Functional Anatomy and Clinical Implications: Part I

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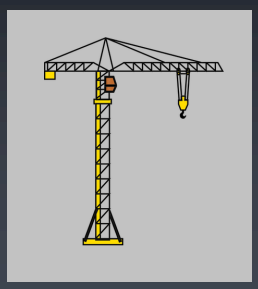
University of Georgia

A Philosophical Introduction

- Concepts over facts (it is not what you know …)
- Can't remember it all
- Knowledge provider → catalyst → teacher
- Knowledge is like money
- Structured repetition (if you don't use it …) and testing (repetitively)

The Equine Digit as a Mechanical System



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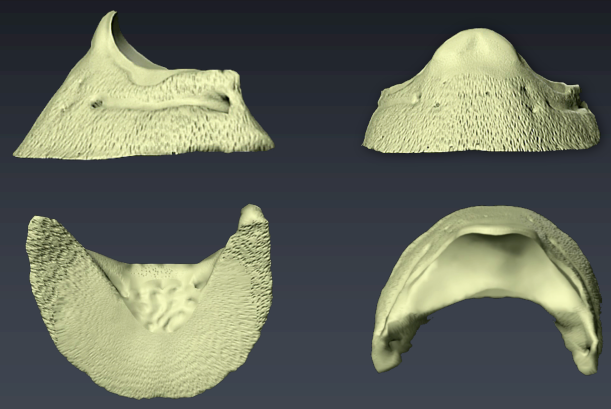
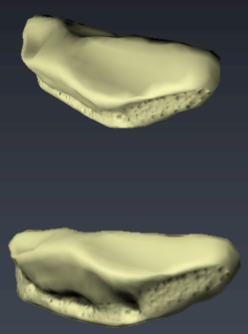
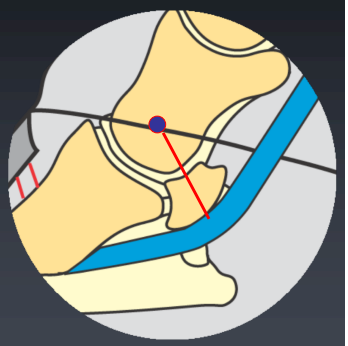
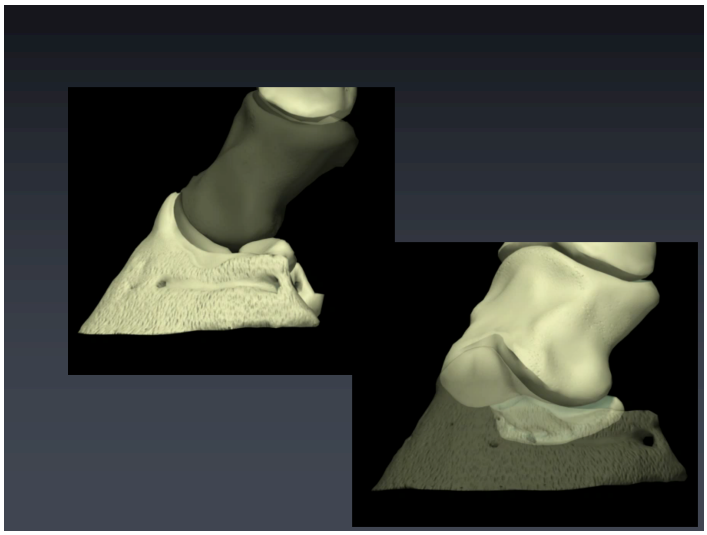
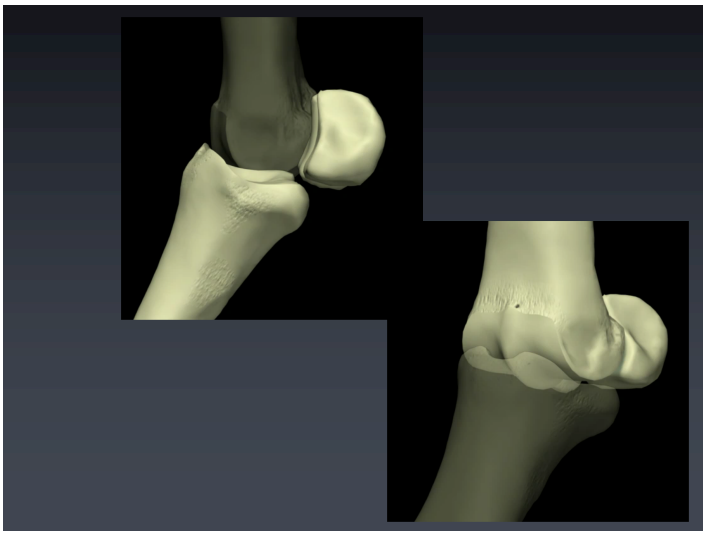
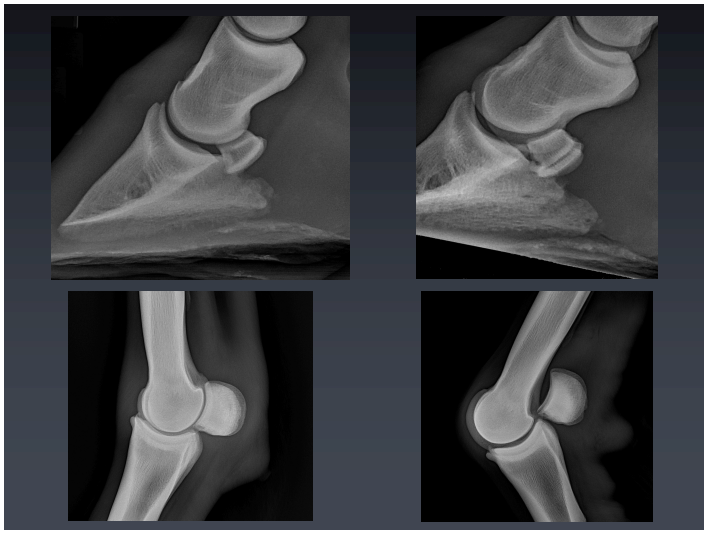


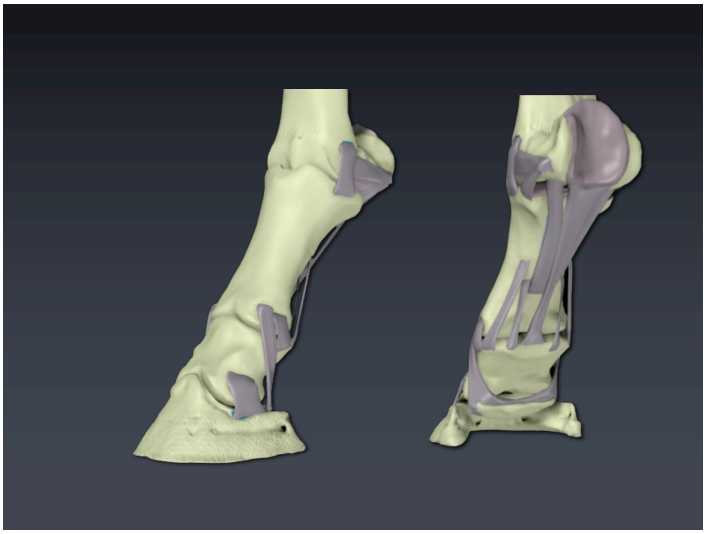


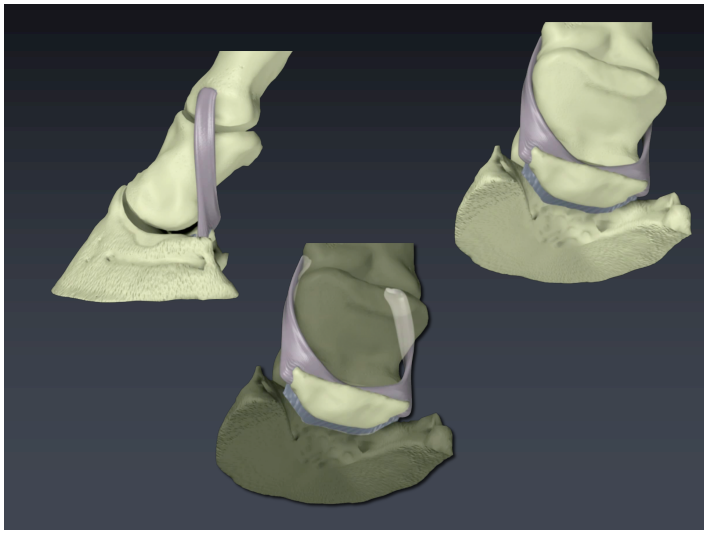


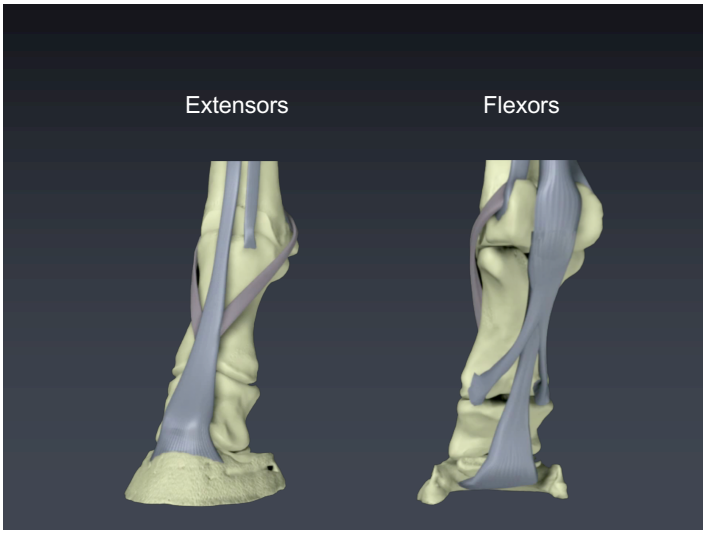


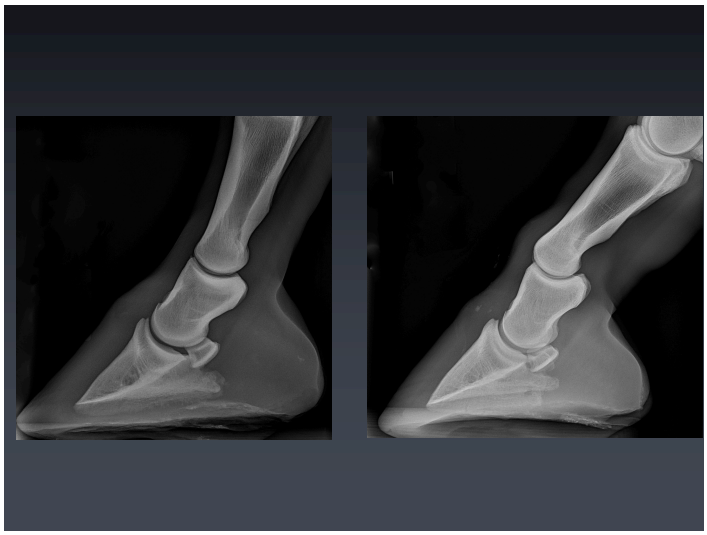


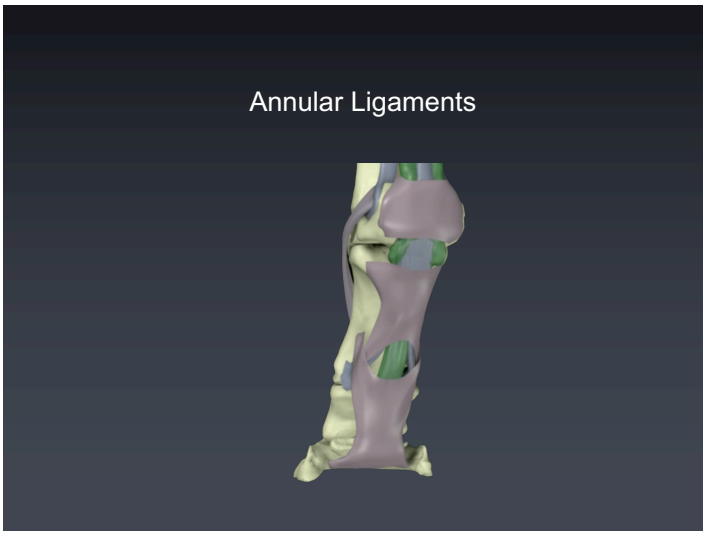


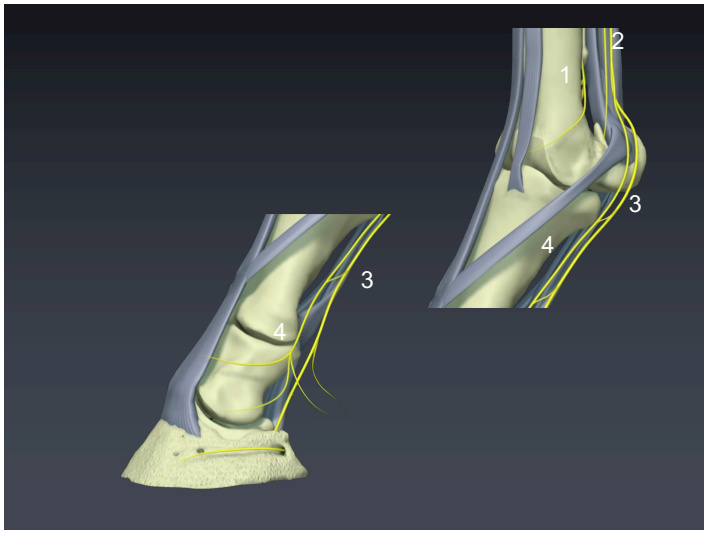


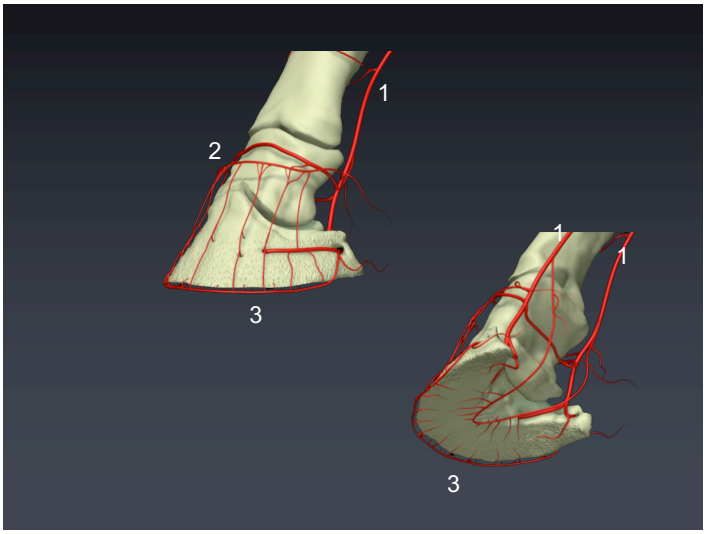


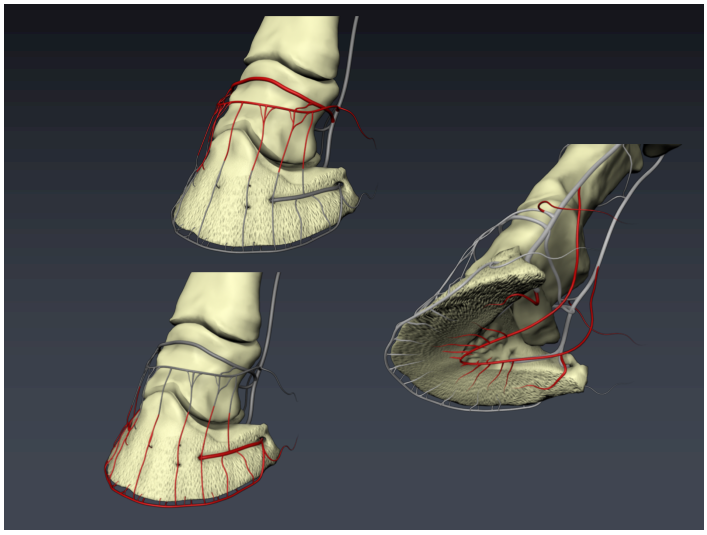

Extensors
Flexors

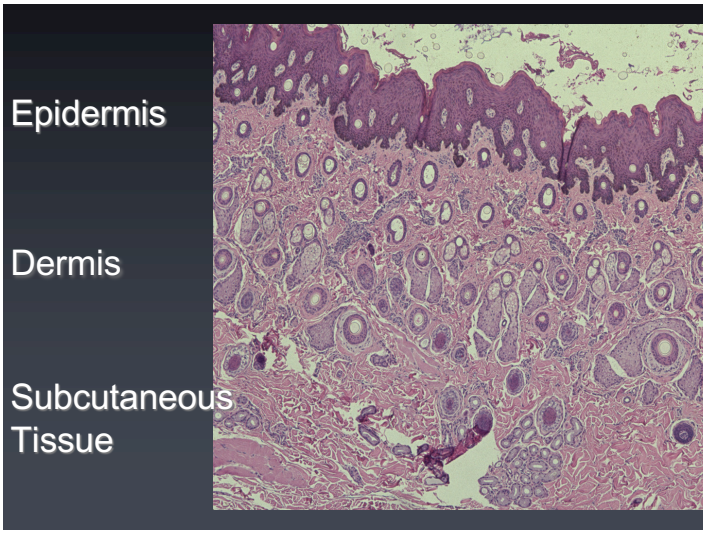


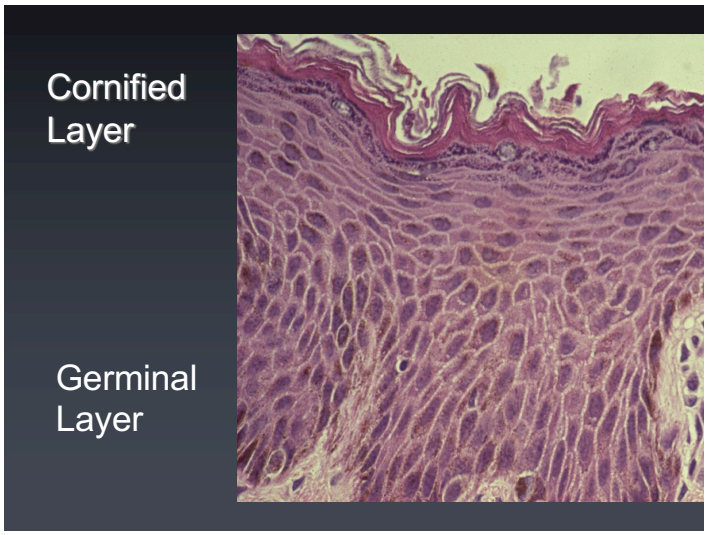

Annular Ligaments

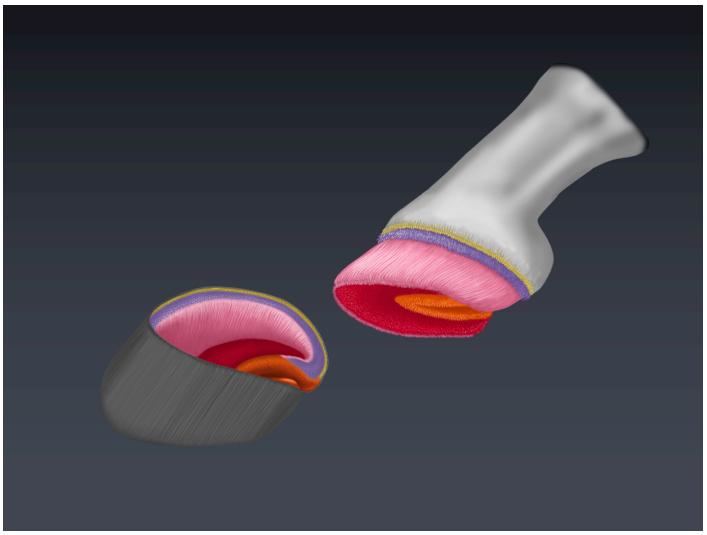

1
2
3
4
3
4

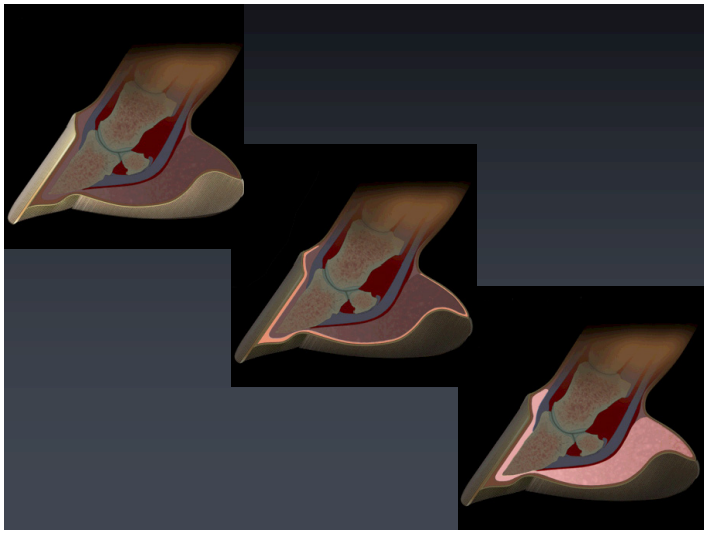

1
2
3
1
1
3

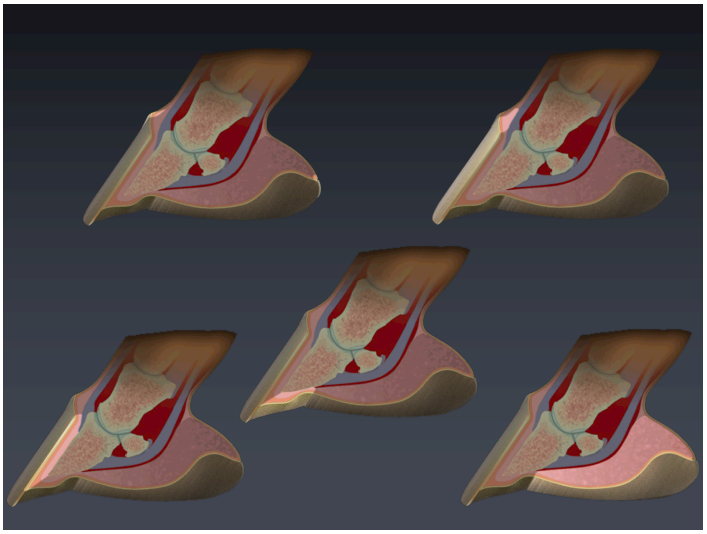


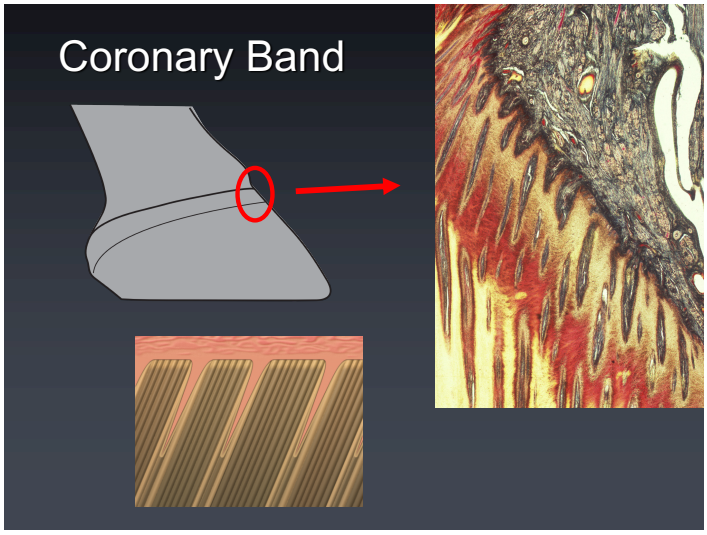

Epidermis
Dermis
Subcutaneous
Tissue

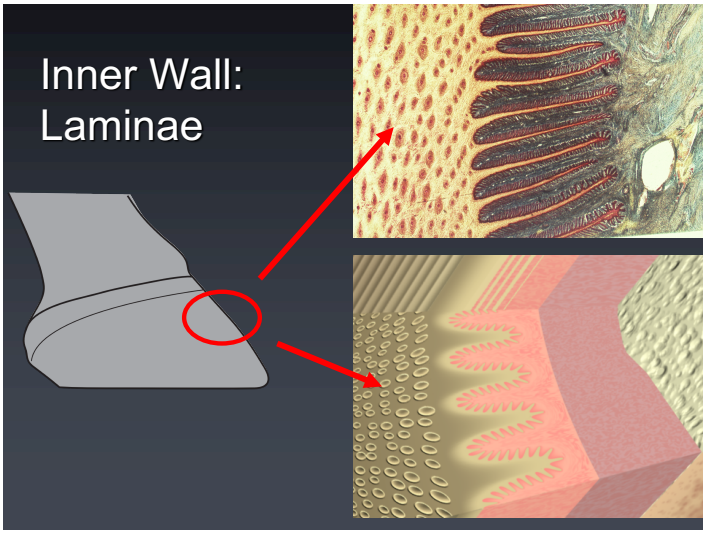

Cornified Layer
Germinal Layer

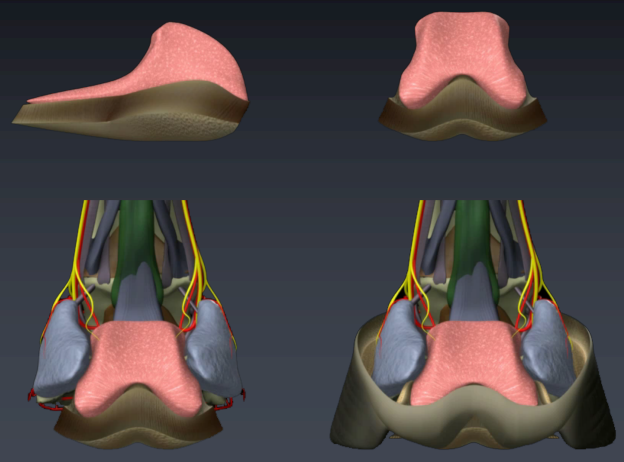






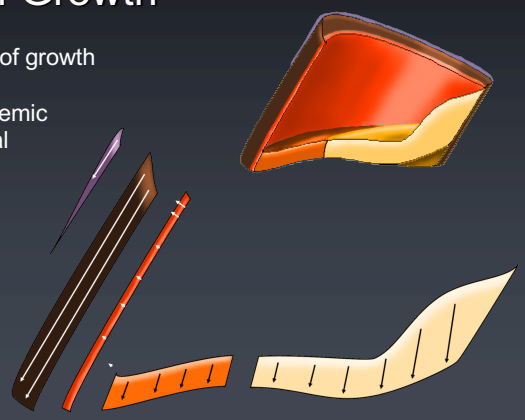

Coronary Band


Inner Wall:
Laminae



Hoof Growth

Pattern of growth
Factors
- Systemic
- Local



But if I was a betting person …

Wang and Li *Sports Medicine, Arthroscopy, Rehabilitation, Therapy & Technology* 2010, **2**:16
http://www.smarttjournal.com/content/2/1/16

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SPORTS MEDICINE ARTHROSCOPY REHABILITATION THERAPY TECHNOLOGY

REVIEW Open Access

Mechanics rules cell biology

James HC Wang*[1] and Bin Li[2,3]

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On the biomechanics and mechanobiology of growing skin

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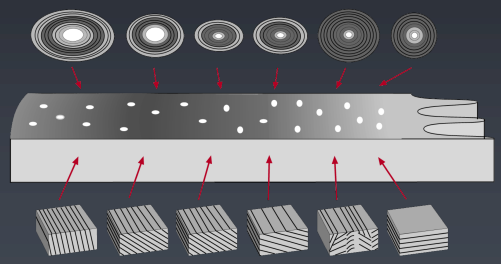
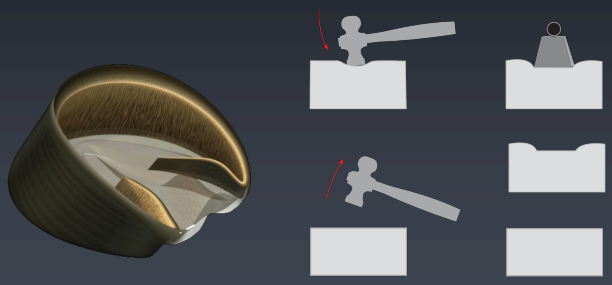


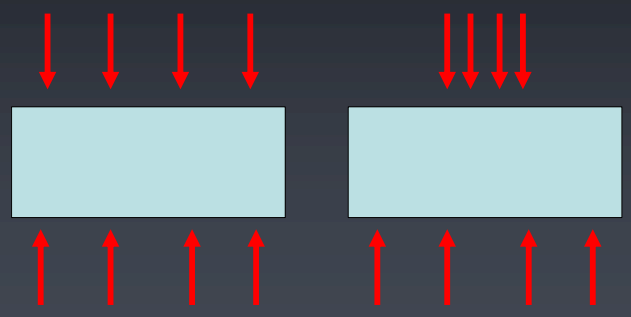
Biomechanics of the Distal Limb: Key Concepts

- Viscoelasticity
- Rate of Application of Force
- Distribution of Pressure
- Ground Reaction Force
- Center of Pressure
- Moment or Torque

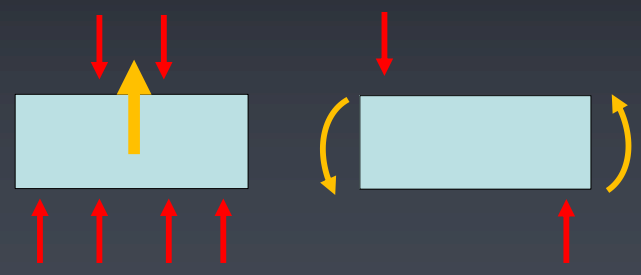
Viscoelasticity and the Hoof Wall



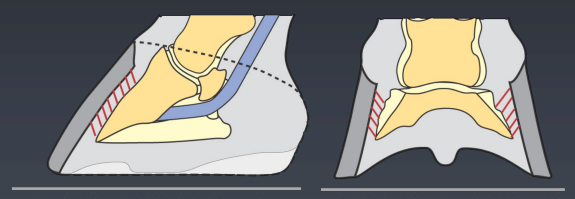
How forces effect movement:
Equal and opposing → no movement



How forces effect movement:
Unequal or unaligned opposing forces → translocation or rotation



Our starting point: the distal phalanx (P3) is suspended in the foot by the lamellae



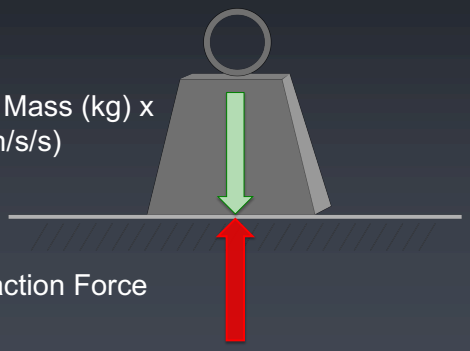
Clinical Evidence

No functional wall
Can't walk

No functional sole
Walks tolerably well

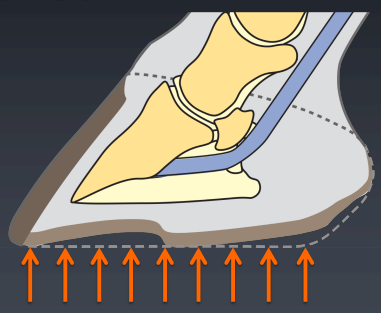
Weight and Force

Weight (N) = Mass (kg) x 9.8 (m/s/s)



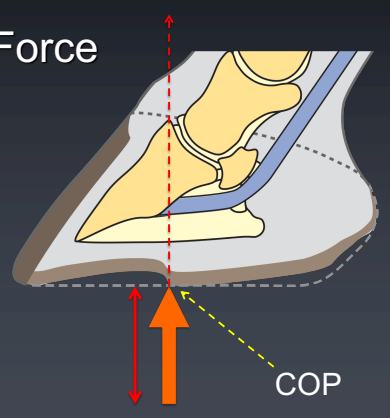
Group Reaction Force

Ground Contact

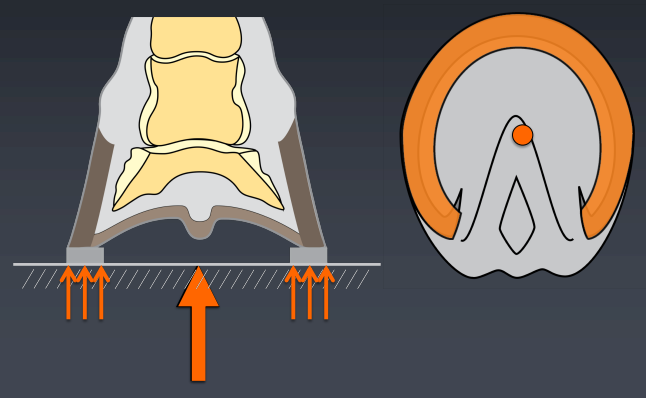


Ground Reaction Force

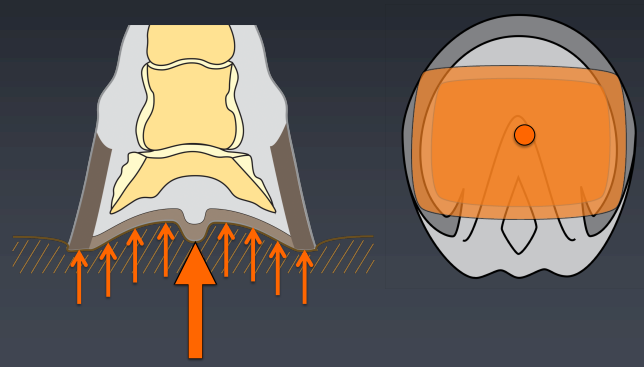
GRF = Vector



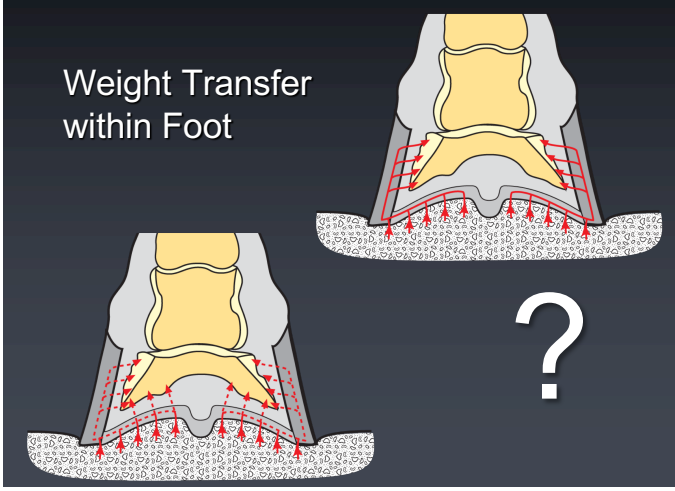
Shod / Flat surface

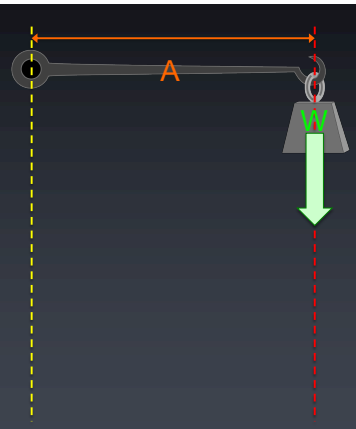


Barefoot / Deformable surface



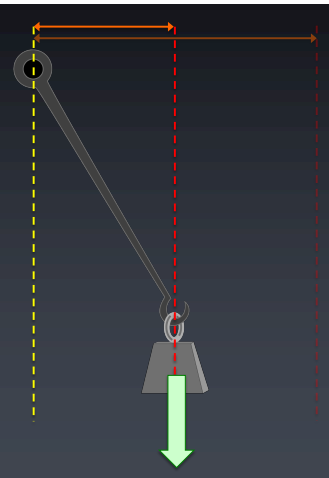
Weight Transfer within Foot





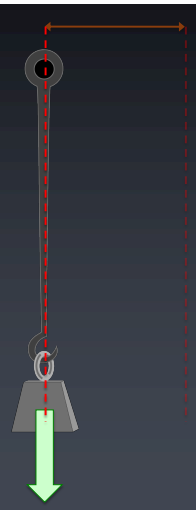
Moment

=
Force (weight W)
X
Length (lever arm A)



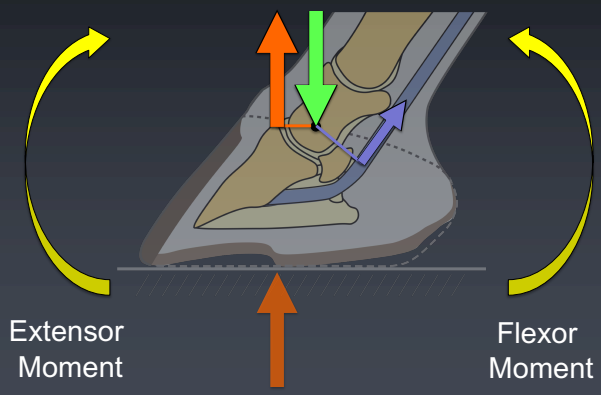
Moments

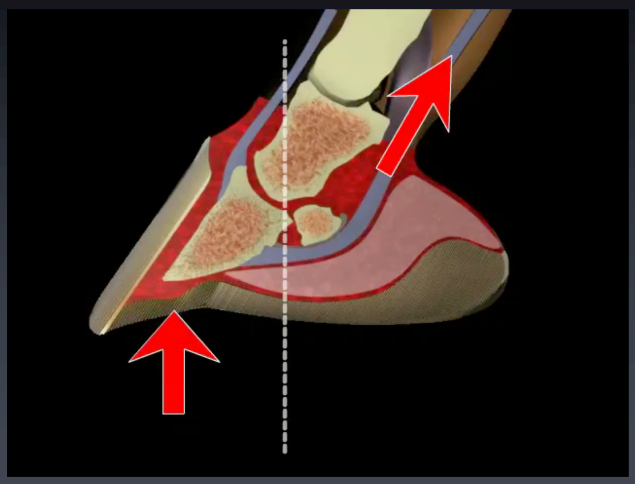
=
Force (weight W)
X
Length (lever arm A/2)



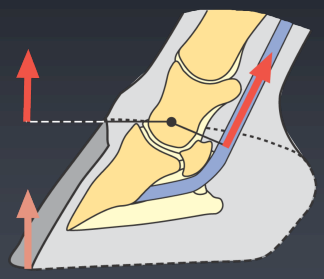
Moments

=
Force (weight W)
X
Length (lever arm 0)



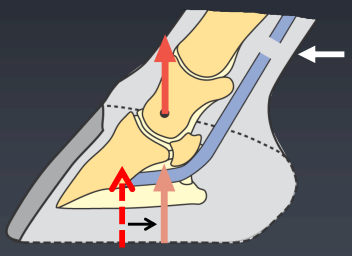


Moments about the DIPJ at Rest in Disease States



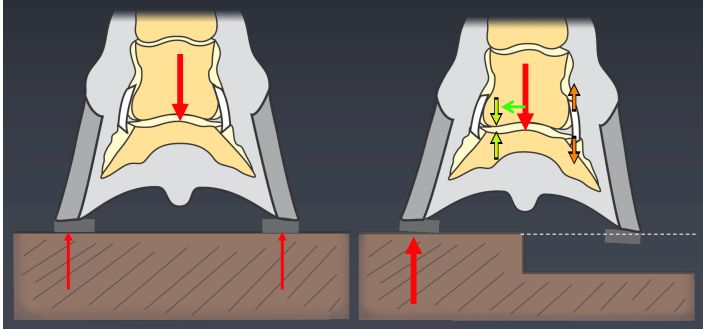
Flexural Deformity
(Caused by increased DDF tension)

Moments about the DIPJ at Rest in Disease States

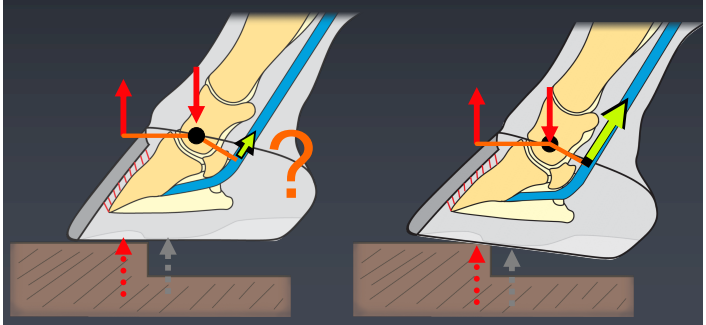


Severed DDF
(Caused by decreased DDF tension)

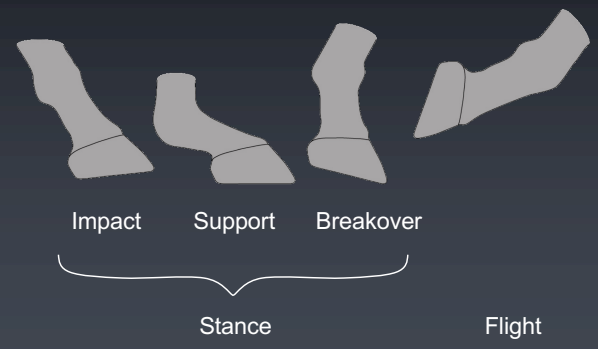
Thought Experiment: ML



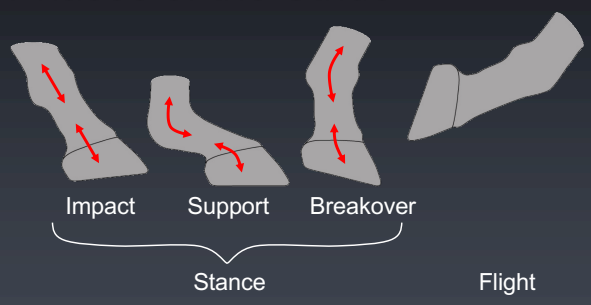
Thought Experiment: DP



Phases of the Stride



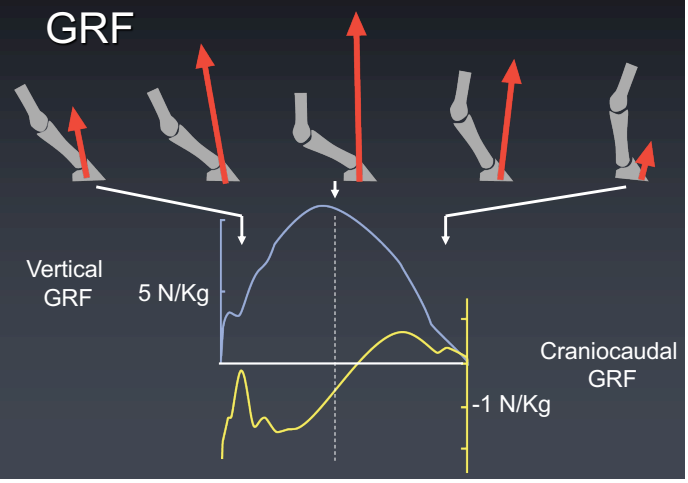
Phases of the Stride



Each of the three phases of stance is associated with different stresses and propensity for injury

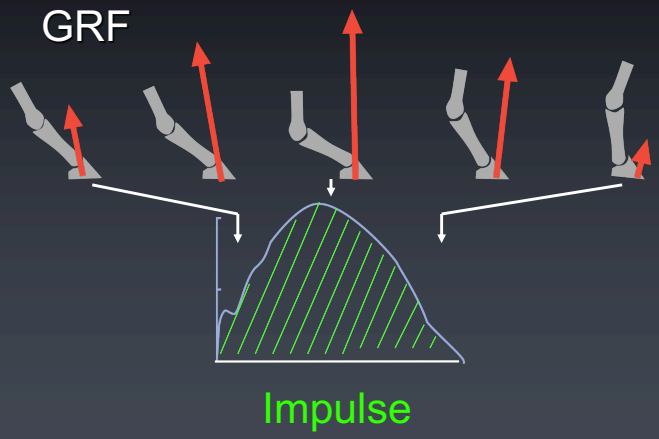
GRF

Force vs. Time at Trot

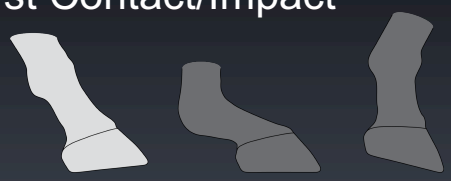


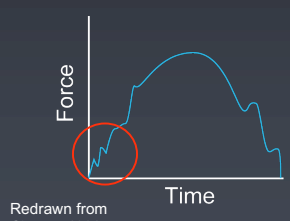
GRF

Force vs. Time at Trot

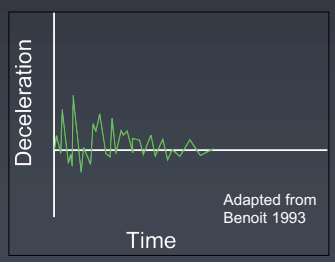


First Contact/Impact



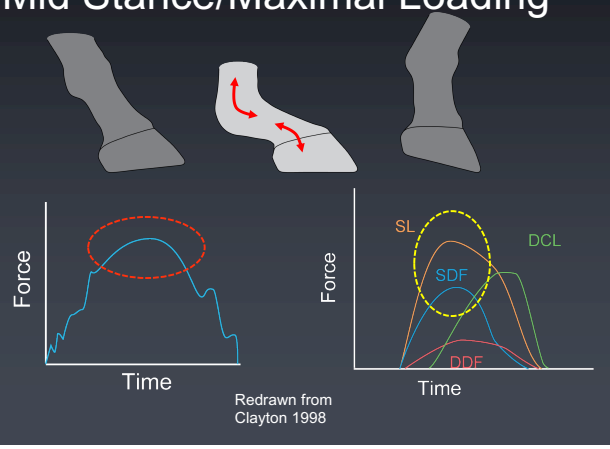


Redrawn from Clayton 1998

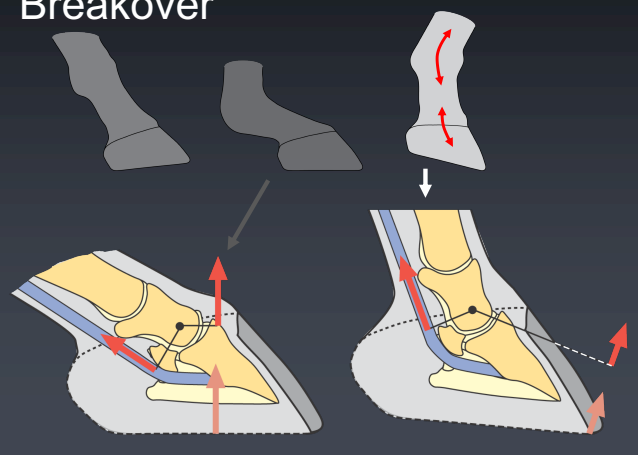


Adapted from Benoit 1993

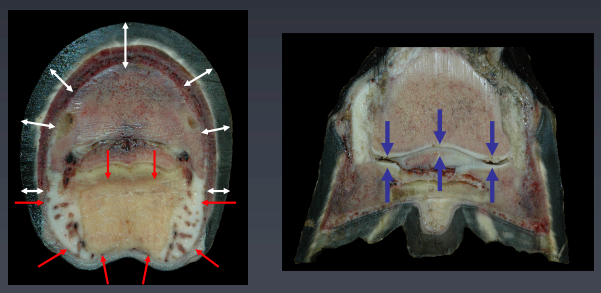
Mid Stance/Maximal Loading



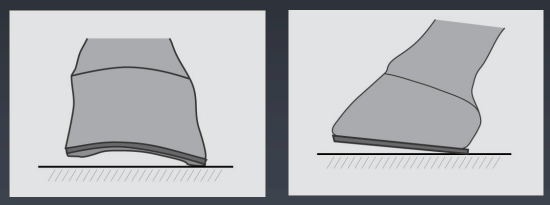
Breakover



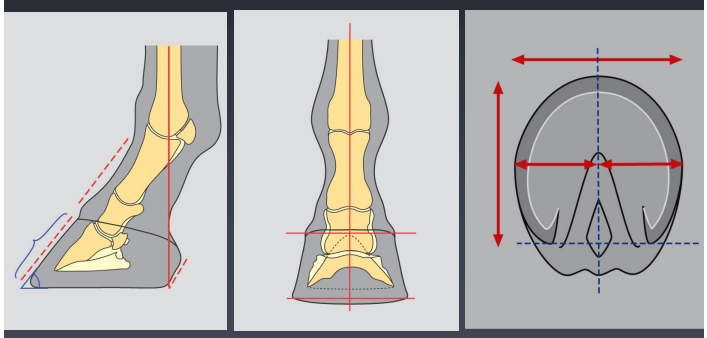
Absorption of Energy of During Impact



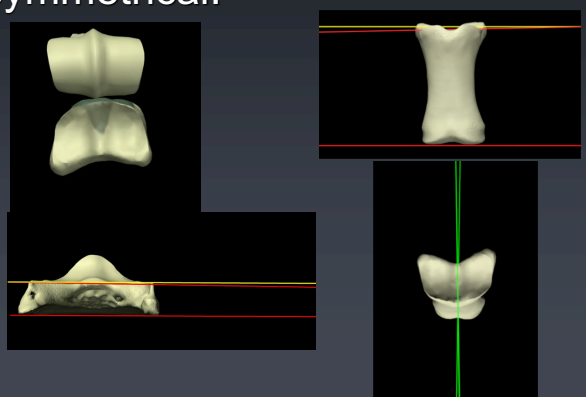
How the horse lands

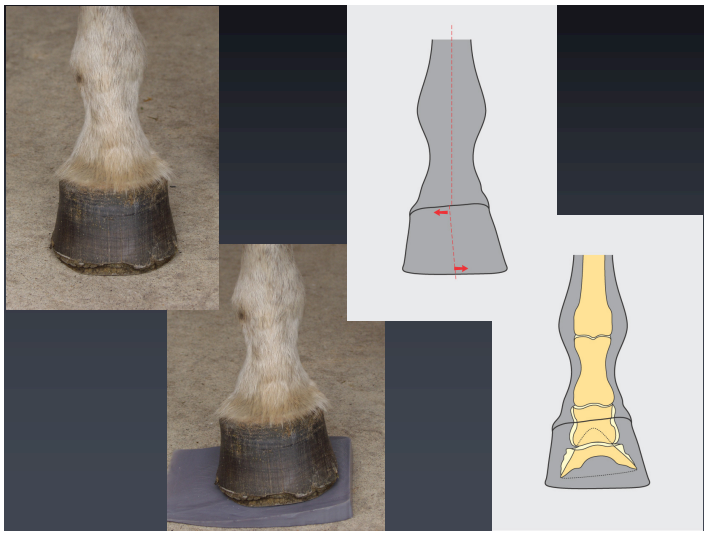


Effect of Shape on Function

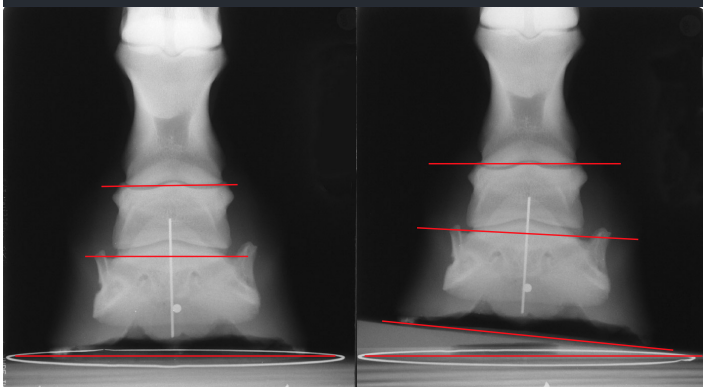


…, but the digit isn't quite symmetrical.

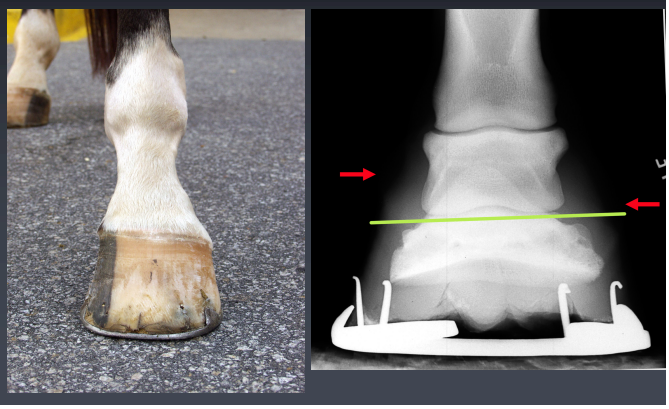


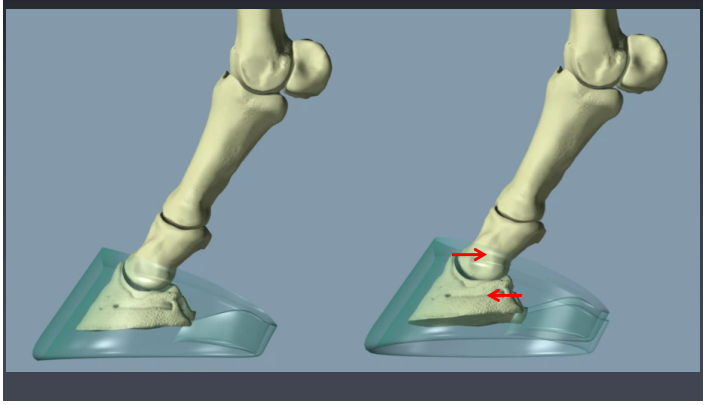


Acute Medial / Lateral Hoof Elevation: Radiographic Evidence

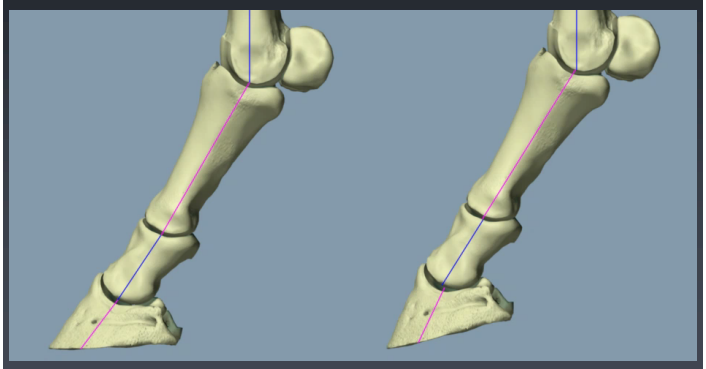


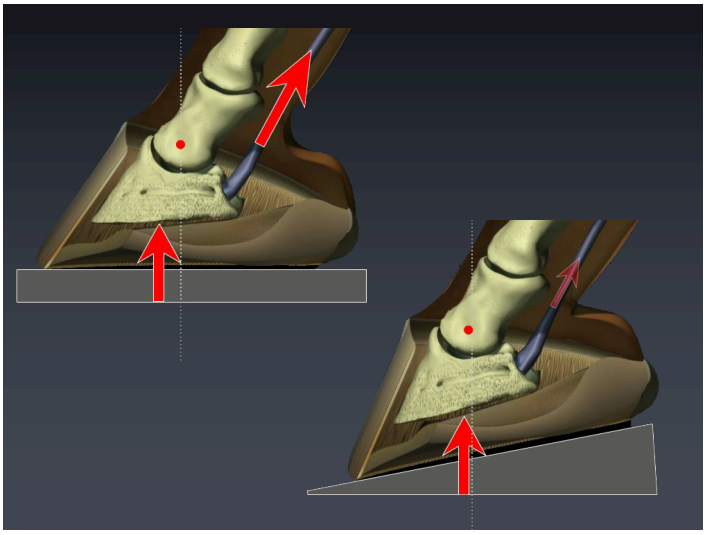
Chronic M/L Evaluation: Radiographic Evidence (or lack of)



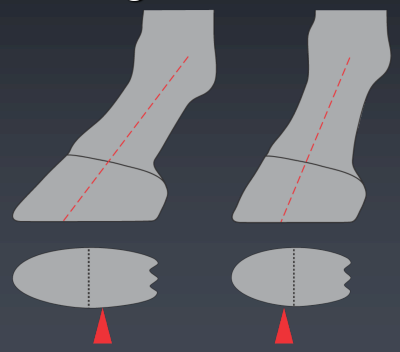


Heel Elevation

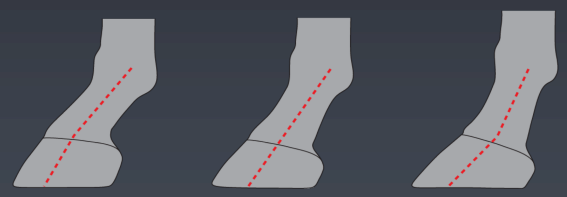




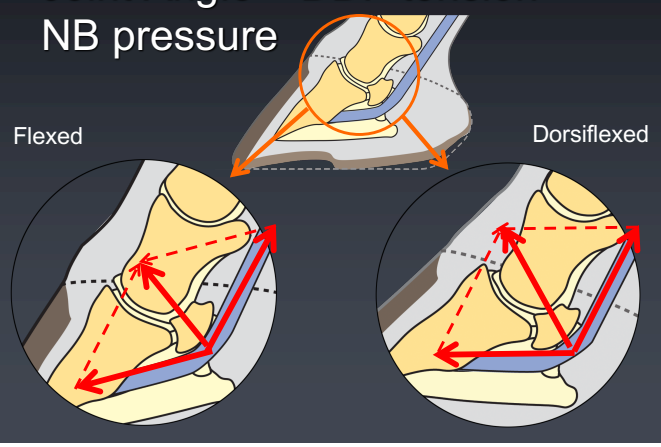
Effect of Conformation: Pastern Angle

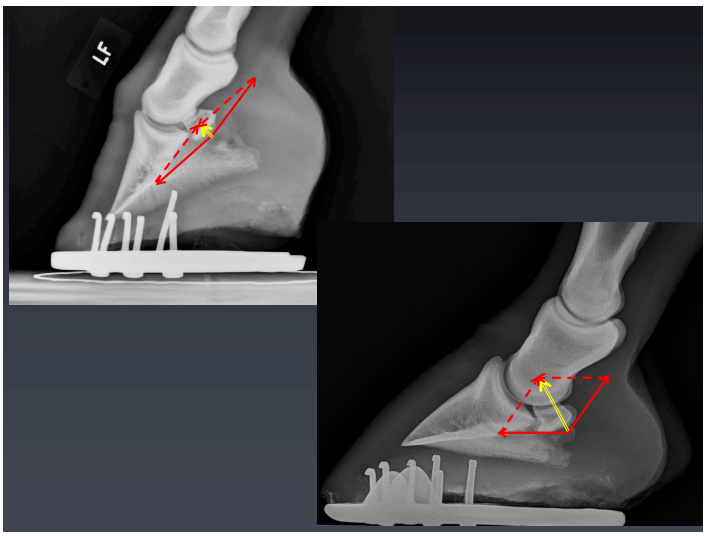


Effect of Foot Pastern Axis

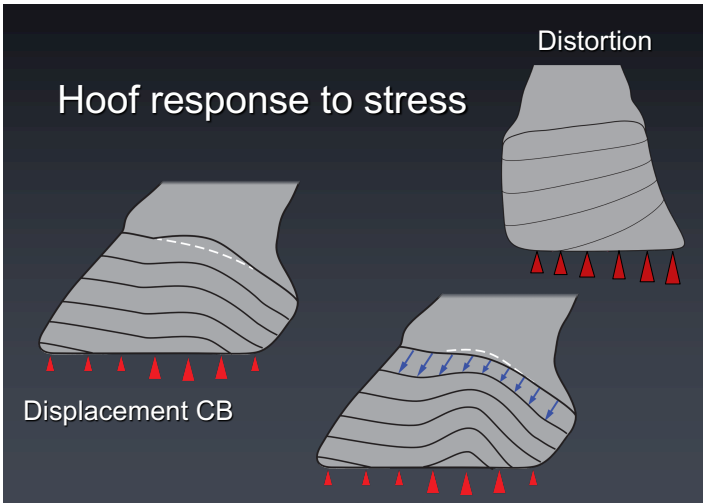


Joint Angle – DDF tension – NB pressure

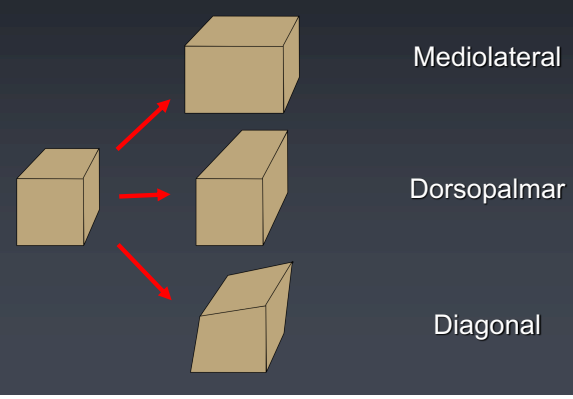




Hoof response to stress



The Foot as a Box



Summary

- A biomechanical mindset is a necessity for significant advances in clinical practice
- The foot can tell you about the distribution of stresses
- Lays the ground work for what might be possible with shoes