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Biomechanical Factors Contributing to Patellomoral Pain: *The Dynamic Q-Angle*

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Abnormal loading as a potential factor in the genesis of patellofemoral pain

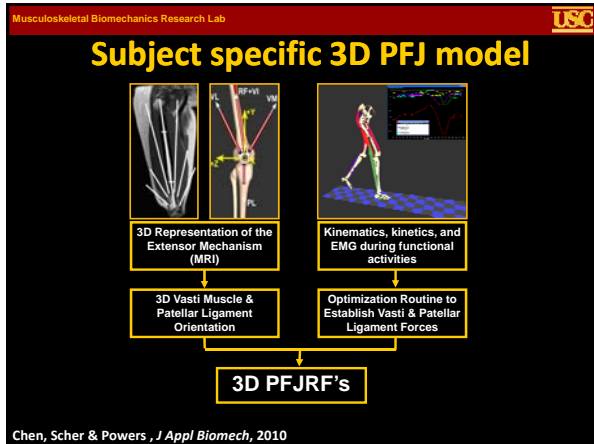
Dye, Sports Med Arthroscopy Rev, 2001

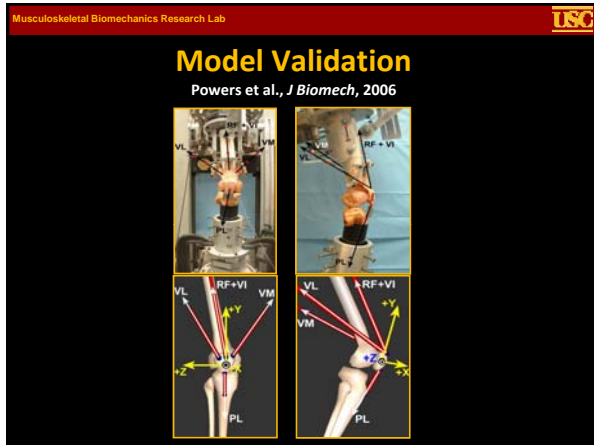
- Pain readily reproduced with activities that require quadriceps contraction

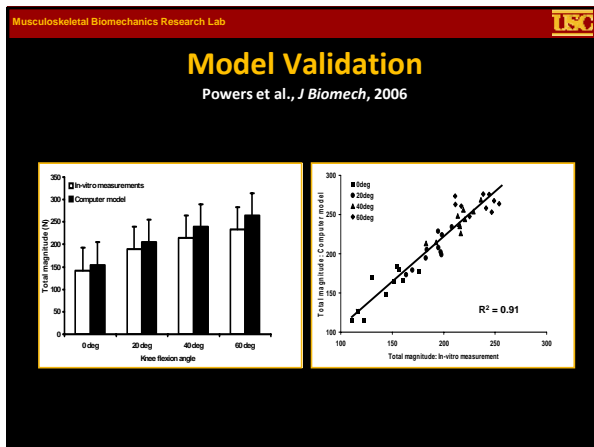


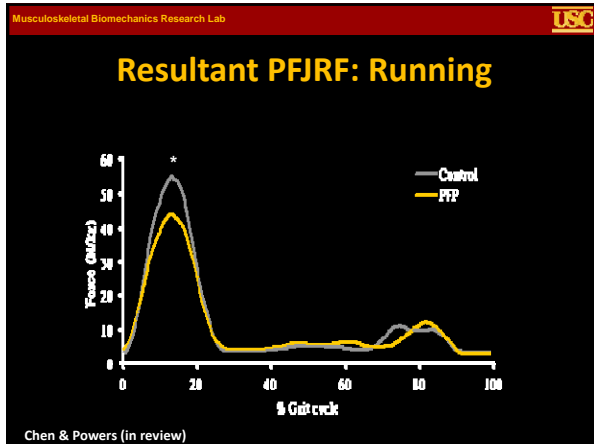
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Do Persons with PFP Demonstrate Elevated PFJ Loading?





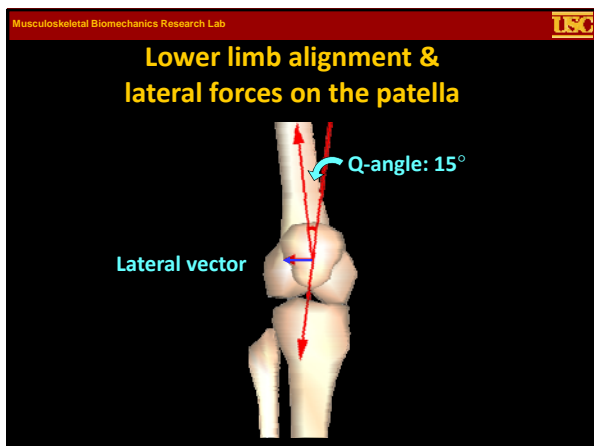


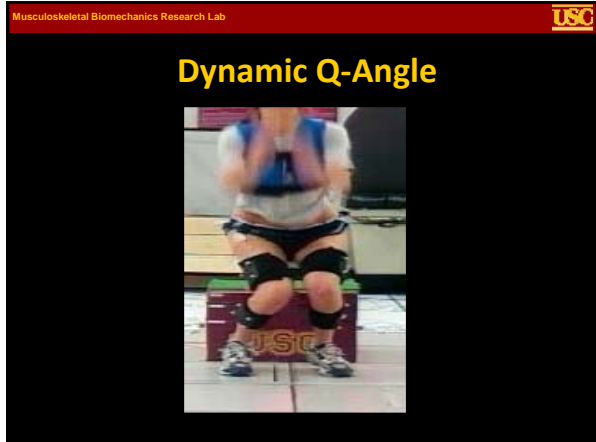


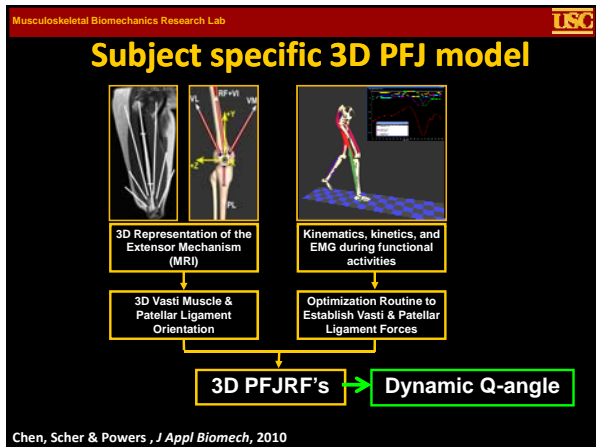
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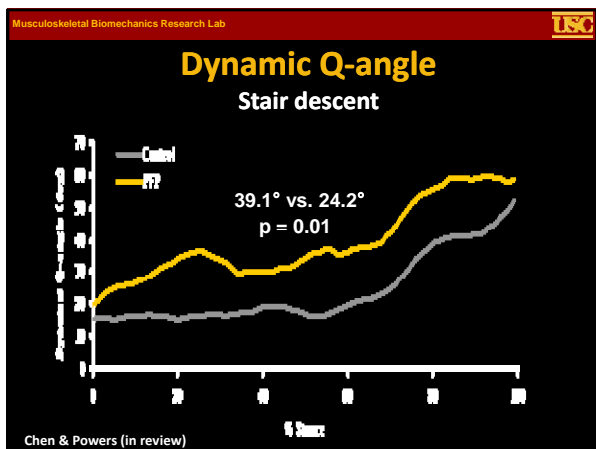
| | Posterior force | | Superior force | | Lateral force | |
|---------|-----------------|---------------|----------------|---------------|---------------|--------------|
| | PFP | Control | PFP | Control | PFP | Control |
| Walking | 6.4 (1.8) | 8.0 (2.1) | 5.1 (1.0) | 6.7 (1.4) | 1.8 (0.6) | 1.6 (0.8) |
| Descent | 20.9 (2.3) | 27.7 (2.9) | 5.1 (1.3) | 6.9 (1.1) | 7.2 (1.5) | 3.3 (1.2) |
| Ascent | 28.2 (3.1) | 34.5 (4.1) | 6.5 (1.7) | 8.9 (2.1) | 7.8 (1.6) | 4.1 (1.3) |
| Running | 41.2 (4.2) | 51.6 (4.7) | 15.0 (2.4) | 18.9 (3.0) | 8.4 (1.0) | 6.6 (0.7) |
| Average | 24.2 | 30.5 | 7.9 | 10.4 | 6.3 | 3.9 |

Chen & Powers (in review)









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Predictors of the Dynamic Q-angle

Four variables combined explained 70.3% of the variance in average dynamic Q-angle

1. Knee frontal plane motion (40.1%)
2. Knee transverse plane motion (13.8%)
3. Patella ligament orientation in the frontal plane (9.1%)
4. Vastus lateralis frontal plane orientation (7.3%)

Chen & Powers (in review)



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Dynamic Q-Angle

- Distal factors
 - Pronation
 - Tibial internal rotation
- Proximal factors
 - Femoral adduction
 - Femoral internal rotation

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Distal motions that can influence the Dynamic Q-angle

Powers CM. *J Orthop Sports Phys Ther*, 2003

- Foot Pronation
- Tibia rotation

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Foot pronation contributes to tibia internal rotation

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Common assumption: Excessive Pronation contributes to PFP

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Tibia internal rotation decreases the Q-Angle

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PFJ contact pressure & tibial rotation

- Tibia internal rotation had no influence on contact area & pressure
- Tibial external rotation results in an increase in lateral facet pressure.

Lee et al., J Rehabil Res Dev, 2001.

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Foot Pronation & Patellofemoral Pain

- Messier et al., 1991
 - No difference between controls and PFP runners on running rearfoot motion measures.
- Powers et al., 2002
 - No differences in peak pronation between patients with PFP and healthy controls

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Foot Pronation & Patellofemoral Pain

- Levinger & Gilleard, 2006
 - Prolonged rearfoot eversion in females with PFP.
 - No difference in tibial rotation between PFP and control groups.
- Hetsroni et al., 2006
 - No relationship between static & dynamic rearfoot measures and the development of PFP.

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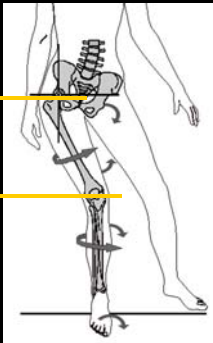
Proximal motions that can influence the patellofemoral joint

Powers CM. *J Orthop Sports Phys Ther*, 2003, 2010.

- Hip internal rotation
 - Contributes to dynamic knee valgus & maltracking
- Hip adduction
 - Contributes to dynamic knee valgus

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Half of the PFJ is the Femur!!

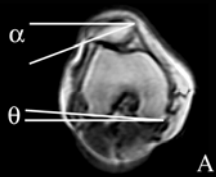


Femoral Rotation



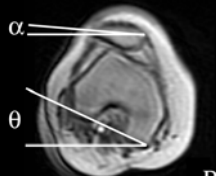
Powers et al. *JOSPT*, 2003

Non-weightbearing



A

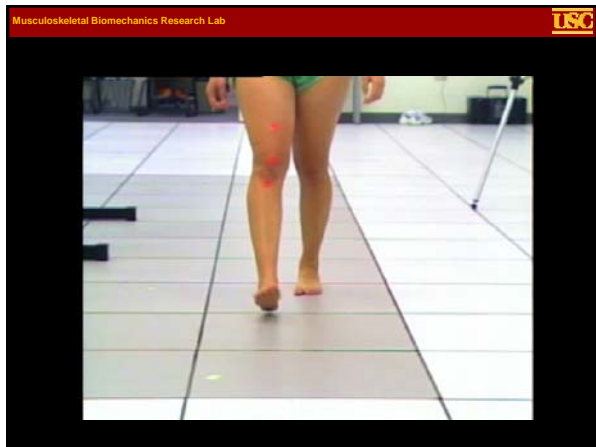
Weightbearing

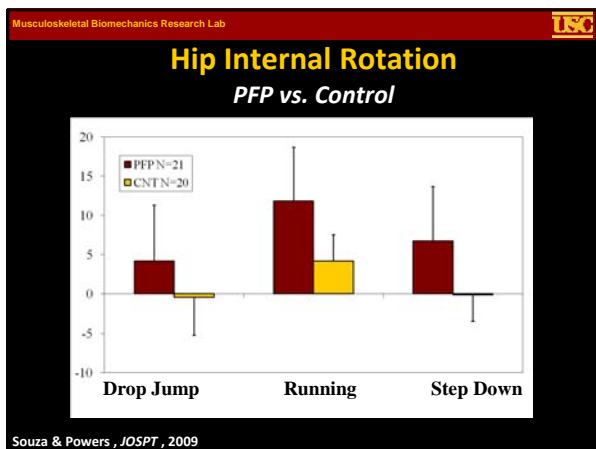


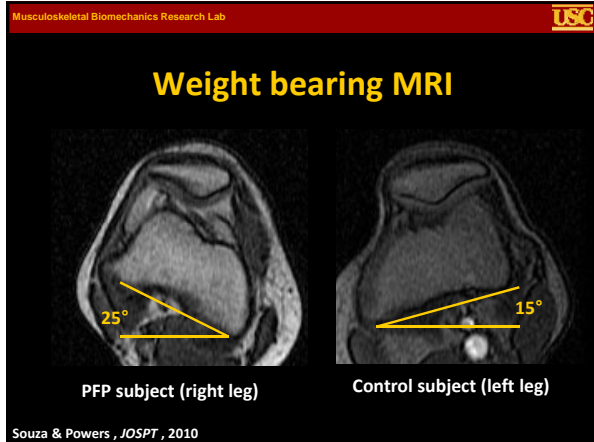
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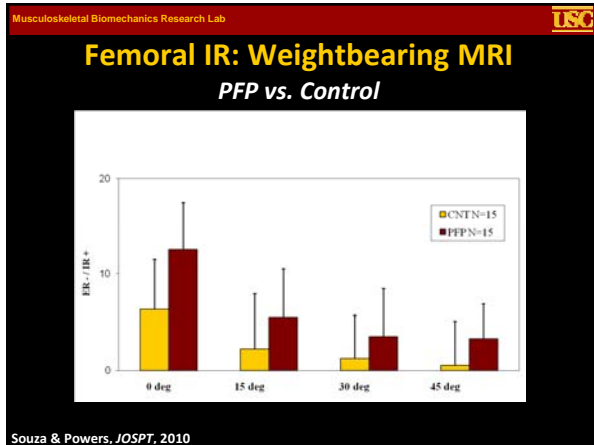
Powers et al. *JOSPT*, 2003

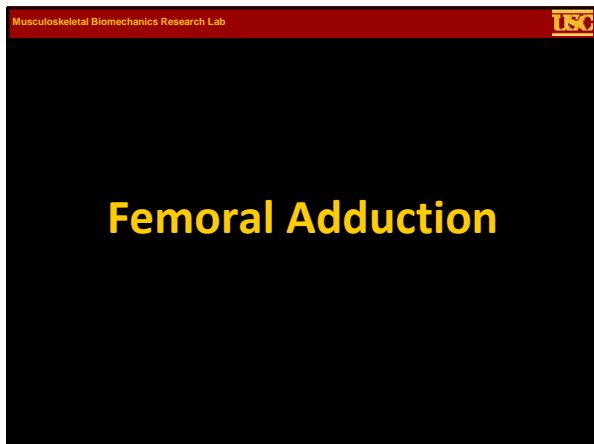


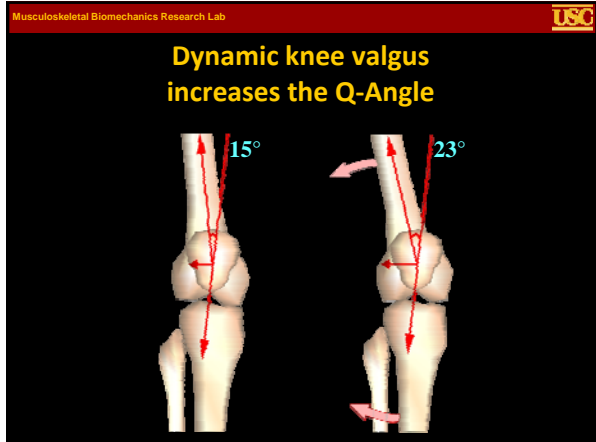


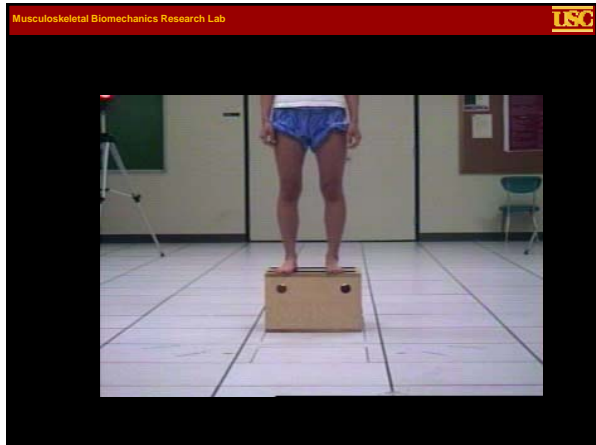










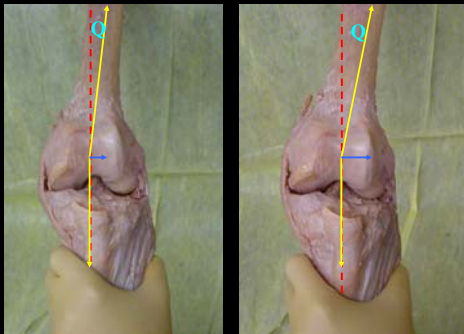




Dynamic Q-Angle



Increased lateral forces



How much of a change in the Q-angle is relevant?

Huberti & Hayes., JBJS, 1984

- 10 degree change in the Q-angle increased peak pressures by 45%.
- A decrease in the Q-angle decreased stress on the lateral facet and median ridge

Summary

- The lateral forces acting on the patella are largely influenced by abnormal motions of the lower extremity.
- Excessive hip rotation and adduction have the largest influence on the dynamic Q-angle.
- Excessive Foot pronation would not be expected to alter the lateral forces acting on the patella

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Questions?