1st Ray Biomechanics

1st Ray: first metatarsal and medial cuneiform
- static stance stability primarily maintained by osseous locking and intrinsic ligament support
- no intrinsic or extrinsic muscular activity during static weight bearing
- functional stability dependant on PL and windlass effect

Contact Phase
- STJ joint pronation causes the medial longitudinal arch to lower
- 1st ray elevates, inverting and dorsiflexing

Midstance Phase
- As the foot resupinates, PL uses the cuboid as a pulley to plantarflex and evert the 1st ray
- eversion effect of PL locks the 1st ray into the medial column, providing increased stabilization
- Most eversion occurs at 1st metatarsal, then sequentially less eversion proximally at the medial cuneiform then navicular
- PL assists with weight transfer from lateral to medial and holds the foot in supination

Propulsion
- To achieve normal 65 degrees of hallux passive dorsiflexion, 1st ray must plantarflex and remain stabile
- hallux dorsiflexes allowing the head of the first metatarsal to roll onto sesamoid apparatus
- At the beginning of propulsion, PL is the primary force to plantarflex the 1st ray, but during the latter part, the intrinsic muscles predominate as well as PA windlass effect
- an increase in IM angle leads to loss in stability of the 1st ray by PA

Swing
- TA is antagonist, pulls 1st ray up as foot prepares for toe-off to allow hallux plantarflexion
- creates straight, rigid beam and foot enters swing phase
- 1st ray must be dorsiflexed by TA before EHL can dorsiflex the foot at the ankle

Sesamoid Apparatus
- held in place by FHB, Ab Hallucis and Ad Hallucis
- 1st metatarsal must be shorter than the 2nd in order to rotate up onto the sesamoids and achieve 65 degrees dorsiflexion of the hallux
- long 1st met will cause jamming at 1st MPJ

Range of Motion
  - 41% MCJ, 50% NCJ, and 9% TNJ
  - supports theory that hallux valgus may be caused by hypermobility of the MCJ when compared with prior studies

  - MCJ arthrodesis results in enhanced structural stability as well as preserves the functional role of PL
  - eversion seen at medial cuneiform after fusion was significantly greater

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