Laws of Physics effecting gait

- Ground Reaction Forces
- Friction
- Stored Potential Energy within body tissues
Normal Gait Mechanics

- Heel Contact
  - Lateral heel
  - Ankle is supinated.
  - Knee is extended.
  - Lower extremity mildly externally rotated at hip.
  - Pelvis is rotated forward.
Heel Contact-Side view
Normal Gait Mechanics

- **Midstance**
  - Foot comes down flat (plantigrade).
  - Pronation occurs thru foot and ankle (calcaneus everts, navicular drop, talus moves medially).
  - Tibia internally rotates.
  - Knee is in slight flexion.
  - Femur internally rotates (but to lesser degree).
  - Weight shifts over stance leg (relative hip adduction).
  - Opposite hip drops.
  - Pelvis is neutral in transverse plane.
Early Midstance-Side view
Midstance-Side view
Midstance-Anterior View
Normal Gait Mechanics

- Late Stance
  - Tibia has moved over fixed foot (relative ankle dorsiflexion).
  - Foot begins to re-supinate (to become rigid lever).
  - Opposite knee is flexing thru with foot and toes pointing down.
Normal Gait Mechanics

- **Push-off**
  - Initiated by knee flexing thru.
  - Ankle is plantar flexed.
  - Primarily occurs thru the 1\textsuperscript{st} MTPJ with hallux planted on ground and toe down.
  - Late stage; knee flexed to 70\textdegree, toes act like spring boards.
  - Weight (COG) has shifted to other side and hip drops.
Peroneus Longus/Cuboid Pulley

- Upward pull causes downward pull on 1\textsuperscript{st} ray
- 1\textsuperscript{st} metatarsal head and sesamoids pulled to ground
- Very important: placement of sesamoids
Toe Off-Side view
Toe Off-Posterior view
Initial Swing

- Knee flexing to 70*, ankle plantar flexed, toes down.
- In running knee flexion approaches 90*.
Solitude, UT 2016
Normal Gait Mechanics

- Other Gait Mechanics to observe
  - Momentum “Walking is controlled falling forward”.
  - Feet should not cross midline.
  - Normal and symmetrical arm swing.
  - Trunk is upright and symmetrical in all planes.
  - Normal translatory motion thru trunk and pelvis in opposite directions.
Pelvic Rotation: Total 8 degrees (forward 4, backward 4)

Figure 8. Pelvic rotation effectively extends the trailing and advancing support points.
Lateral Pelvic Displacement:

- Normal walking base 5-10 cm
- Wider base>>increases stability, but more energy exertion
- Femoral Varus and Knee valgus keep tibia vertical

Figure 13. Lateral pelvic displacement improves the position of the center of mass over the support limb.
Efficient and Effective Gait
(Pettman)

- Striding (anatomical features only in humans)
  - Wbing Lumbar Lordosis
  - Hip Joint can extend past vertical
  - Angle of femoral neck: Min rotational displacement
  - Knee Joint: condyles lock at heel strike and thru most of stance
Foot/Ankle Rocker Motion (Perry)

- Heel Rocker: contact calc tuberosity, fulcrum
- Ankle Rocker: advance tibia over stationary foot
- Forefoot Rocker: terminal stance, metatarsal heads serve as axis of rotation
Gait Dysfunction; Abnormal gait mechanics due to structural / functional reasons.

- Leg length discrepancies (static or dynamic).
- Hip Anteversion/Retroversion.
- Genu valgum/varum.
- Tibial torsion (internal or external).
- Pes planus, cavus, met adductus.
- Hallux limitus (functional or structural), valgus or varus.
- Scoliosis.
Gait Dysfunction - External rotation torquing @ push-off.
Gait dysfunction - Cross-over patterning
Gait Dysfunction-Decrease back knee flexion.
Gait Dysfunction-Knee flexion at heel contact, early heel rise.
Gait Dysfunction-Excessive knee flexion at mid-stance.
Gait Analysis; Pre and Post interventions, Video’s.
Gait Dysfunction - Excessive pronation, ankle valgus
H/o left hip flexor/adductor strain, twisted pelvis, pronated feet.
Post
Six year h/o right achilles tendonitis
Right lateral ankle pain
Pre
Post
50 yr old runner, repeated calf pulls

Pre
Post
College baseball pitcher, LLD(L short), pronated feet/valgus ankles.
Post
40 yr old runner with bilateral foot/ankle, back pain.
Post
Postural dysfunction, LLD
78 yo diabetic, left knee varus/DJD with LLD (R short).
Post
College runner, long h/o calf/plantar fasciitis pain, recent R big toe pain.
Post
High school runner with bilateral tibial stress fractures.

Pre
Post
20 y.o. college runner; LLD, high arch’s, with c/o bilateral feet and L hip pain.

- Pre
Post
High school runner; medial shin splints.

- Pre
Post
Left lateral ankle, shin pain, high arch’s.

- Pre
Recreational runner TM, bilateral heel, big toe joint pain.

- Pre
Post
S/p R Chielectomy 4 yrs ago, now R neuroma/heel pain.

- Pre
Post
Long h/o right knee pain, pelvic rotation, B heel and shin pain.

- Pre
Post
Runner LLD R short, 6 month h/o medial shin splints.

- Pre
Post
External rotation torquing, LLD.
Summary

- When your athlete or patient comes to you with complaints involving the trunk or LE’s take a minute and watch how they move when they walk. Look for asymmetries, they may be subtle but will often point to the problem.
- Pain is the body’s way of telling you there is a problem. Listen to it, pushing through pain often results in substandard compensatory movement patterns and further injury.
- Addressing symptoms earlier results in less chance of greater injury and return to play sooner.
- When dysfunction or symptoms are not improving with your appropriate interventions computerized plantar surface pressure analysis can be an adjunctive tool in helping to solve the problem.
Thank You!

Questions?