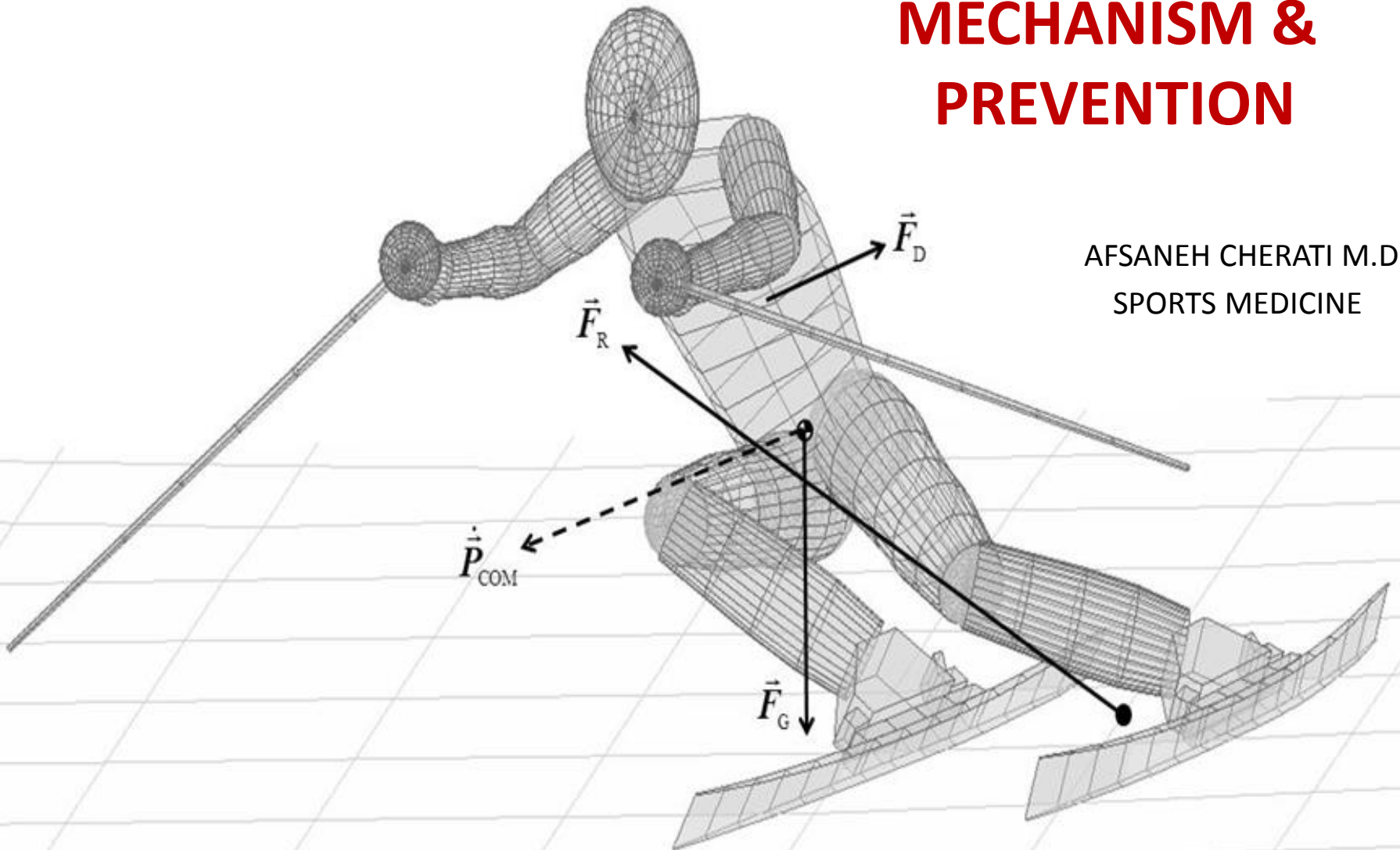


# ACL INJURY MECHANISM & PREVENTION

AFSANEH CHERATI M.D  
SPORTS MEDICINE



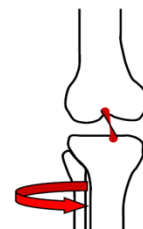
# Injury Mechanism

- ACL injury ,most frequent
- Combination of factors
- Equipment
- Snow conditions
- Course setting and speed
- Athlete preparation and conditioning





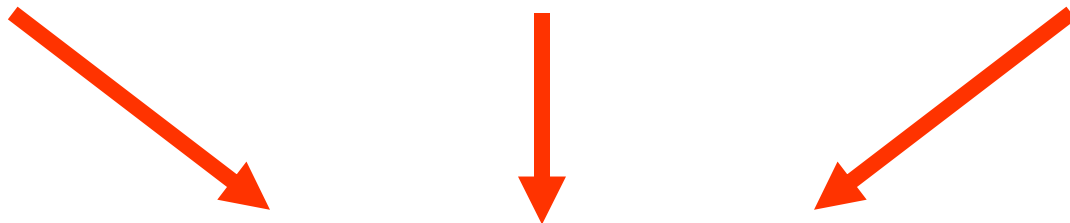
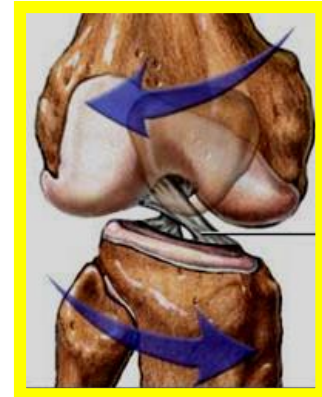
- **ACL Restrains Motion in All Planes**
- **Primary restraint to anterior shear force**  
→ anterior tibial translation  
**(Sagittal plane)**
- **◆ Supports valgus-varus moments**  
**(Frontal plane)**
- **◆ Supports rotational moments (Transverse plane)**



# *ACL Load-Deformation Factors*

- Multi-Planar Loading
- ♦ Combined loading magnifies ACL load

- Anterior Tibial Shear      Knee Valgus      Tibial Rotational

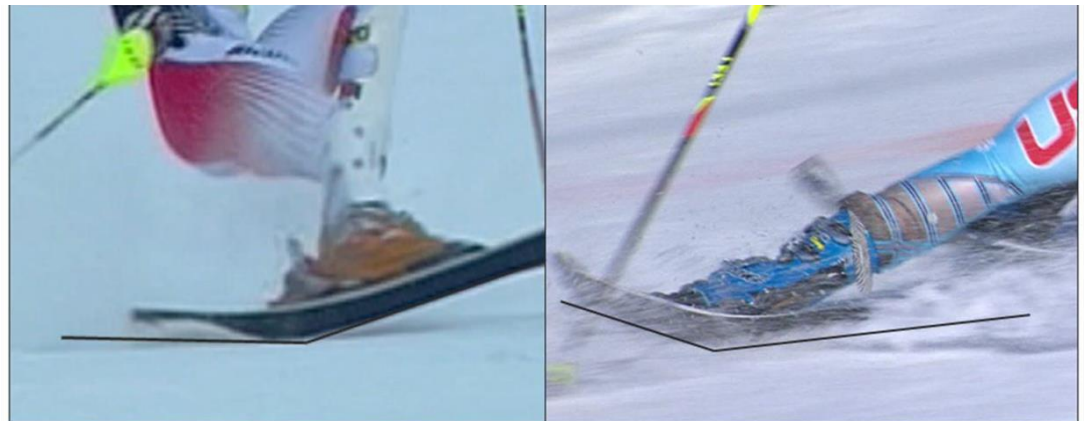


**Greatest ACL Load**

# ACL injury in professional skier

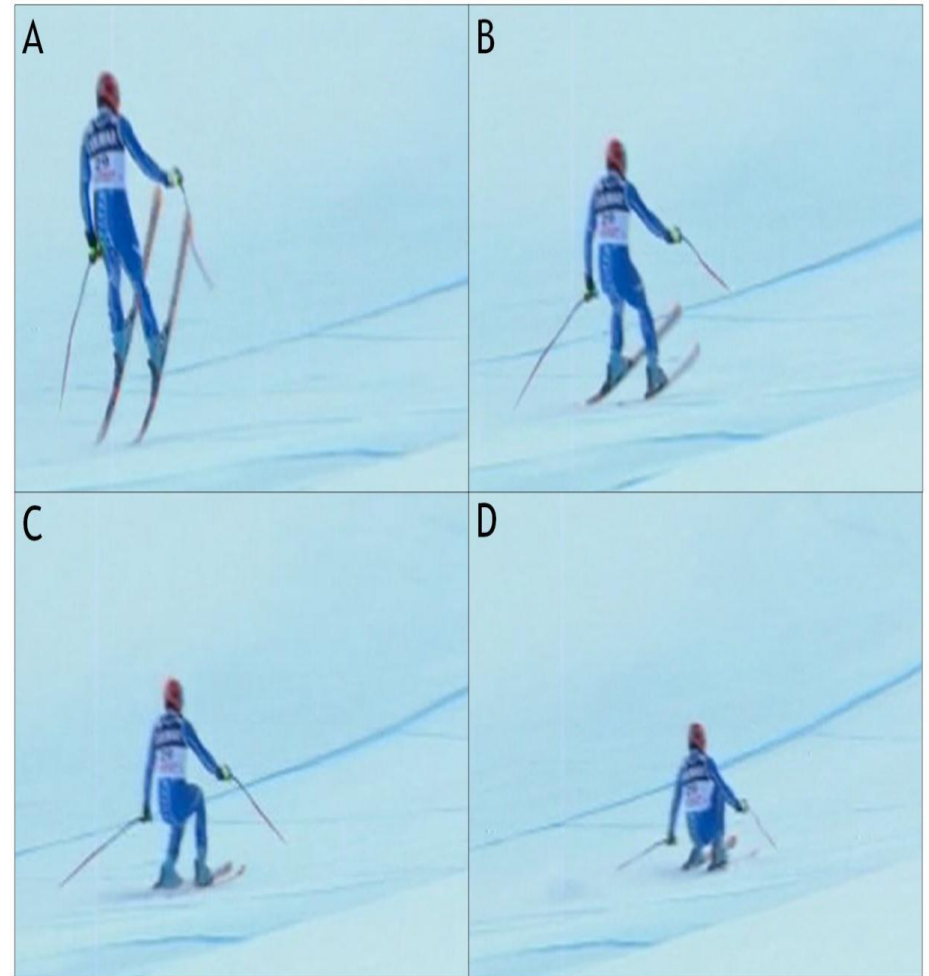
- Three main categories
- Slip-Catch
- Landing Back-Weighted
- Dynamic Snowplow

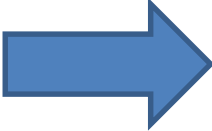
Skier mistakes as the key factors leading to the injury situations



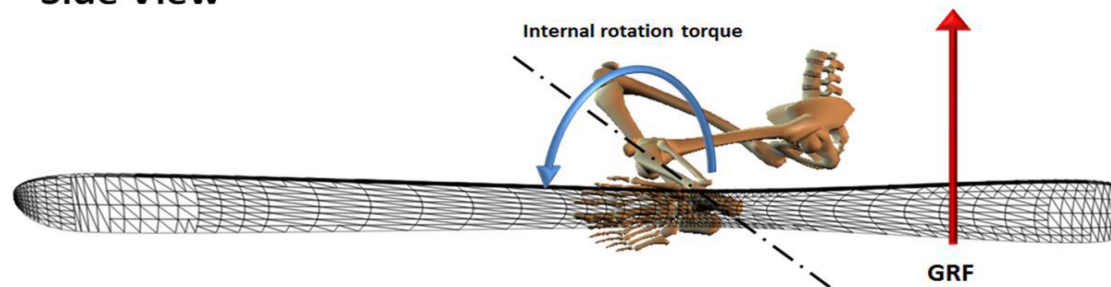
# Knee valgus and tibia internal rotation

- End result of Slip-Catch and Dynamic Snowplow mechanisms is internal rotation and valgus loading of the knee

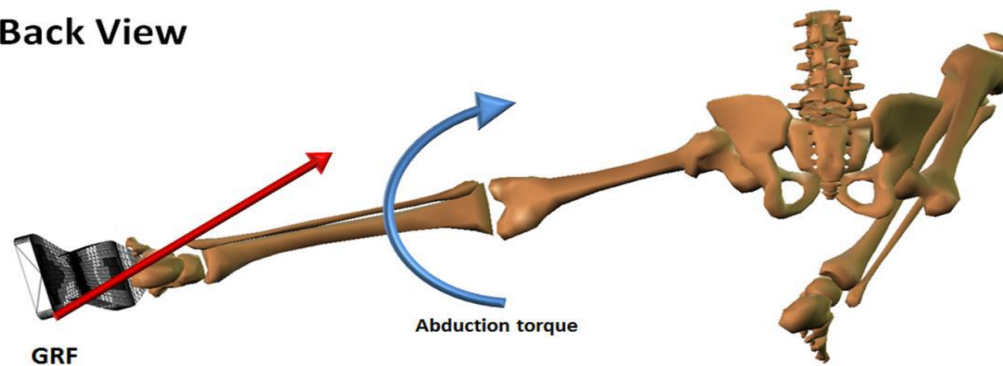


- Edging a carving ski  knee valgus angles up to 12°

Side View



Back View



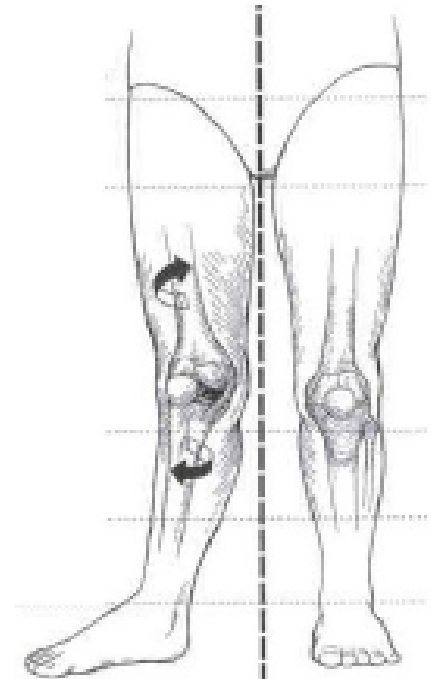
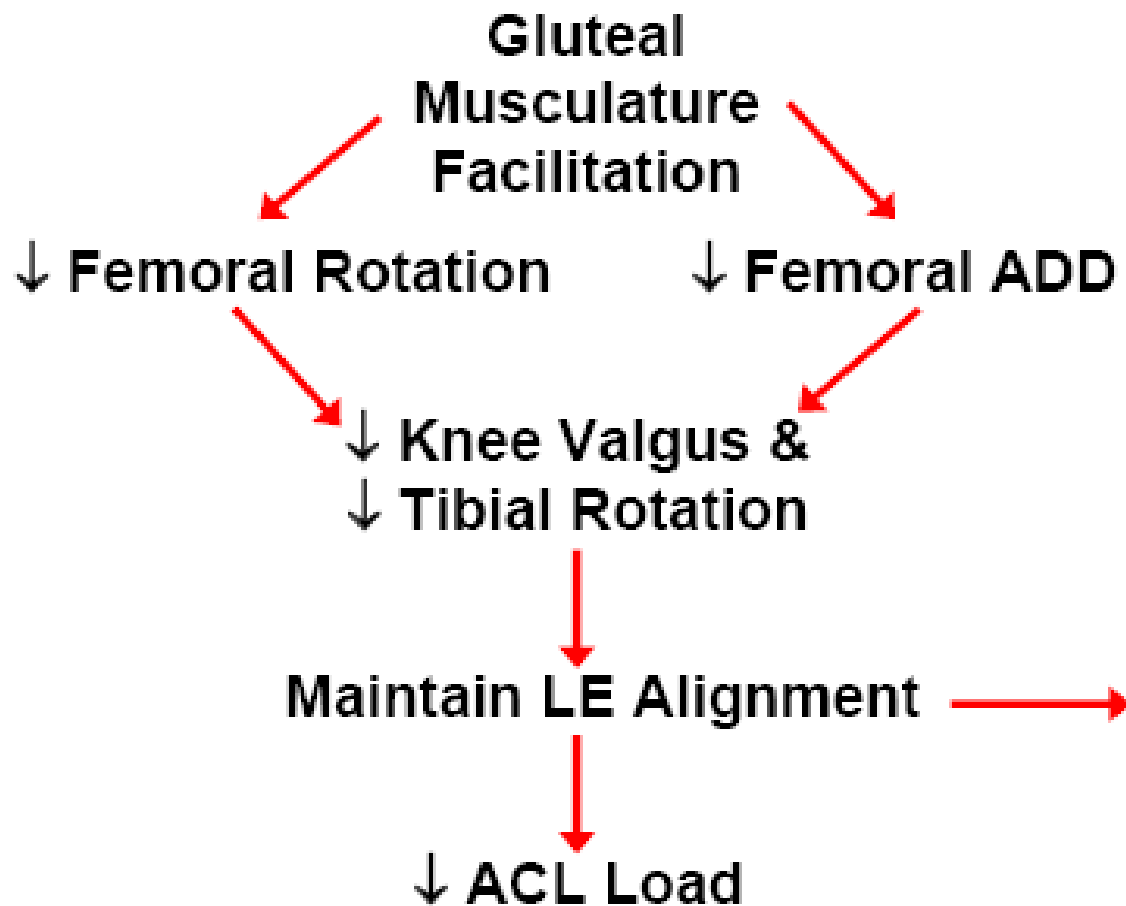
# *ACL Load-Deformation Factors*

- Influenced by **biomechanical-neuromuscular factors and postural alignment**
- **Muscle activation**
- **Joint kinematics during motion**
- **Lower extremity alignment**



# Muscle Activation

**Gluteal musculature helps control LE alignment**





# Gender Differences

- ◆ ↓ knee flexion in females
- ◆ ↑ knee Valgus in females
- Muscle Activation
- ◆ Hamstrings reduce:
  - Anterior shear force
  - Knee Valgus
  - Tibial rotation



## Gender Differences

- ◆ ↓ activity & altered timing of hamstrings in females

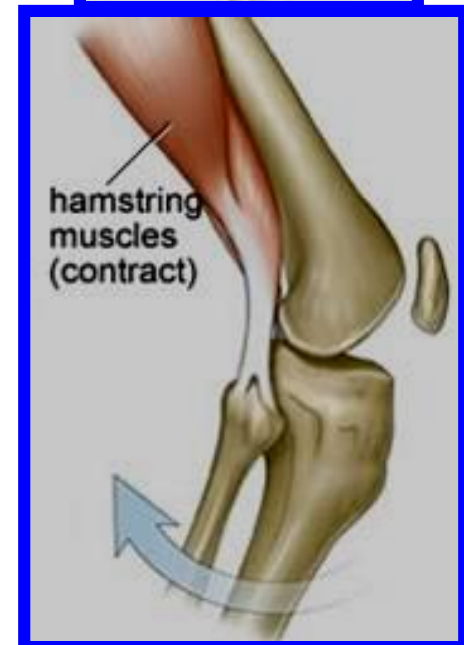
# Female Neuromuscular Imbalances



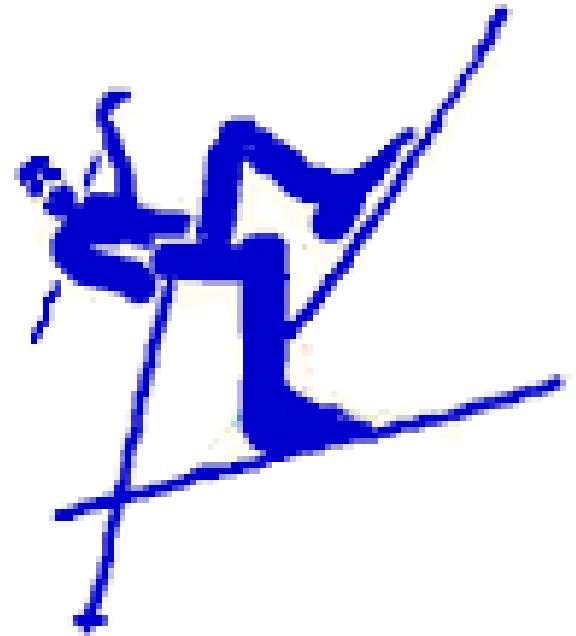
- 3 typical traits in females
  - Ligament Dominance
    - Athlete allows ligaments to absorb GRF
  - Quadriceps Dominance
    - Athlete preferentially increases knee extensor moments
  - Leg Dominance
    - Athlete demonstrates side-to-side differences in lower extremity measures

# Risk Factors

- Hamstring/Quadriceps imbalance
- Poor hamstring strength
  - Hamstrings protect ACL
  - Quads stretch/stress ACL
- Slow activation of hamstring muscles with pivot / landing

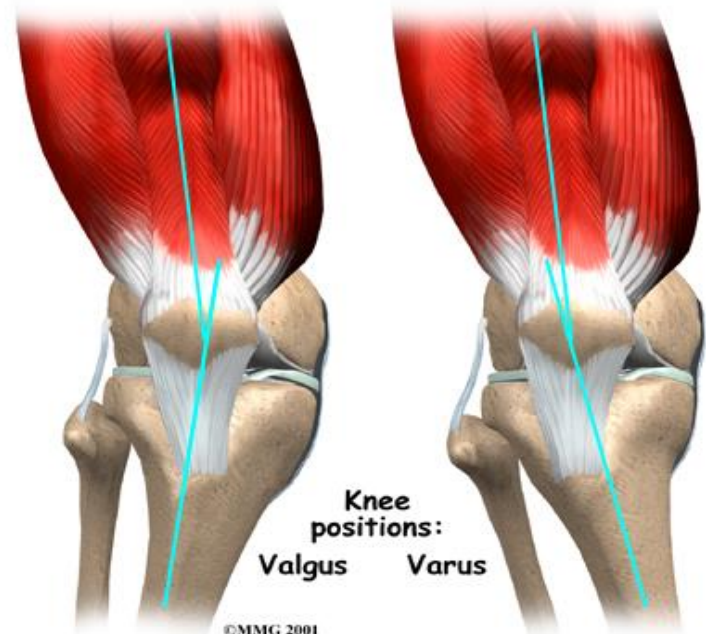


- Quadriceps contraction may cause a tibia anterior drawer when the skier tries to recover from an unbalanced position backwards on slightly flexed knees.



# • “High Risk” Muscle Activation Patterns

- ◆ ↑ Quadriceps activity
- ◆ ↑ Gastrocnemius activity
- ◆ ↓ Hamstrings activity (co-activation)
- ◆ ↓ Gluteal activity



# ACL injuries in recreational skiing

- Phantom Foot( **Backward Twisting Fall** )
- Boot-Induced Anterior Drawer(**backwards while jumping and lands on the ski tails ,extended knees** )
- Valgus-external rotation (**falls forward while catching the snow with the tip of the ski , MCL, Carving** )

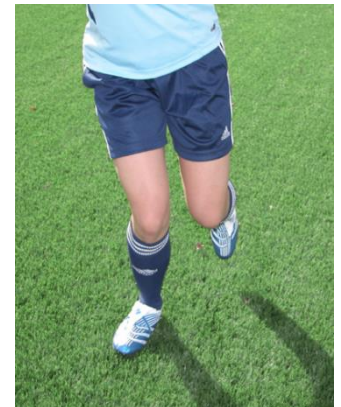


# *ACL Injury Prevention*

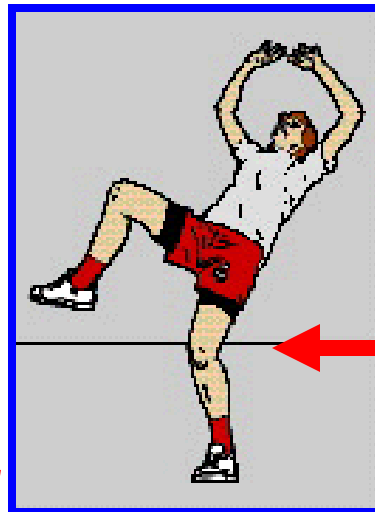
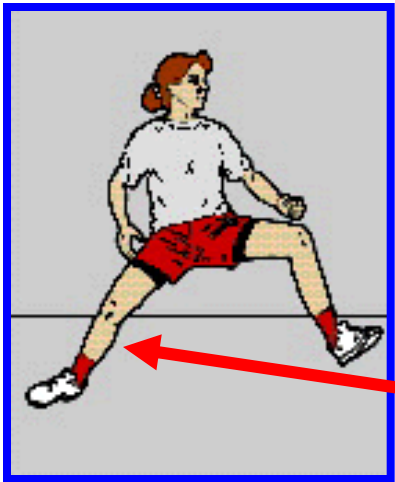
- ◆ Appropriate *functional ratio* between quadriceps and hamstrings
- ◆ Appropriate Q & H co-contraction, coordination & timing as knee dynamic stabilizers
- ◆ Assess “high risk” tasks
  - Jump-landing maneuvers
  - Cutting maneuvers

- For jumps/lands , 4 basic techniques should be stressed:

- Correct posture throughout jump
  - Alignment and distribution
- No excessive side-to-side or A/P movement in knee
- Soft landings
  - Toe-Heel rocking, knees bent, etc.
- Instant recoil
  - Preparation for next jump



- Landing / Pivoting with knee slightly bent
  - Do not place ACL in vulnerable position
  - Additional torsion/twisting can → ACL injury



# Emphasize proper land techniques

- Land on balls of feet
  - Soft landing
  - Toe-to-heel rocking of the foot
    - ↓ ground reactive forces
- Knees flexed
- Knees forward
  - Discourage inward buckling of knees (knock-kneed landing)
- Chest over knees



## Correct landing



## Incorrect landing

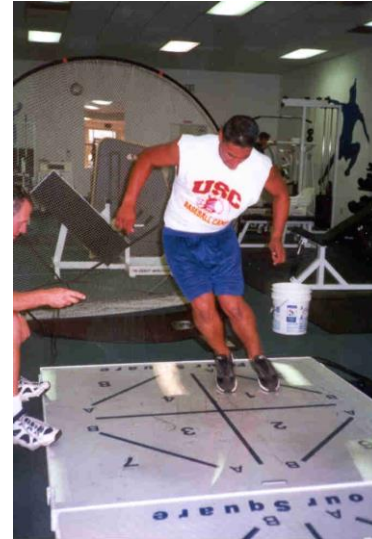


- Warm up
- Stretch : Calf , Q,Hamstring,inner thigh , hip flexor
- Strength
  - Walking lunges
  - Russian hamstring
  - Single toe raise



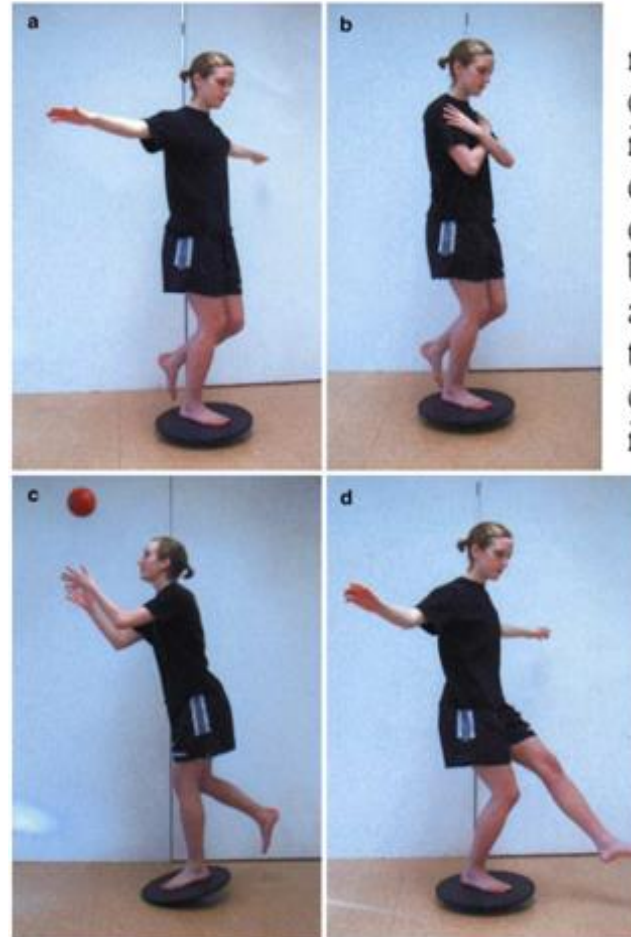
# Neuromuscular Components

- Strength Training
  - Resistance
  - Plyometrics
- Balance board training
- Proprioception
- Sport Specific
  - Dynamic Training
- Education



# Proprioceptive Training

- ACL plays a significant
- role in *normal*
- proprioception of
- the knee
  
- Learn to control loads
- in coronal plane
  
- Develop dynamic
- balance



Balance board training program with gradual increasing difficulty. a,b Standing on one leg with arms in different positions. c Standing on one leg on the balance board, bouncing the ball against the floor, or throwing the ball in the air. d Standing on one leg "drawing figures" in the air with the opposite leg

Questions?