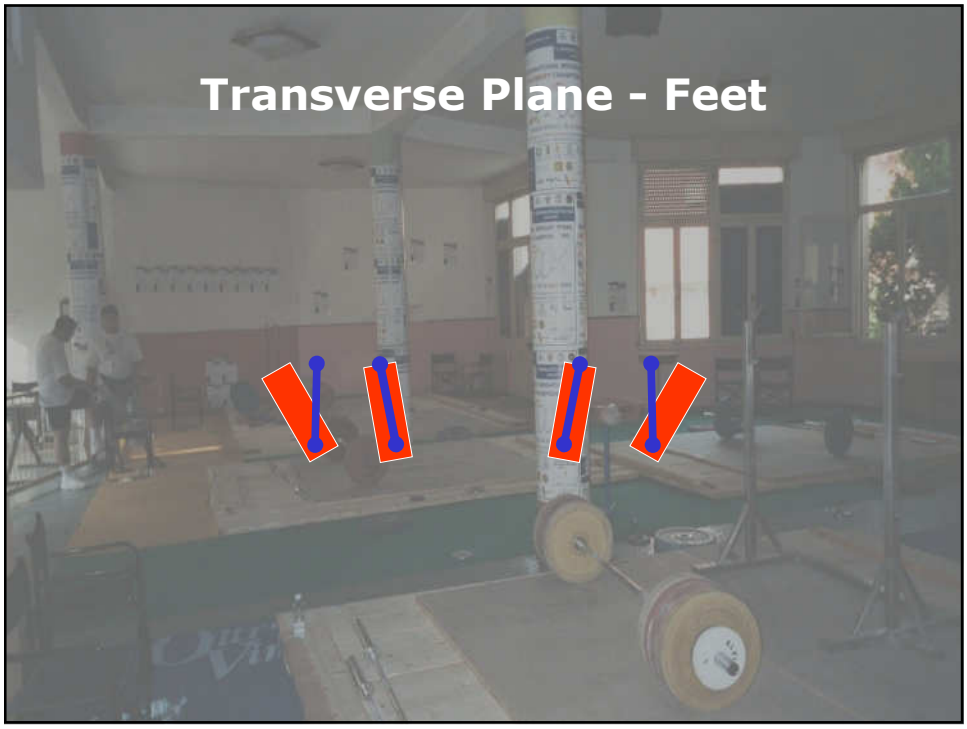


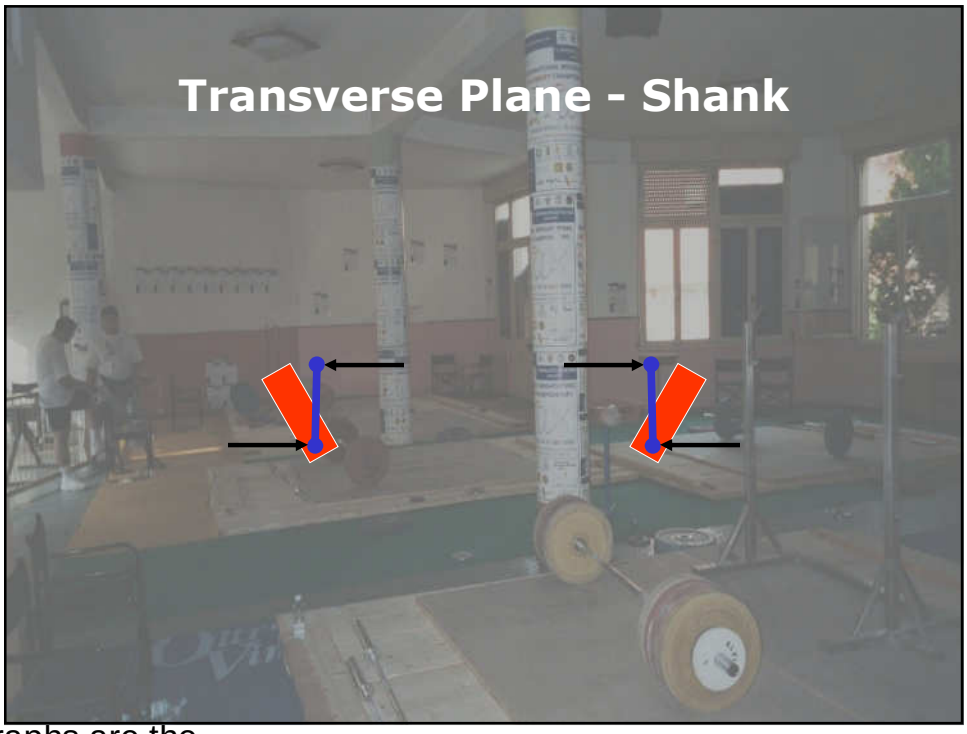
Narrow vs. Wide Stance

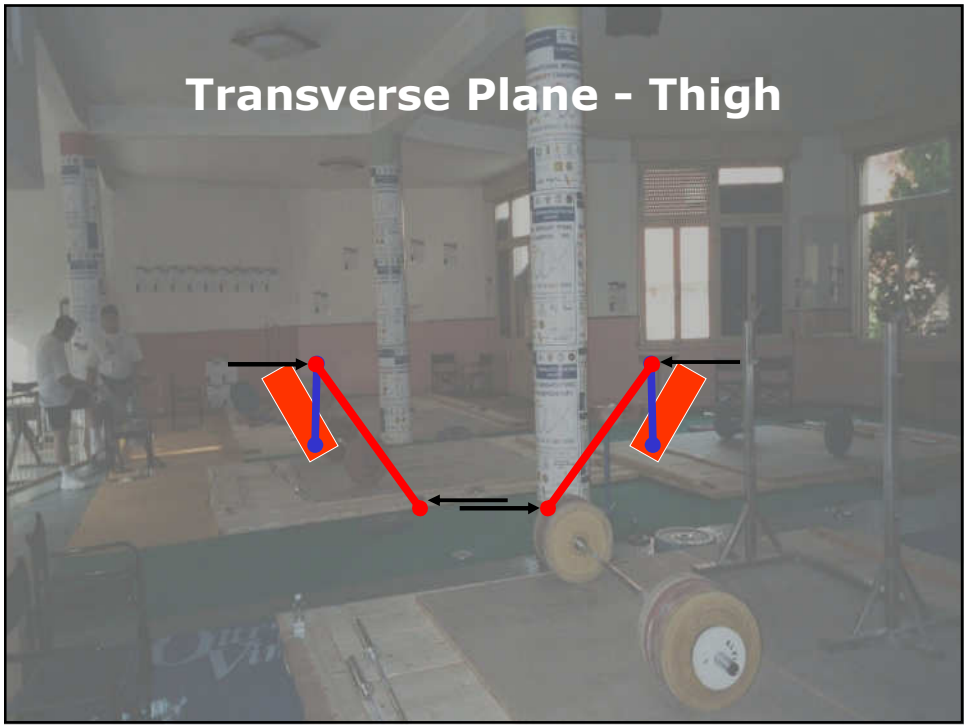
Narrow	Wide
Moderate ankle PF NJM	Low ankle PF NJM
Moderate knee extensor NJM	Moderate – High knee extensor NJM
Moderate hip extensor NJM	High hip extensor NJM
Moderate lumbar extensor NJM	High lumbar extensor NJM





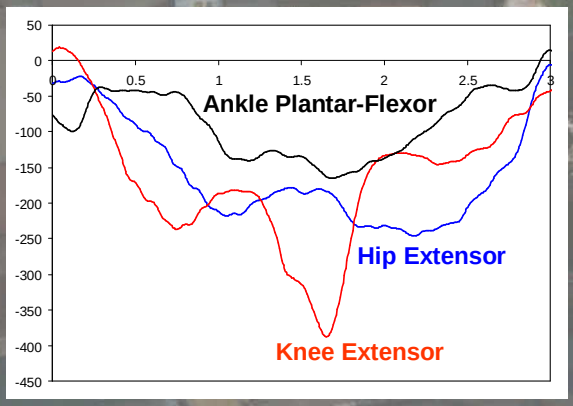






Optimal Squat Stance

Effect of Depth



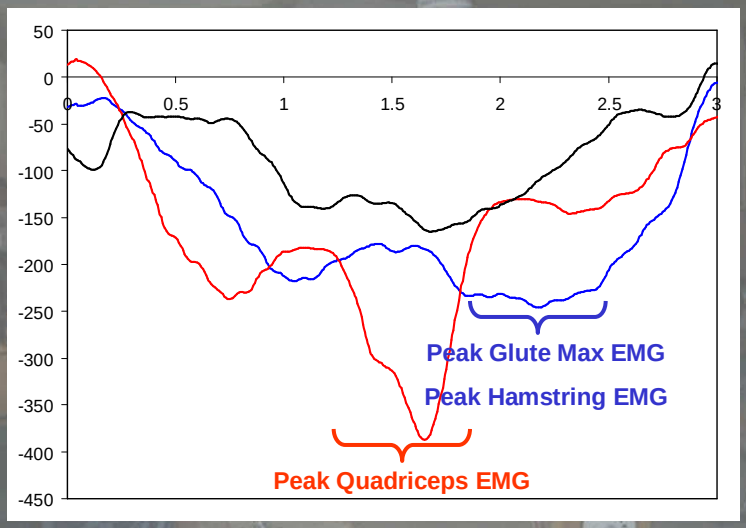
Data from: Chiu & Salem, JSCR 2007

Knee Extensor NJM

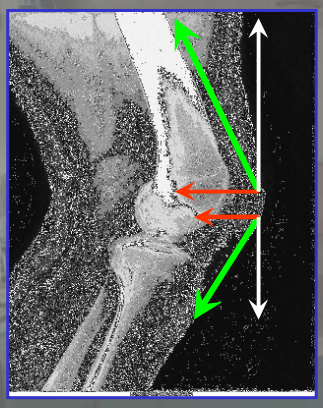
- Full squat @ 85% 1 RM
  - NJM = 1.3-1.5x > parallel squat
- Assuming the same kinematics for the parallel squat…
  - Would require 100% increase in barbell load to equal NJM for full squat

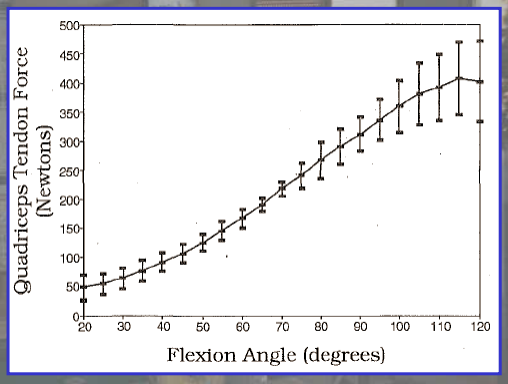
Centre of Pressure

Muscle Activation



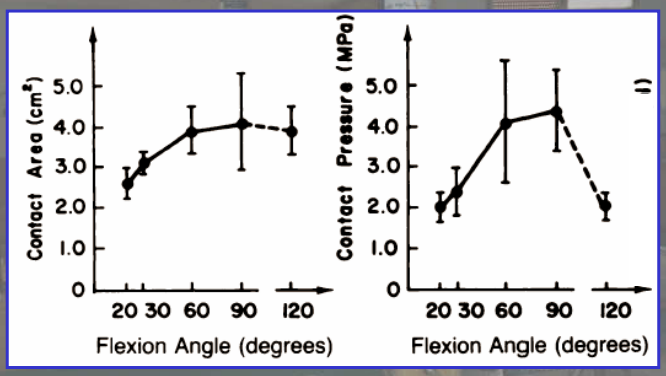
Patellafemoral Force





From: Singerman et al., J. Biomech. Eng. 1999

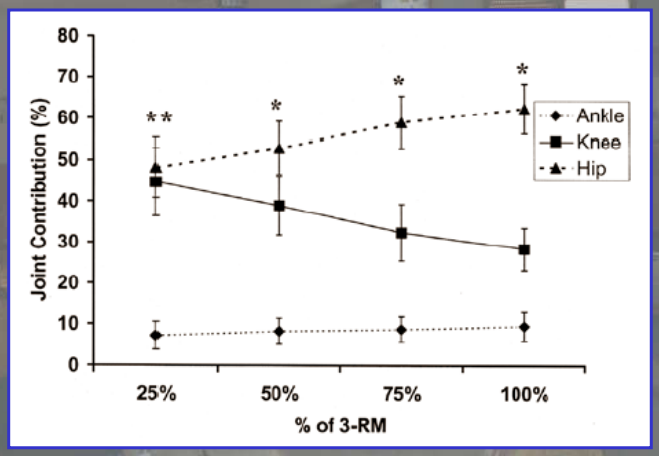
Patellofemoral Pressure



From: Huberti & Hayes, JBJS 1984

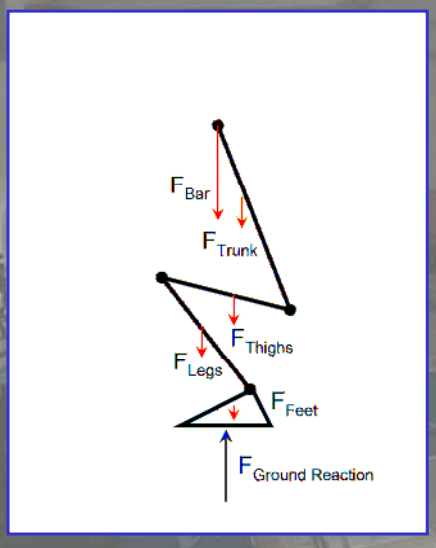
Optimal Squat Depth

Effect of Load



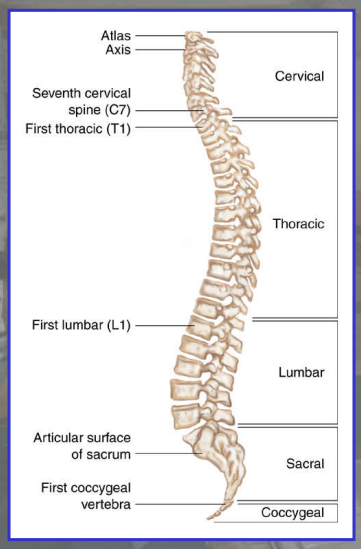
From: Flanagan & Salem, JAB 2008

Effect of Load



- ↑ bar mass
- ↑ forward lean
- COP shifts forward

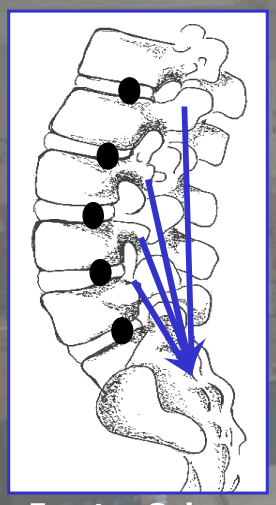
Spine Curvature



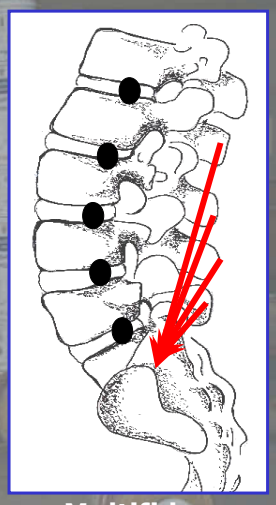
- Maintain "neutral" curvature
  - Prevent forward lean
- Extensor mechanism
- Intra-abdominal & intra-thoracic pressure

Essentials of Strength Training and Conditioning. Human Kinetics.

Extensor Mechanism



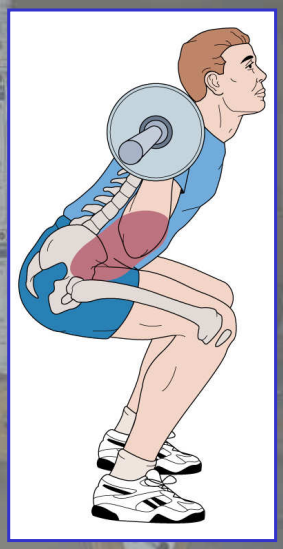
Erector Spinae



Multifidus

IAP & ITP

- Passive resistance to spine flexion
- Reduces torque required by extensor mechanism
- Valsalva maneuver

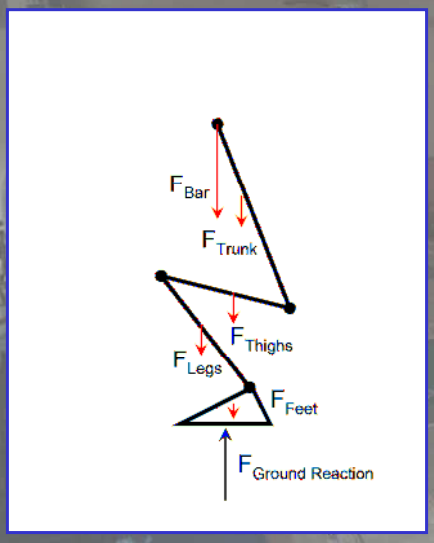


Essentials of Strength Training and Conditioning. Human Kinetics

Single-Limb Squats?

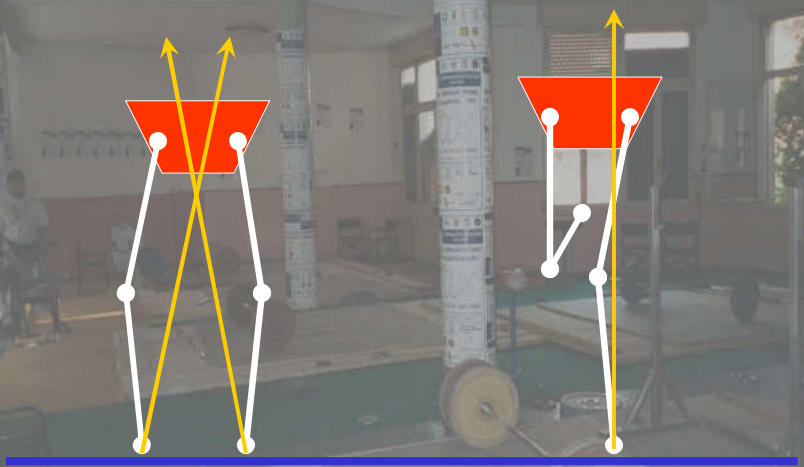
- More appropriate for beginners?
- Utilize more stabilizing muscles?
- Emphasize hip abductors?
- More specific to running, change-of-direction tasks?

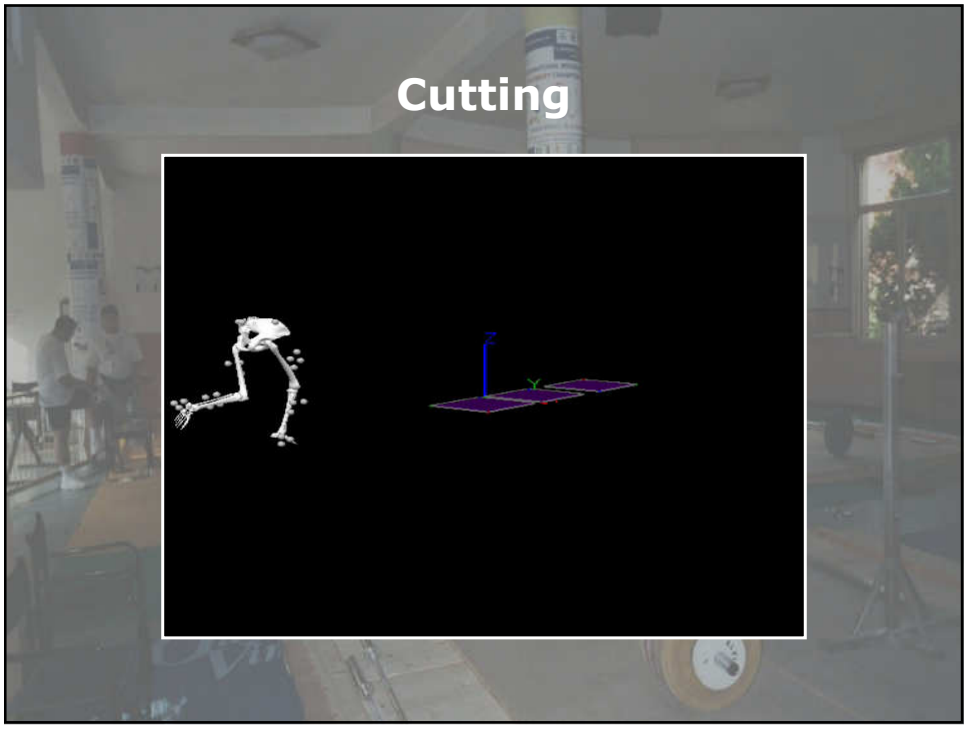
Joint Kinetics

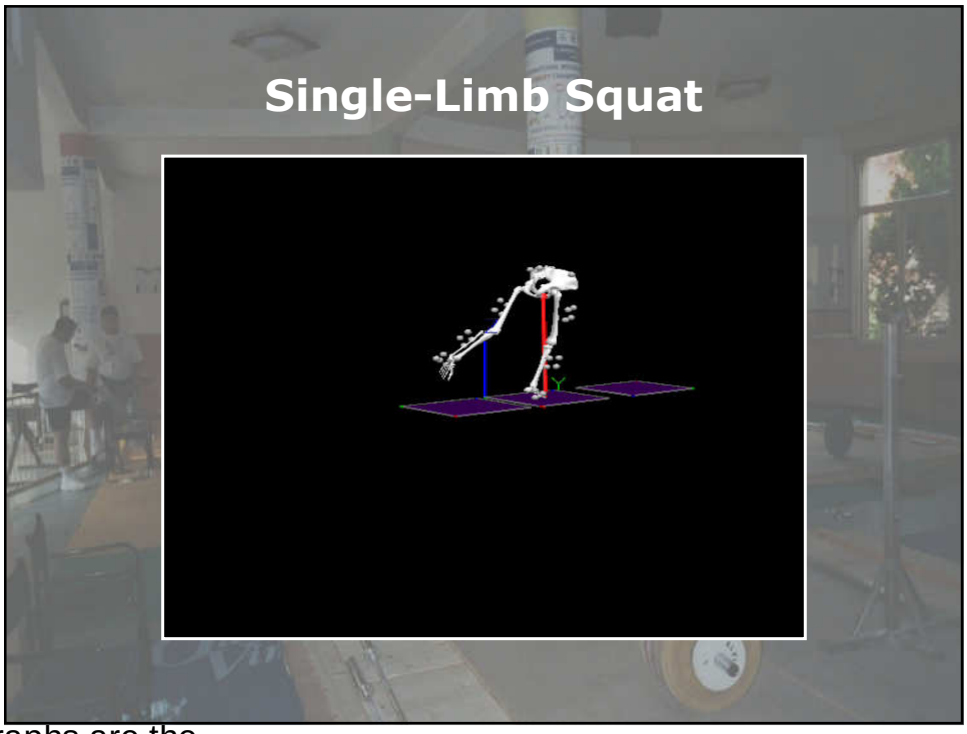


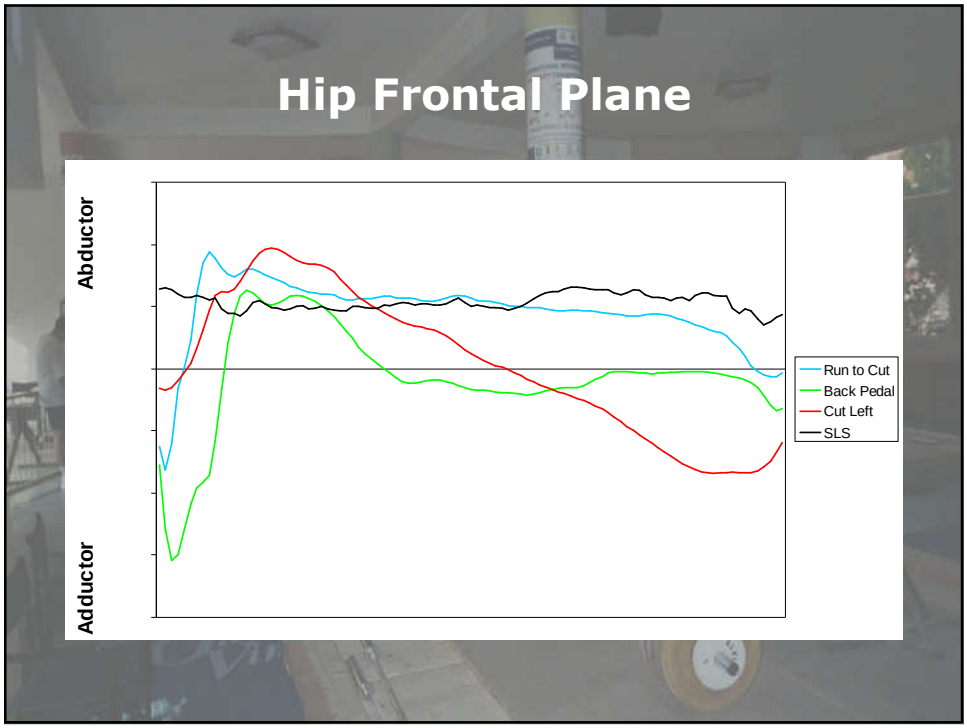
- Free-body diagram
- Assuming the same kinetics
  - GRF acts through 1 limb only (i.e. doubles)
  - Hip extensor, knee extensor and ankle plantar-flexor NJM doubles
  - For 80kg individual, SLS = Back squat with 80kg (176lb)

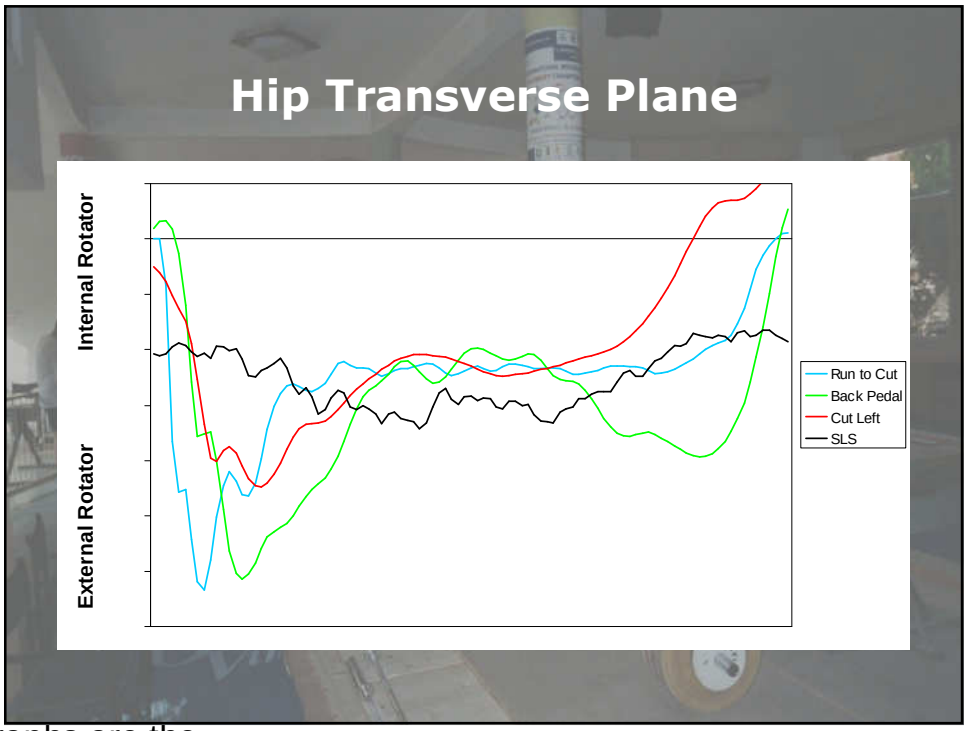
Single- vs. Double-Limb – Front

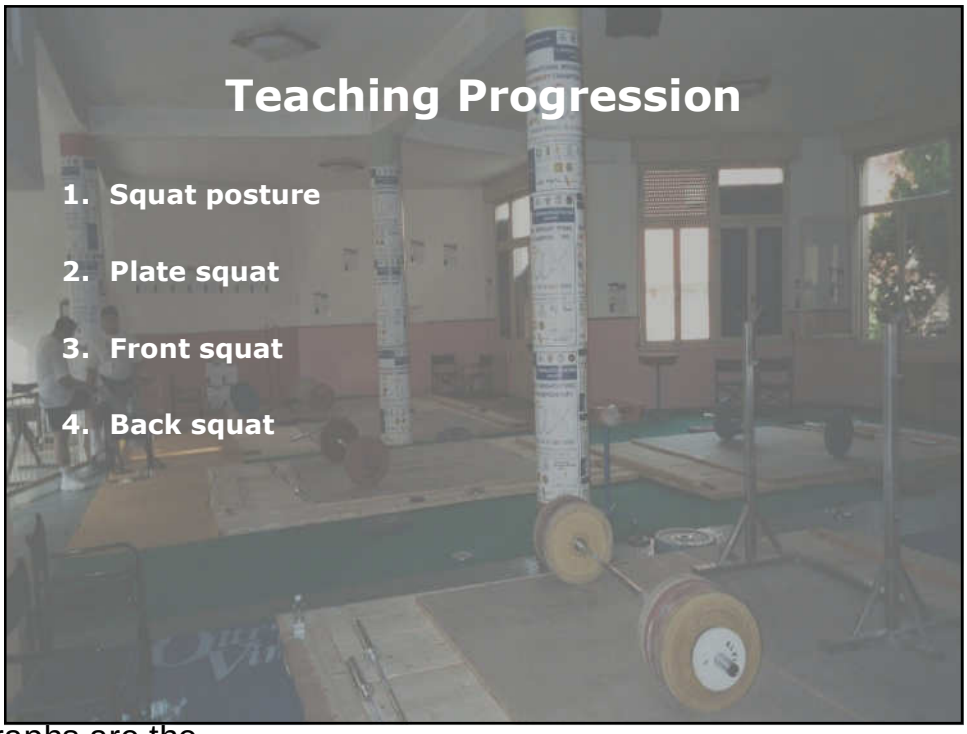












Squat Posture

- Feet pelvis width
- Deep breath
- Push knees forward
- Hips move straight down
- Tempo

Plate Squat

- Hold 10kg plate parallel to ground
- Maintains appropriate posture