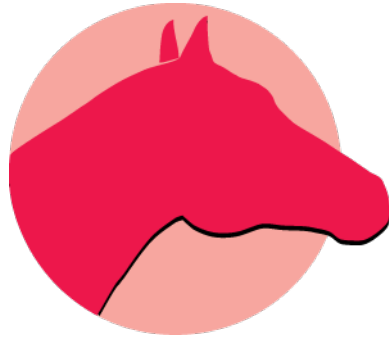


# Training and the Musculoskeletal System



**Dr. Larry Bramlage**

Surgeon/Partner

Rood and Riddle Equine Hospital

# Lameness

## A Sign or a Disease?

L.R. Bramlage DVM MS

# Sometimes? Most times? All the time?

- Trainers regard lameness as “the” problem as it prevents performance
- Ideally lameness would be regarded as a “sign” of the problem that needs attention
- Understanding and prevention is always way better than treatment.



# What is lameness?

- The shifting of weight from one limb to another
- What causes lameness? pain (there are a few mechanical lameness)
- What causes pain, inflammation?
  - Tumor
  - Calor
  - Dolor
  - Rubor



# What causes inflammation?

- Trauma
  - Neoplasia
  - Immune responses
  - Degeneration
  - Metabolic Disorders
- For practical purposes in the racehorse = trauma
    - Almost all fractures in the race horse are stress fractures
    - What are stress fractures? Fractures caused by multiple sub-maximal loads (cyclic stress)



# Repetitive Cyclic Stress to the Skeleton is the primary cause of lameness in the Racehorse

## Relationship

*Am J Vet Res.* 1996 Nov;57(11):1549-55.

**High-speed exercise history and catastrophic racing fracture in thoroughbreds.**

Estberg L, Stover SM, Gardner IA, Drake CM, Johnson B, Ardans A.



# Load Stress = Magnitude X Frequency

- Why don't all bones eventually fail
- Because the horse repairs them
- But there is a limit on the rate of repair and training can overwhelm the system



*Am J Vet Res. 1996 Nov;57(11):1549-55.*

Results:

...A horse that had accumulated a total of 35 furlongs of race and timed-work distance in 2 months, compared with a horse with 25 furlongs accumulated, had an estimated 3.9-fold increase in risk for racing-related FSI (95% confidence interval = 2.1, 7.1)...

All horses get the same diseases  
but the level of performance and  
the extreme ability of  
Thoroughbred racehorses  
magnifies skeletal effects





# Why do racehorses have so much trouble with their musculo-skeletal system

- Wonderful cardio-vascular system
- The musculo-skeletal system is the system that:
  - Requires the most training
  - Sustains the most wear and tear



# Why does the skeleton require so much training?

- The skeleton has to be literally molded into a performance skeleton
  - How do you do this?
    - Selective breeding and exercise  
(skeletal modeling)
    - Adaptive training  
(skeletal modeling and re-modeling)
- Skeletal remodeling is work specific



# How many loads are required to train bone?

- 36 cycles /day
- Bone trains to the level of work, not the amount
- Not true of cardiovascular system

- Additional cycles become detrimental to bone
- We gallop too much and don't vary gaits enough

Regulation of bone formation by applied dynamic loads  
CT Rubin and LE Lanyon  
The Journal of Bone and Joint Surgery, Vol 66, Issue 3 397-402



# The highest load 36 cycles / day guide the bone response

- A little better than a furlong
- The rest is trauma
- Lots of implications for training
  - Galloping a horse lots of miles doesn't strengthen the bone, it weakens it
  - One furlong should be a little faster than the rest



# Wolff's Law

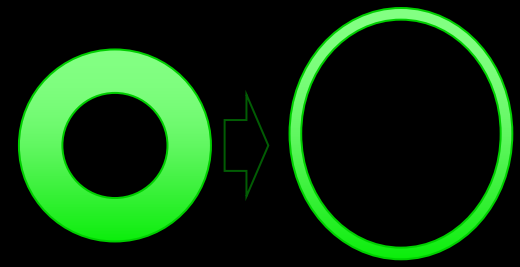
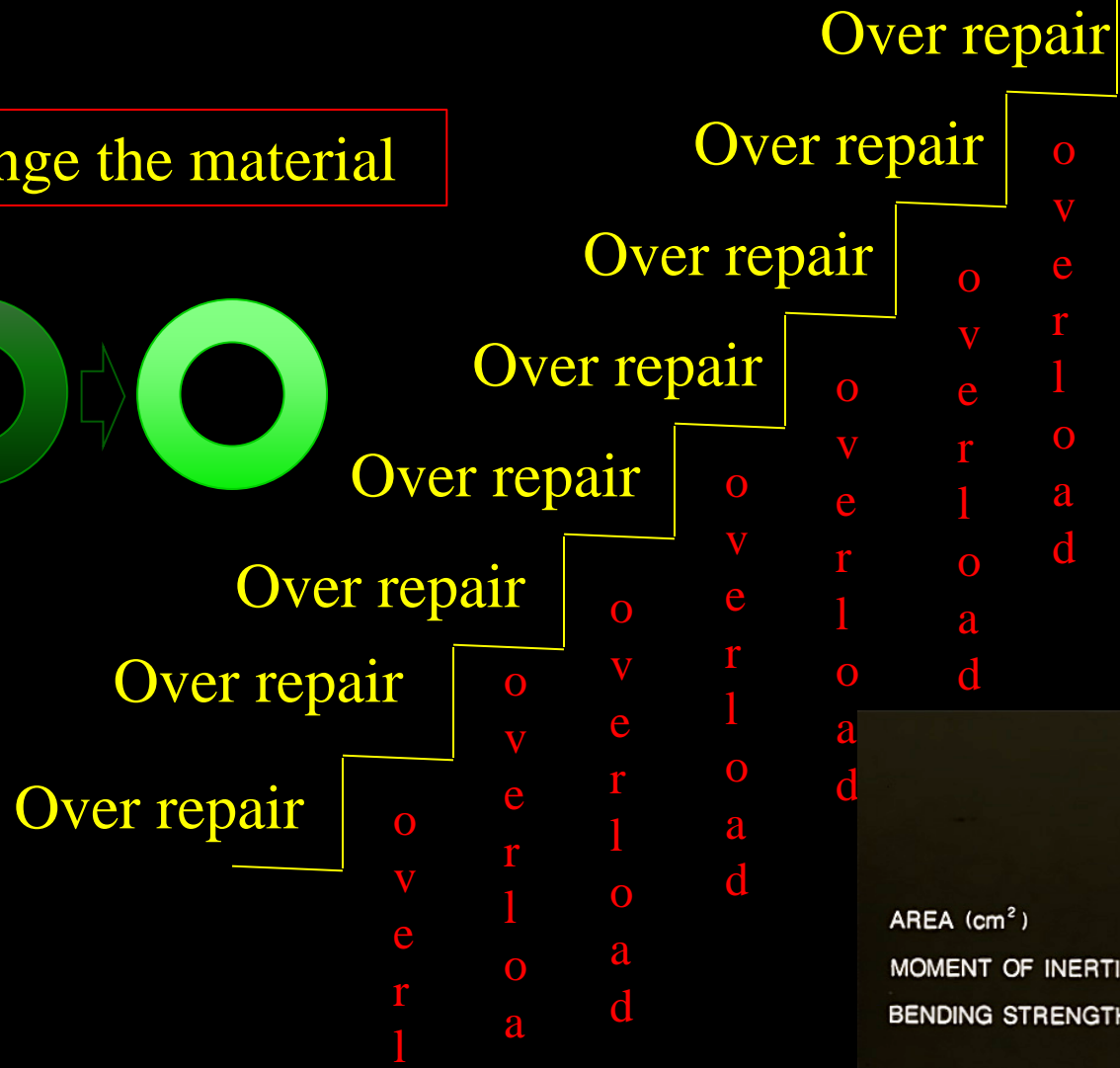
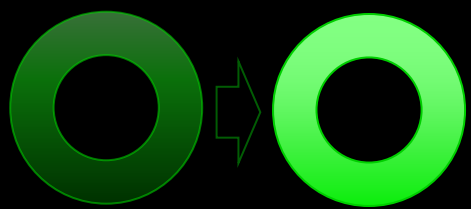
- “Bone is laid down where strength is needed and removed where strength is unnecessary.”
- Horses carry this to the extreme





# How bone responds

Change the material



Change the shape

	A	B	C
AREA (cm <sup>2</sup> )	2.77	2.77	2.84
MOMENT OF INERTIA (cm <sup>4</sup> )	.61	1.06	1.54
BENDING STRENGTHS (%)	100%	149%	193%

# Adaptation necessary to accommodate to the high stress of repetitive cyclic load

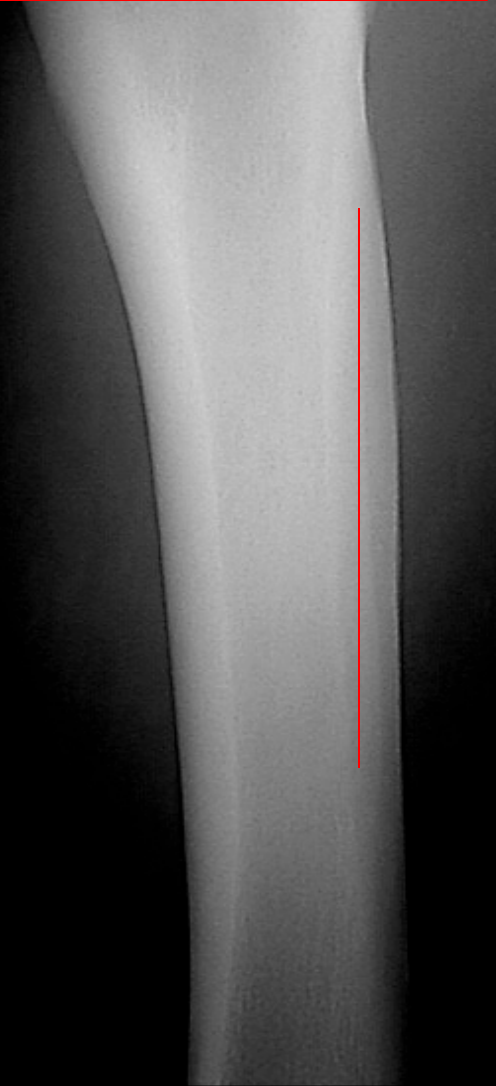
- Horses are not born with racehorse skeletons they are made by training
- Dorsal cannon bone hypertrophies to twice it's yearling diameter
- Caudal Tibia almost doubles in thickness
- Other sites must similarly adapt





# Adaptation necessary to accommodate to the high stress of repetitive cyclic load

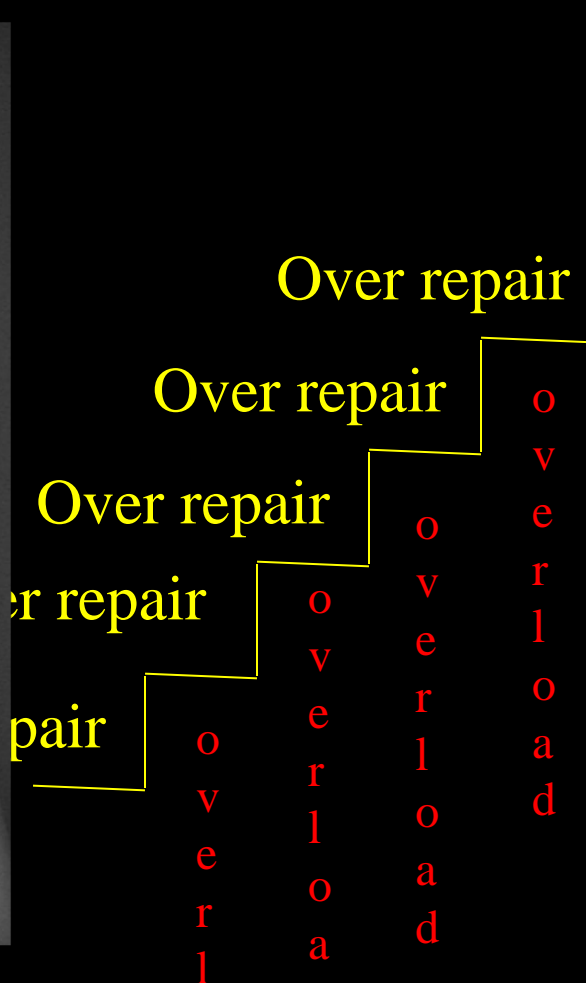
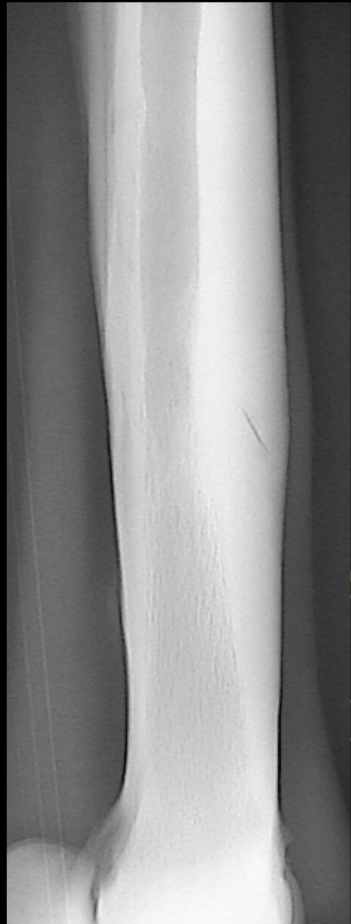
- Dorsal cannon bone hypertrophies to twice it's yearling diameter
- Caudal Tibia almost doubles in thickness
- Other sites must similarly adapt
- Usually it does both increase its density and change its shape



# How Bone trains

Overload results in micro-fracture  
generation

## Failure/Fracture



o  
v  
e  
r  
l  
o  
a  
d

o  
v  
e  
r  
l  
o  
a  
d

o  
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d



Failure of Bone occurs  
in the absence of adequate  
repair

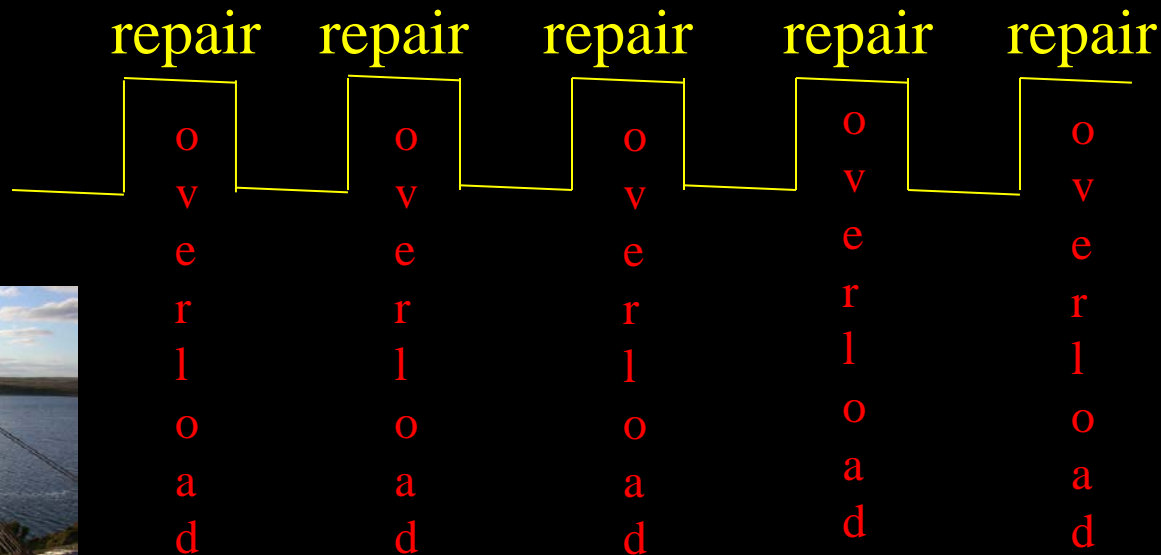
# How Bone Maintains

Overload results in micro-fracture generation

- High speed furlongs result in bone damage that must be healed.
- Biologic systems remain plastic, never gain elastic status.



## Racing



# How Bone Maintains

Overload results in micro-fracture generation

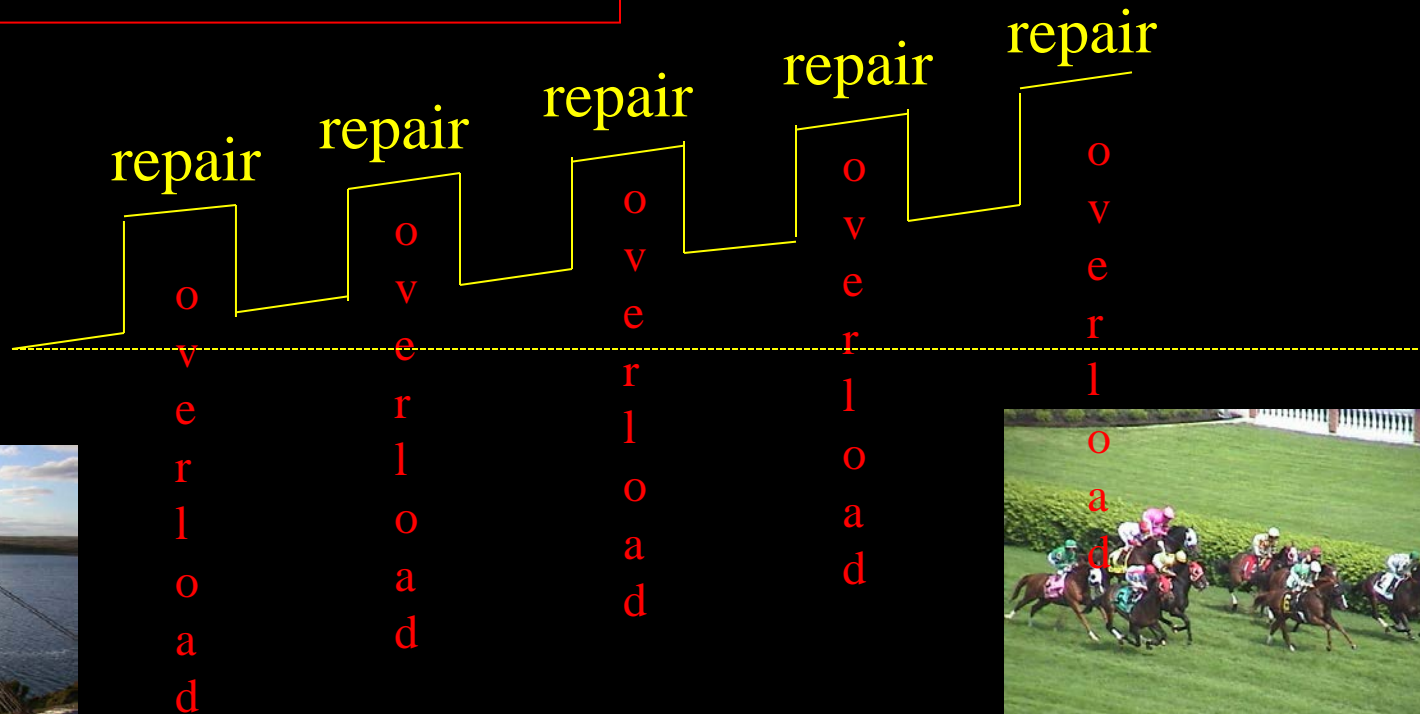
- High speed furlongs result in bone damage that must be healed.
- Biologic systems remain plastic, never gain elastic status.

## In Reality

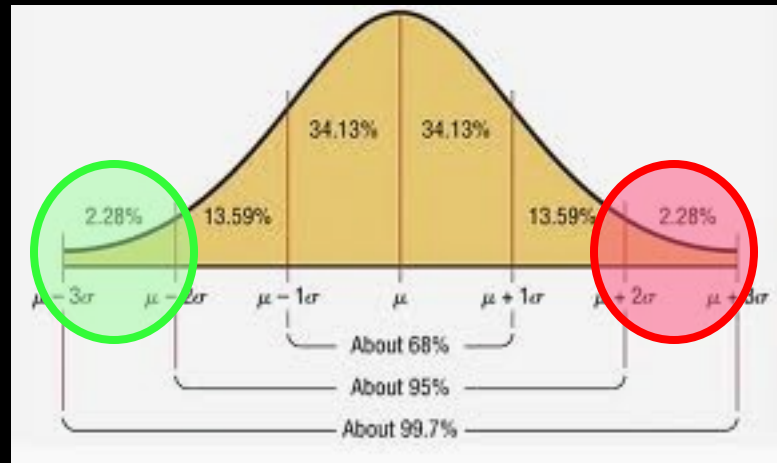
*Am J Vet Res. 1996 Nov;57(11):1549-*

*55.*

## Racing



# Individuals Vary



# Exceptions

- Edwin Moses



- Serena's Song



# Usain Bolt



# Adaptation is work specific

- You can alter the balance by altering input
  - Different surfaces
    - Variety is good
      - distances
      - speeds
    - Exclusivity is bad
      - Different surfaces at the same track
      - Vs. changing tracks

Regulation of bone formation by applied dynamic loads

CT Rubin and LE Lanyon

*The Journal of Bone and Joint Surgery,*

*Vol 66, Issue 3 397-402*





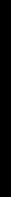
Have we altered the raw material?

e  
Natural Selection Multiplied by Man  
Are we reaching the Endgame?

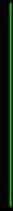
|

Thoroughbred  
Racehorse  
Natural Selection Multiplied by Man  
Are we reaching the Endgame?

enhance  
Viscera  
Dead Weight



me?



# Are we moving the breed?

- It is an unconscious choice
- We are selecting for the wrong type horse
- We have made the average height 3" taller in 100 years
- Are we selecting for unsoundness by not rewarding longevity?



# The event driven mentality selects our stallions and therefore drives our evolutionary selection

- The Triple Crown
- The Breeders Cup
- The Weekend Stakes
  
- Formerly “Home-breds” were generally rewarded for longevity and stamina



# Which quality do we desire most in a stallion?

Early brilliance  
(genetic ability)

or

Career stamina  
(ability to withstand  
training)



# How do you make a successful stallion?

- Early career brilliance
- Early success in the breeding shed



# How do you make a successful stallion?

- Early career brilliance
- Early success in the breeding shed
- If we don't select for longevity in our breeding programs why do we expect it?
- Lack of longevity is not wrong, but we should realize why it is happening.

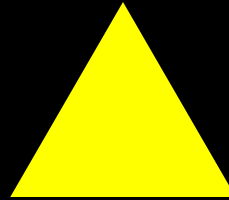




This makes the trainers job  
harder!



Performance Ability  
= Natural ability  $\times$  Training



# Performance Ability = Natural ability $\times$ Training



Horses had less  
Natural ability, Speed



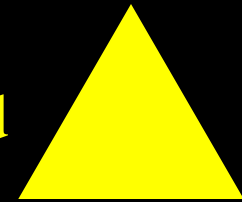
But they were more  
durable and could  
stand more training

Some former time

# Performance Ability = Natural ability $\times$ Training



They have more speed



Currently

But you can't  
train them as hard or  
they get injured

# Increased time between races (especially quality horses)

- They are healing
- Current efforts are more stressful
  - Horses are trained harder
  - Horses are more mobile
  - Horses don't dominate a local division any more



# Wolff's Law

- Joint surfaces such as the distal cannon bone can't change their size because they are within the joint
- They must change their structure



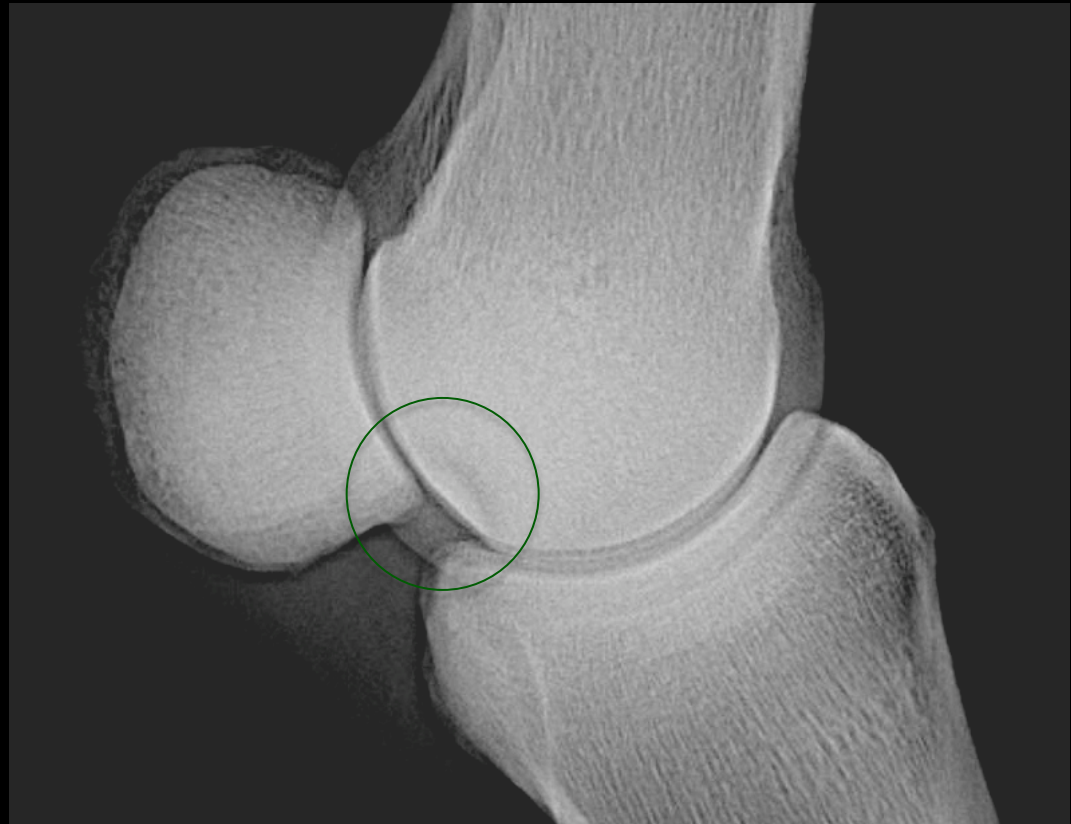
# Cumulative Stress Induced Bone Injury, and eventually stress fractures cause insidious lameness and eventually fracture

- All bones are vulnerable
- The distal cannon bone is “highly” vulnerable because it can’t change its shape, it is part of the fetlock joint
- Training fatigue
- “Track sour”
- Suddenly won’t load

# Diseases of the McIII/MtIII Articulation

## *Inflammation of the distal cannon bone*

- **Inflammation of the distal cannon bone**
  - Perhaps the single most important lameness of the racing Thoroughbred
  - Also occurs in the racing Standardbred
  - Also occurs in high level performance horses





# Diseases of the McIII/MtIII Articulation

## *Palmar McIII/Plantar McIII – Sesamoid Articulation*

- Is a consequence of the major adaptation required of the skeleton for high level work
  - Distal cannon bone edema
    - Reining
    - Cutting
    - Eventing
    - Jumping



*Palmar McIII/Plantar McIII – Sesamoid  
Articulation*

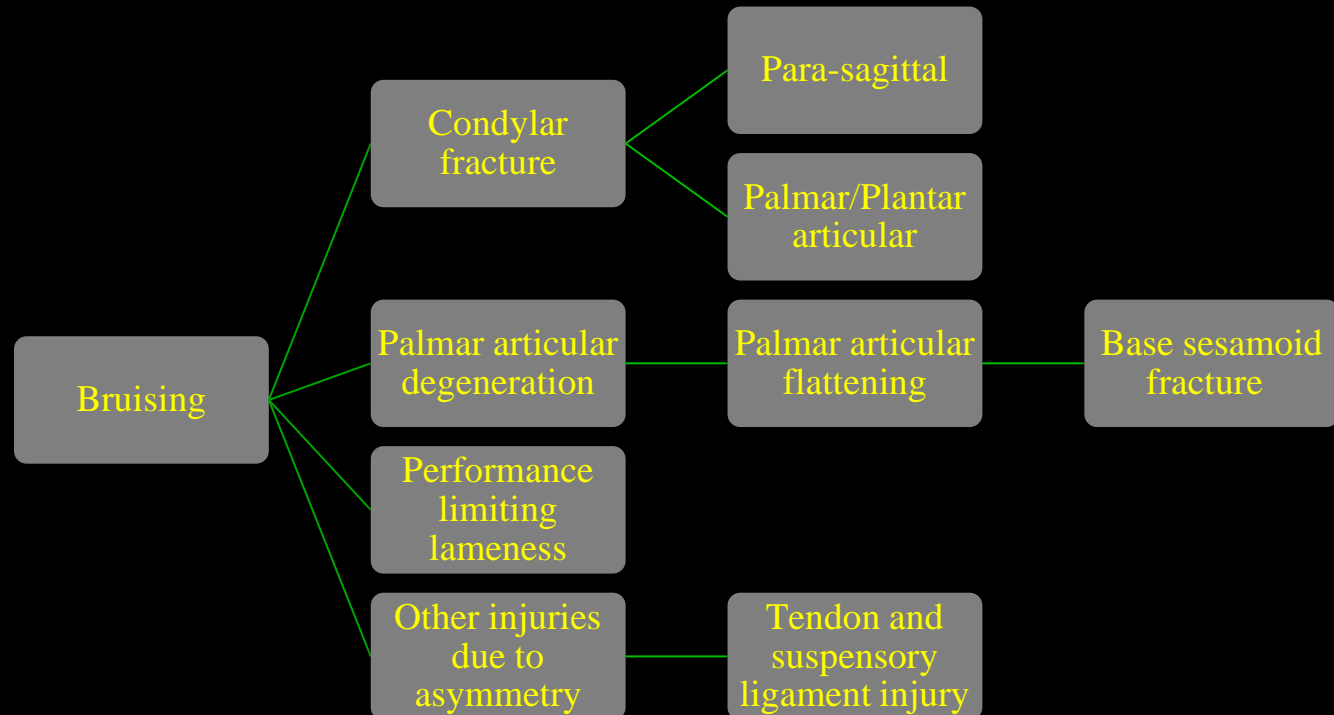
*Inflammation of the distal cannon bone*

- **Mal-adaptation vs.  
Bruising**



# Inflammation of the distal cannon bone

- The problem starts as bruising then branches into many pathologic conditions of clinical importance

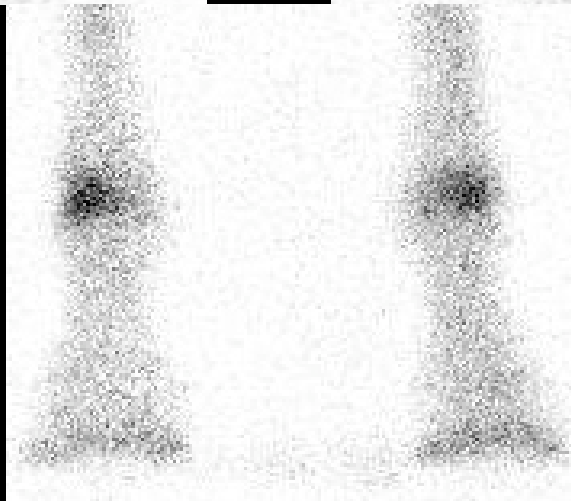
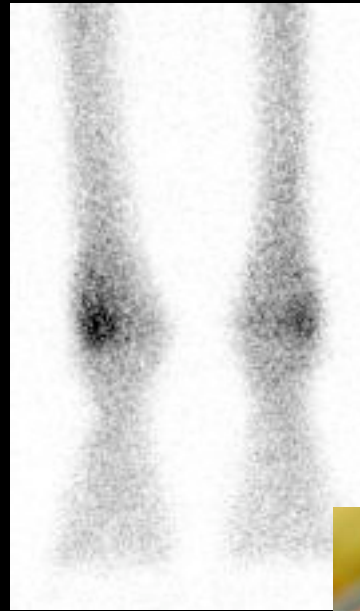
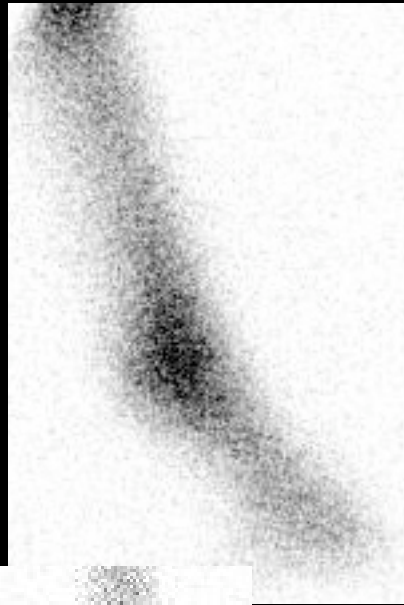
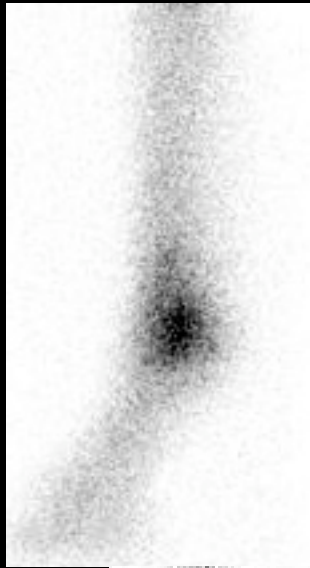


# Inflammation of the distal cannon bone

- Many contributing factors
  - Equine Anatomy
  - Shoeing Practices
  - Track surfaces
  - Training methods
  - Intrinsic individual biomechanics
  - Management practices
  - Abused medication
  - Many more

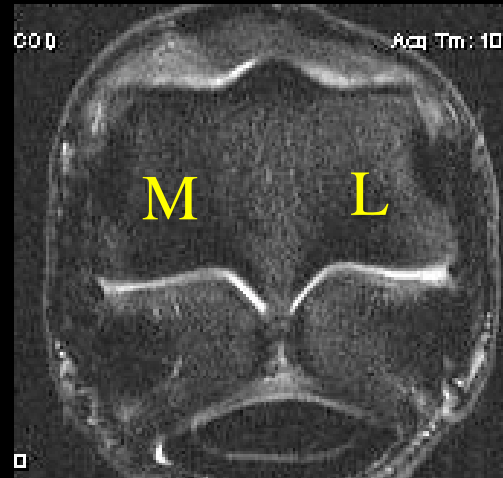


# Palmar Distal Cannon Bone Inflammation Forelimb vs. Hindlimb

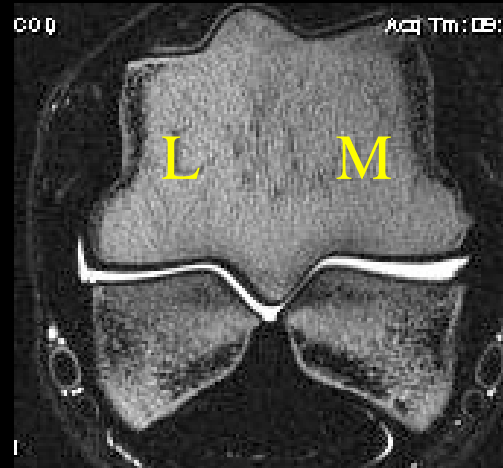


# Inflammation of the distal cannon bone

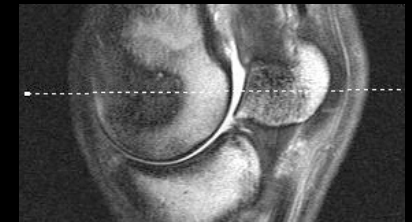
- Fractures are more common on the lateral condyle
- Degeneration and flattening are more common on the medial condyle



Forelimb



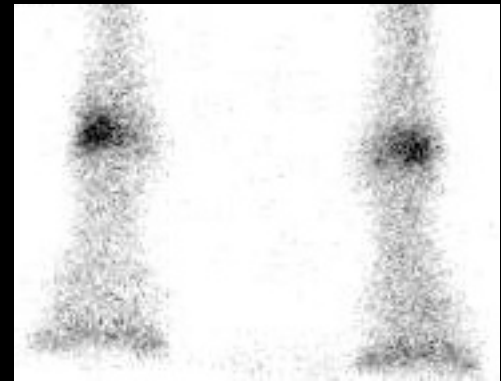
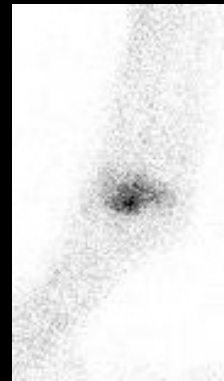
Hindlimb

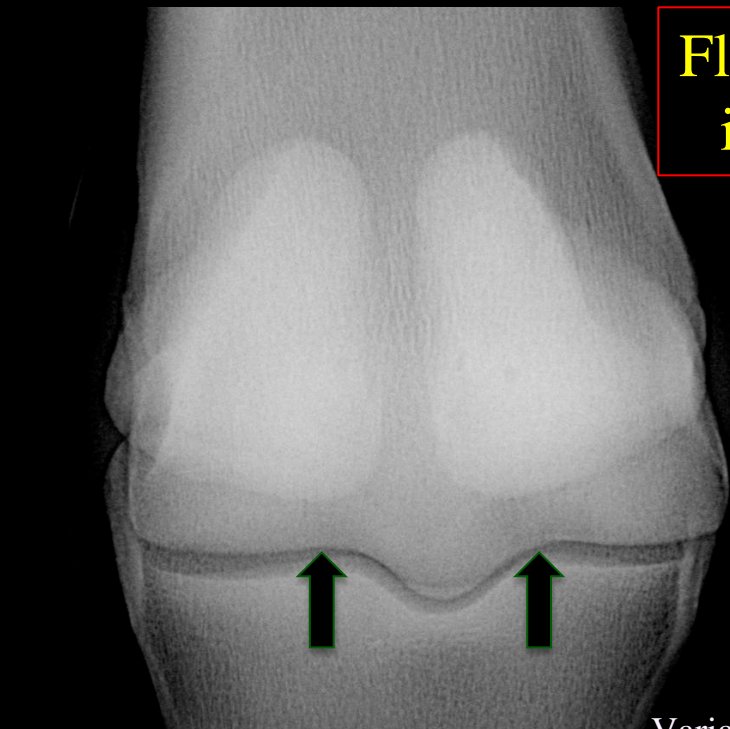
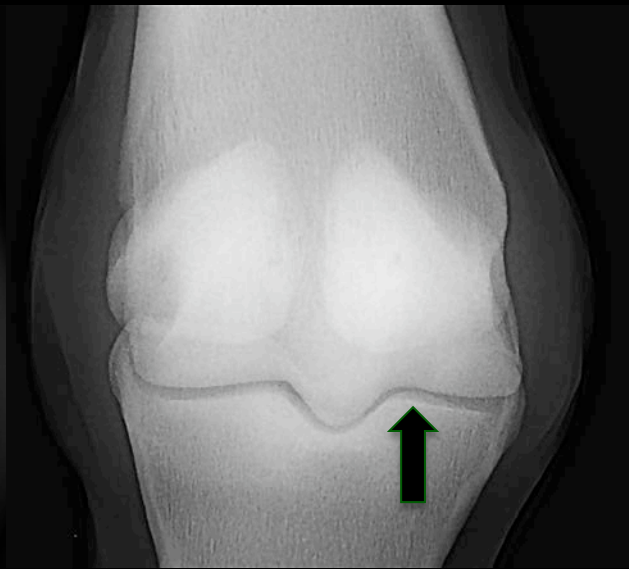
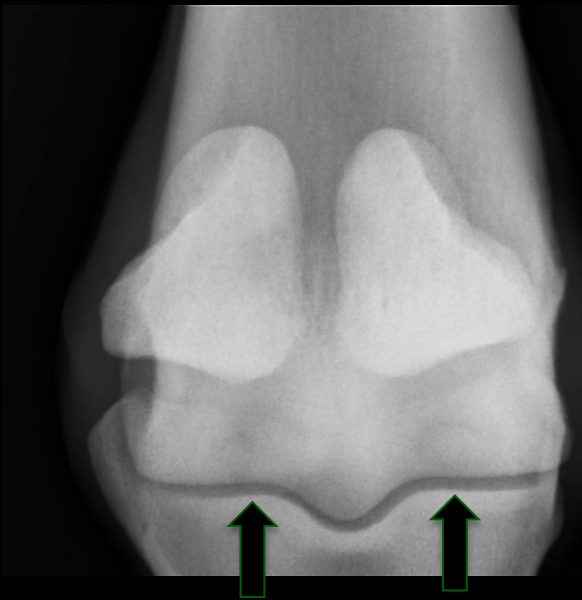
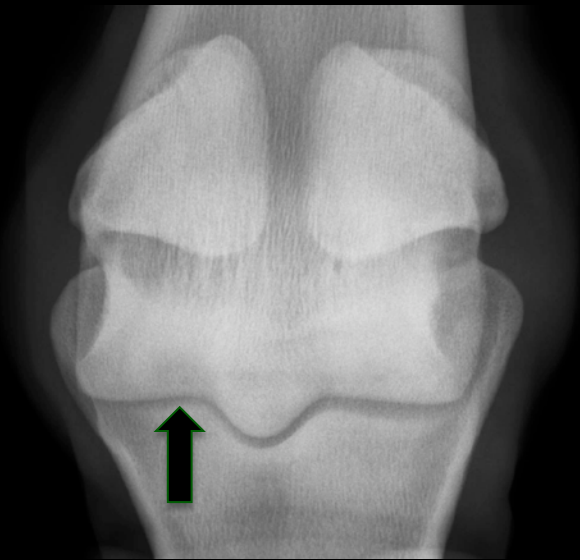


# Distal Cannon Bone Inflammation

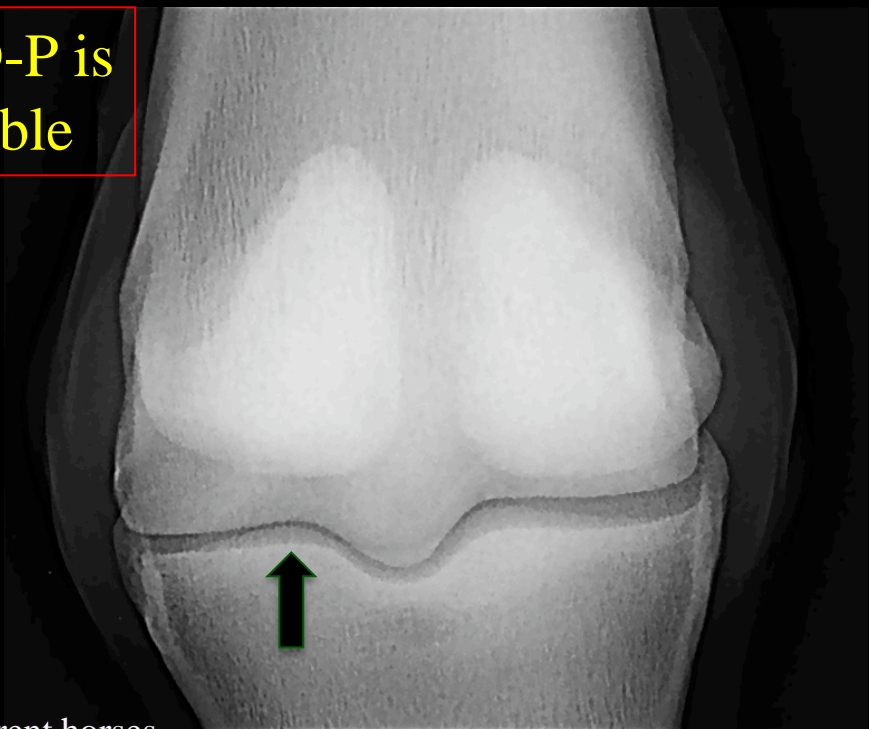
## How Should You Diagnose It?

- History
- Characteristic Lameness
- Nuclear Scintigraphy
- Pain on Flexion
- Radiography
- MRI
- Diagnostic Local Anesthesia



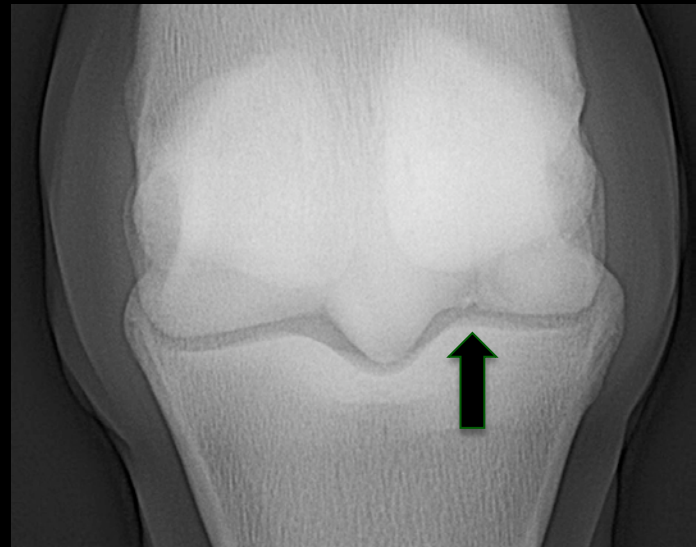
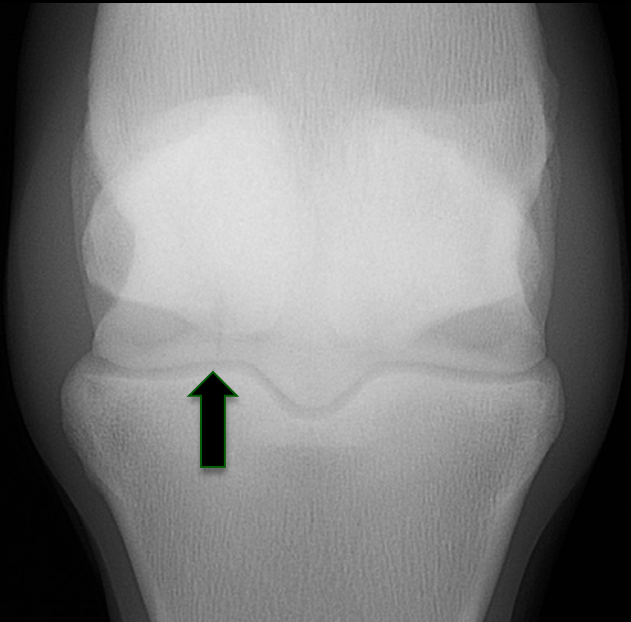
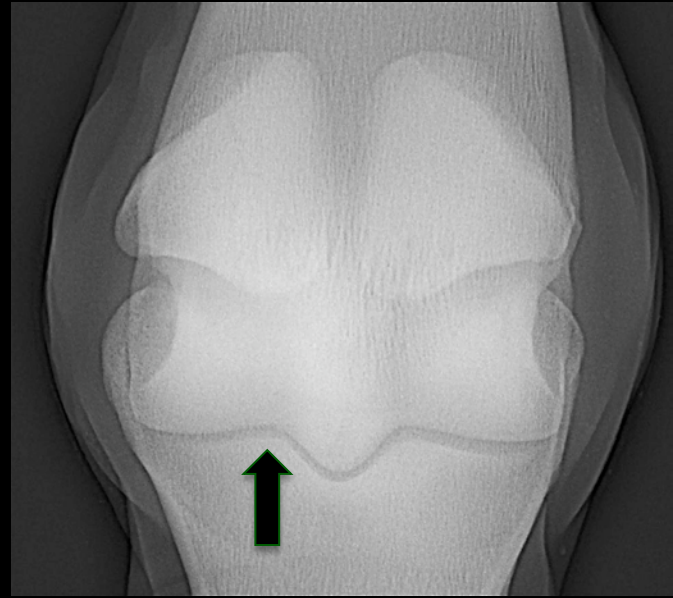
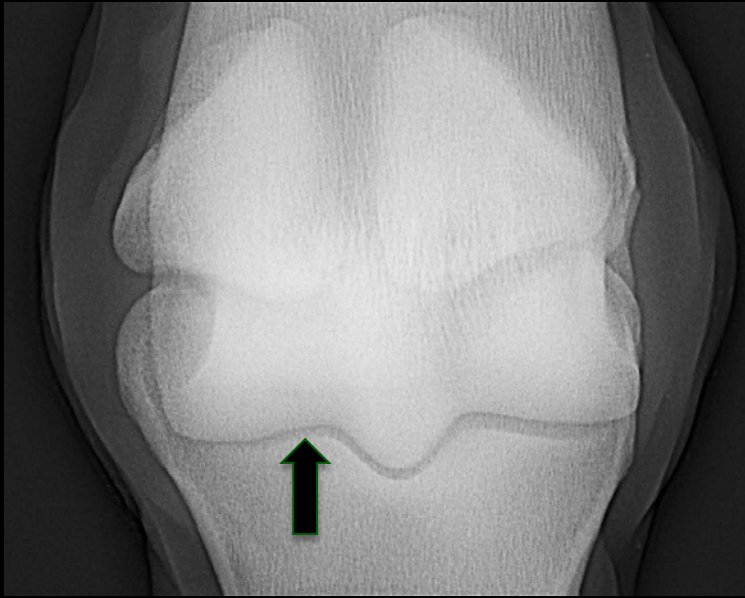


Flexed D-P is  
invaluable



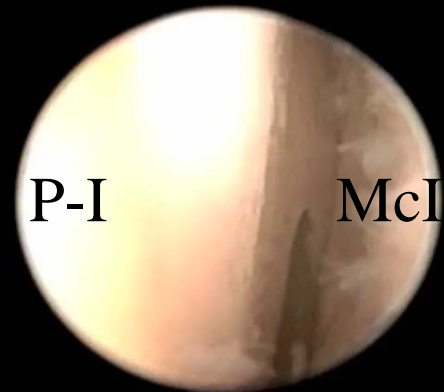
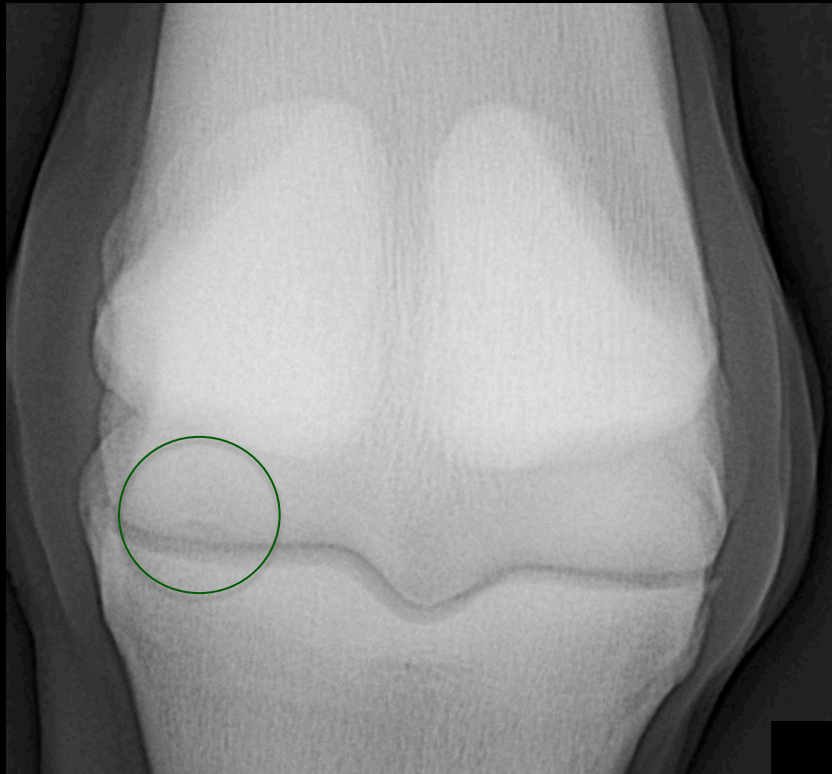
Variations, different horses



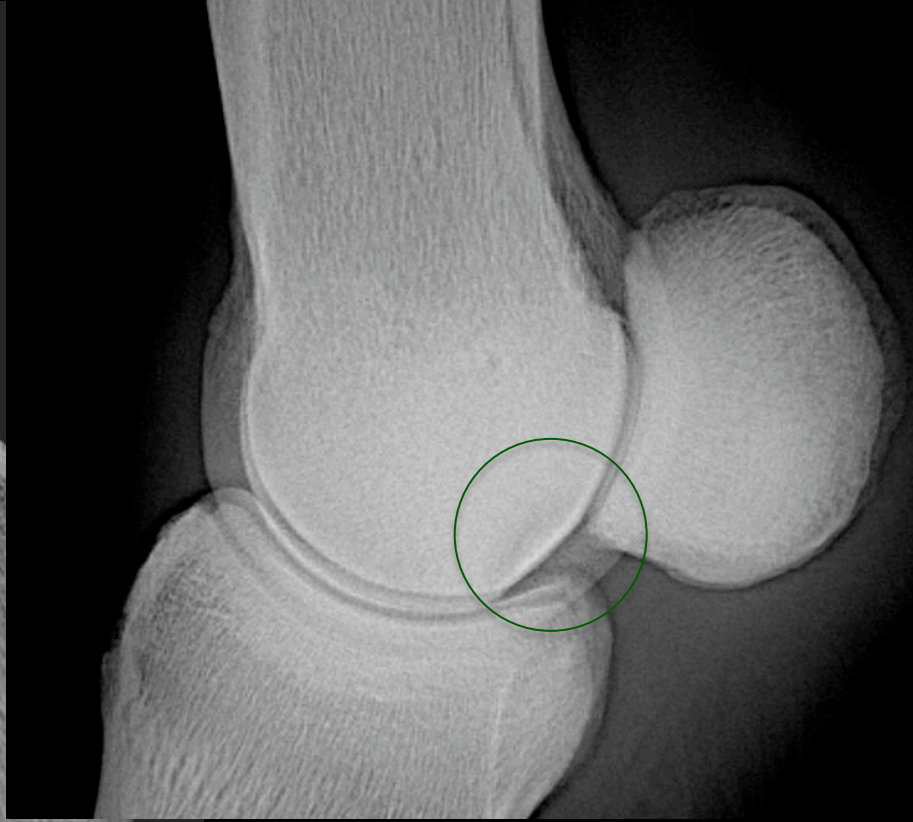
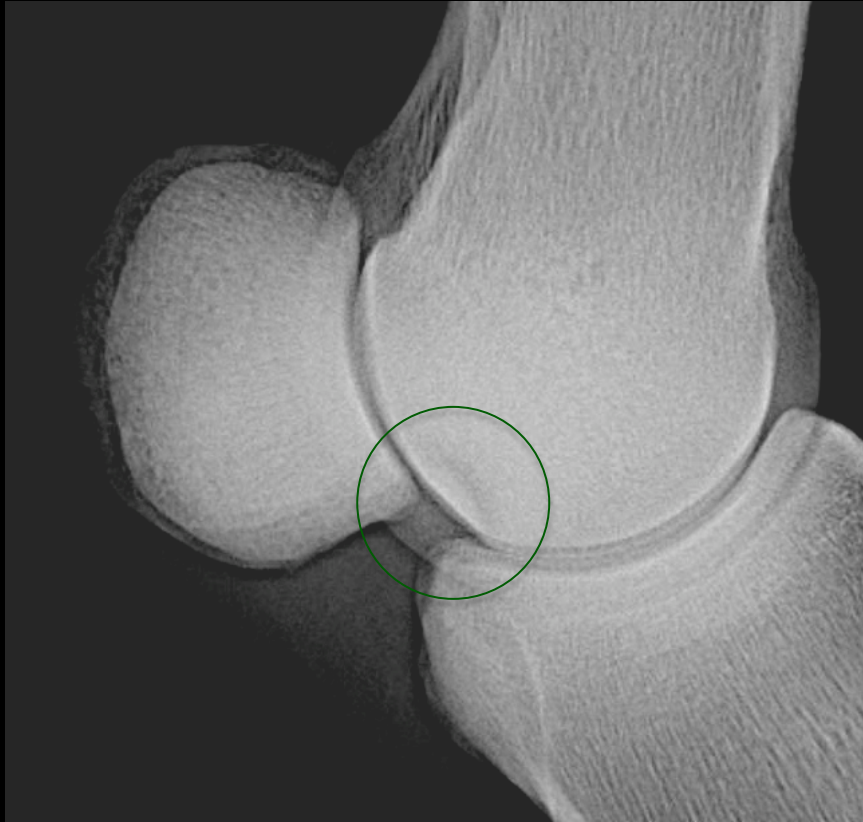


Variations, same horse

# Palmar distal cannon bone



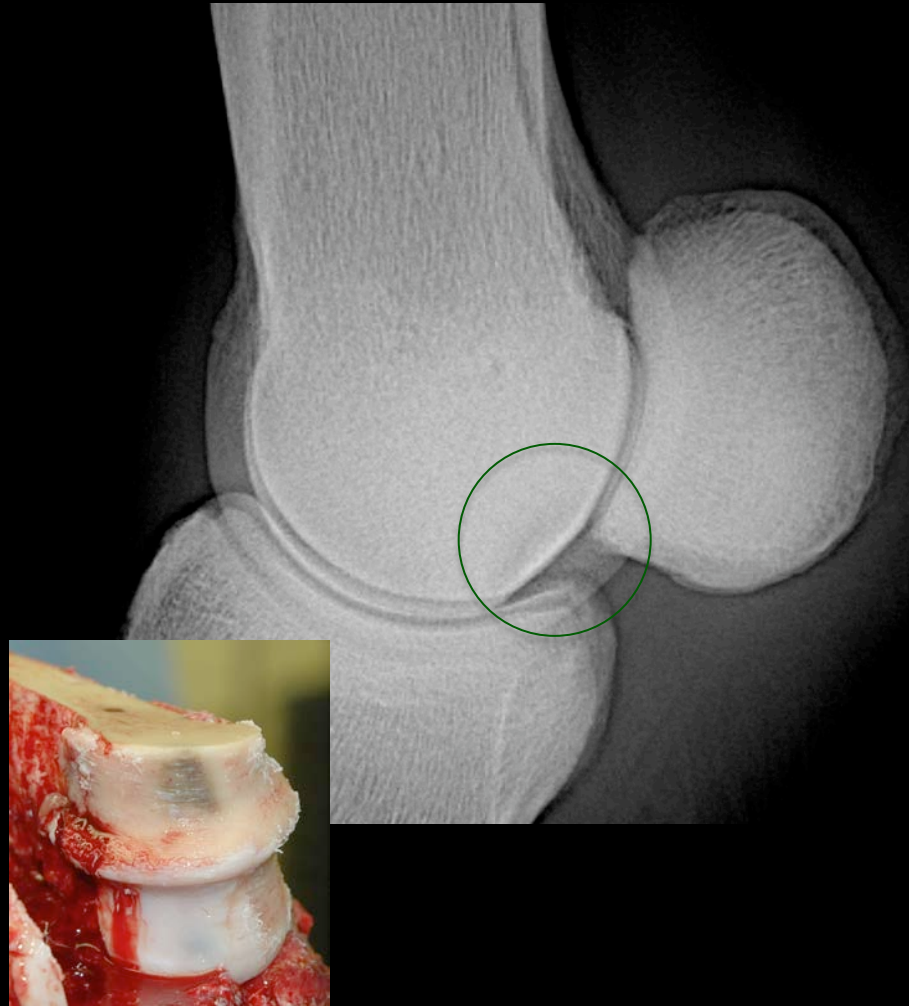
# Palmar distal cannon bone



# Diseases of the McIII/MtIII Articulation

*Palmar McIII/Plantar McIII – Sesamoid Articulation*  
*Inflammation of the distal cannon bone*

- The bone's response to the trauma is likely normal
- The bone's ability to respond with the way we manage horses is slowed
- Damage just accumulates faster than the horse can respond



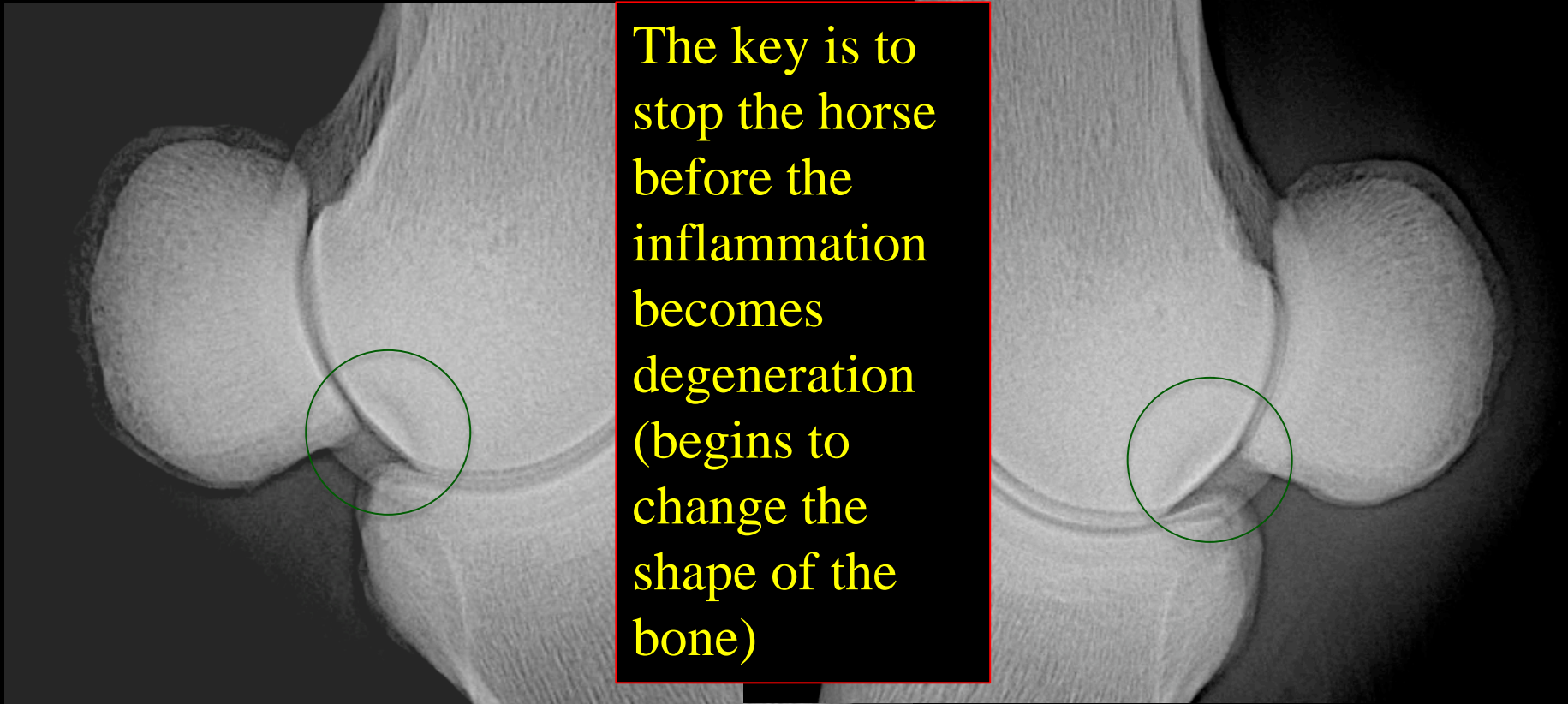
# Diseases of the McIII/MtIII Articulation

*Palmar McIII/Plantar McIII – Sesamoid Articulation*  
*Inflammation of the distal cannon bone*

- How do we treat it?
- Encourage normal bone remodeling
  - Nothing compares to paddock turnout
- Many of our bone remodeling diseases are the result of the way we manage training horses



# *Inflammation of the distal cannon bone*



– Prognosis ?

**Journal of the American Veterinary Medical Association**

*May 15, 2011, Vol. 238, No. 10, Pages 1316-1322*

*doi: 10.2460/javma.238.10.1316*

**Racing prognosis after cumulative stress-induced injury of the distal portion of the third metacarpal and third metatarsal bones in Thoroughbred racehorses: 55 cases (2000–2009)**

**Travis M. Tull, DVM, DACVS; L. R. Bramlage, DVM, MS, DACVS**

*Rood and Riddle Equine Hospital, 2150 Georgetown Rd, Lexington, KY 40580.*

# After 2-3 months in the paddock

## **Results**

Mean age was 3.2 years...Ninety-five percent (52/55) of horses with CSBI raced after injury...

There was no significant difference in post-injury total earnings, compared with total earnings before injury....

Median time to first start after injury was 194 days...

Previous studies that used various combinations of restricted activity and medication had 40% to 60% return to racing



# Man-made predilection to distal cannon bone injury

- Short periods of high intensity exercise with prolonged periods of stall rest



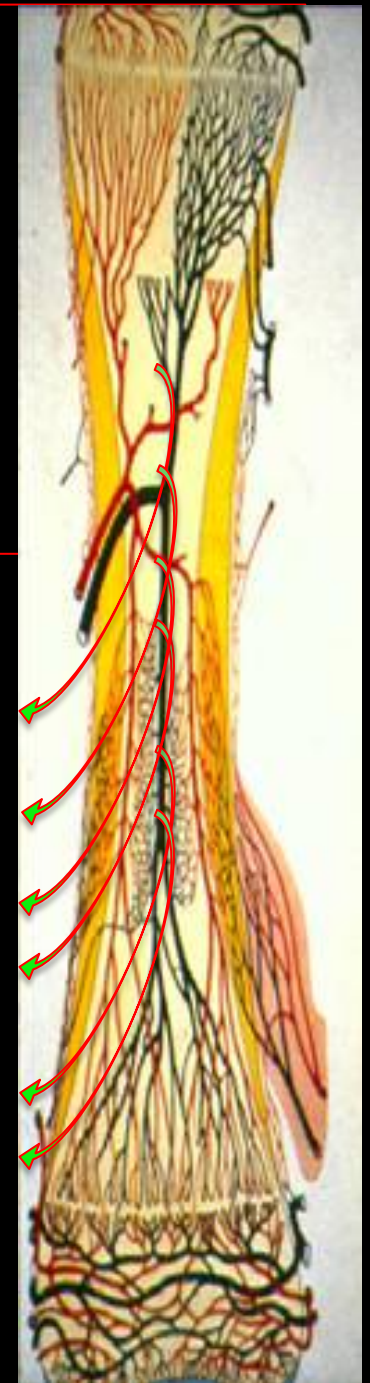
# Normal distal limb circulation most effective at its evolutionary optimum

- **Horses are grazing animals**
  - No venous valves in their limbs
  - They depend on motion for the return portion of circulation
  - As natural grazers they spend hours eating a few bites, then walk a few steps, then repeat .....



Bone circulation is:  
Limited  
Low pressure  
Medullary to periosteum in  
diaphysis

- Restricted exercise tends to cause stagnation of circulation
  - Stocking up
  - Increased incidence of remodeling diseases?



One of the reasons we have so many bone remodeling diseases is that we impede the natural response mechanism with our management practices

- High stress exercise
- Cool out and stand for hours



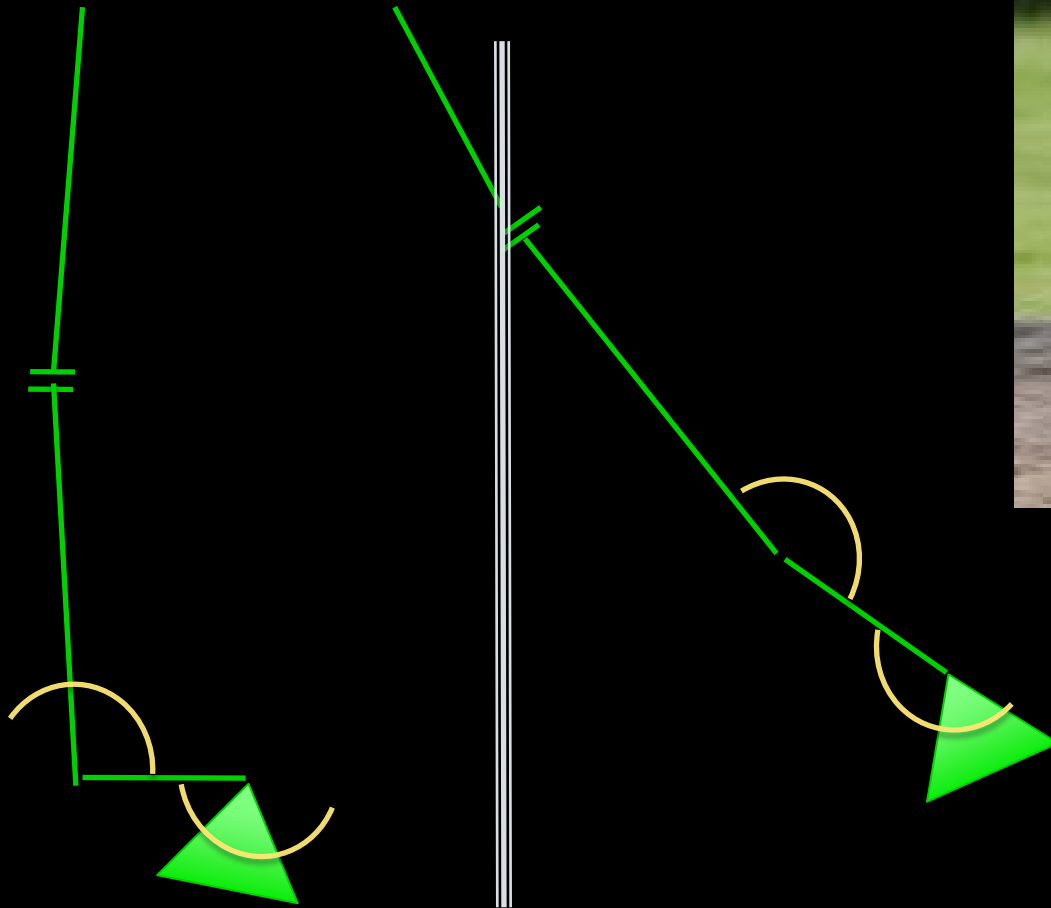
# Man-made predilection to distal cannon bone injury

- Shoeing appliances



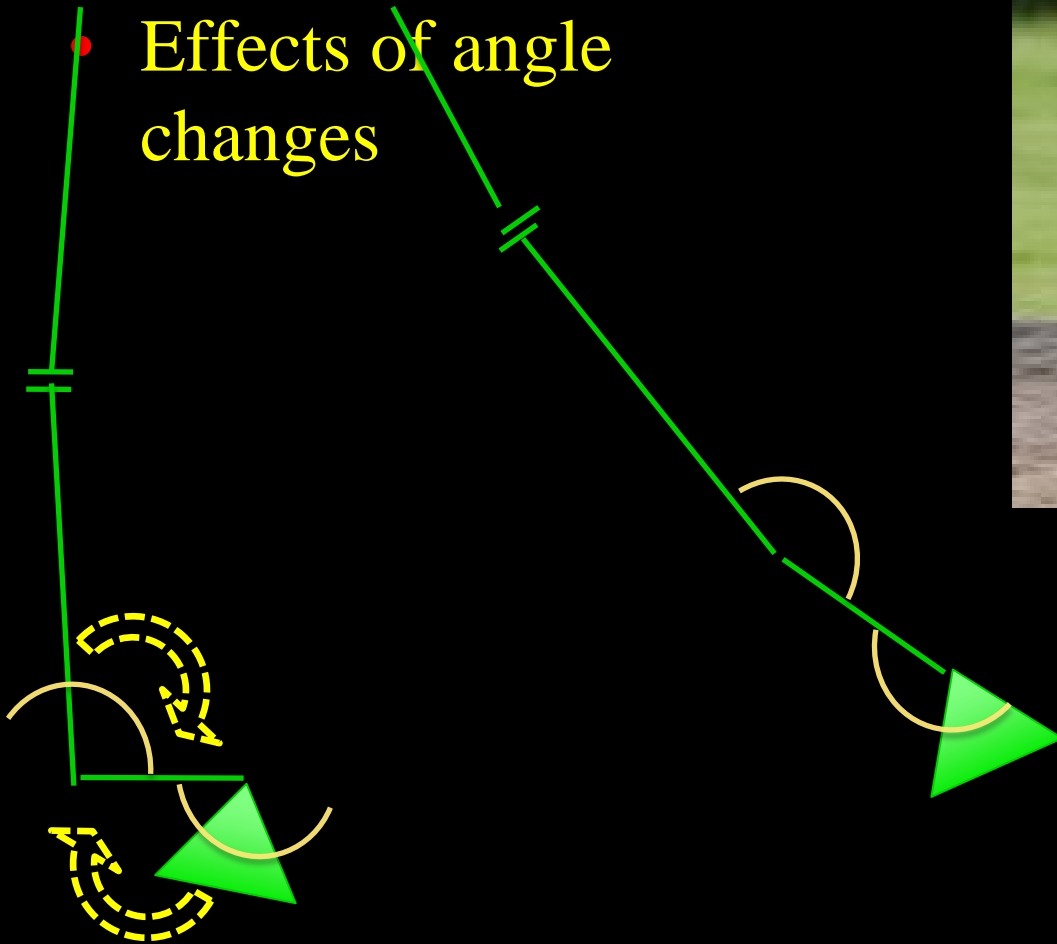
# Man-made predilection to distal cannon bone injury

- Shoeing appliances



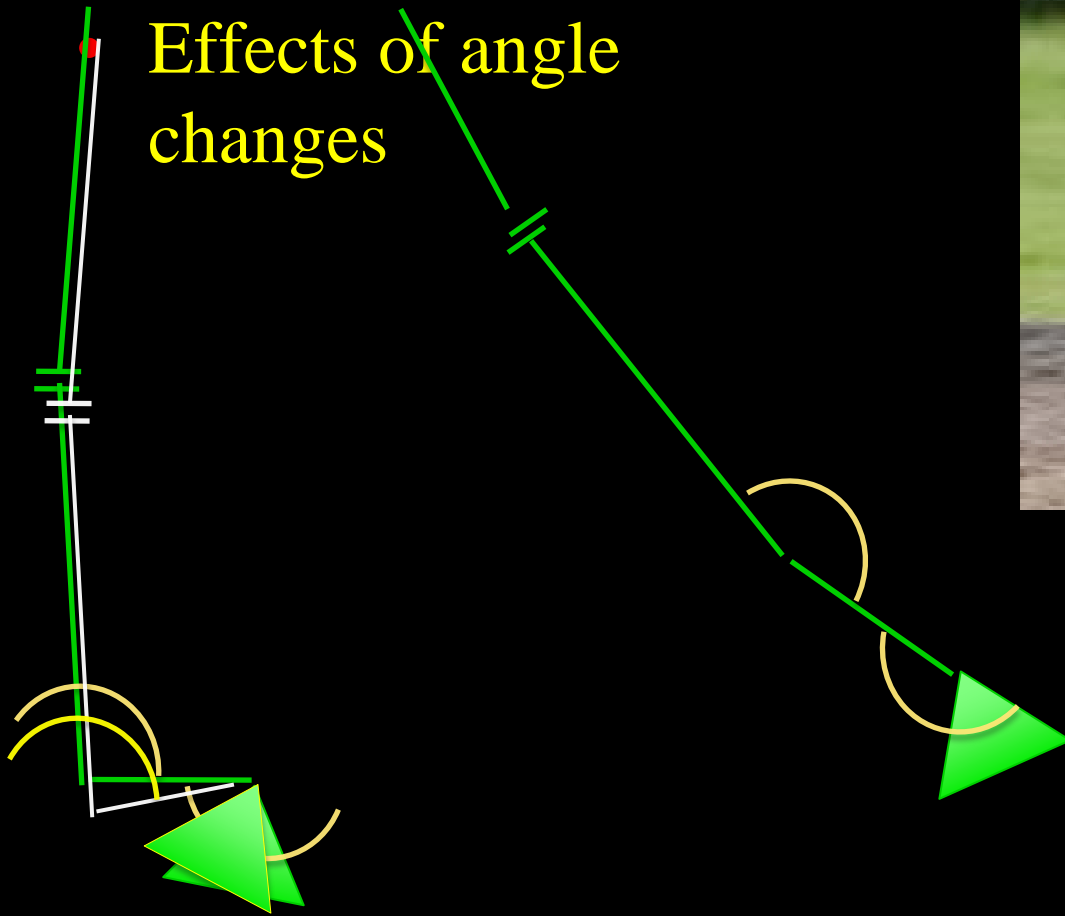
# Man-made predilection to distal cannon bone injury

- Effects of angle changes



# Man-made predilection to distal cannon bone injury

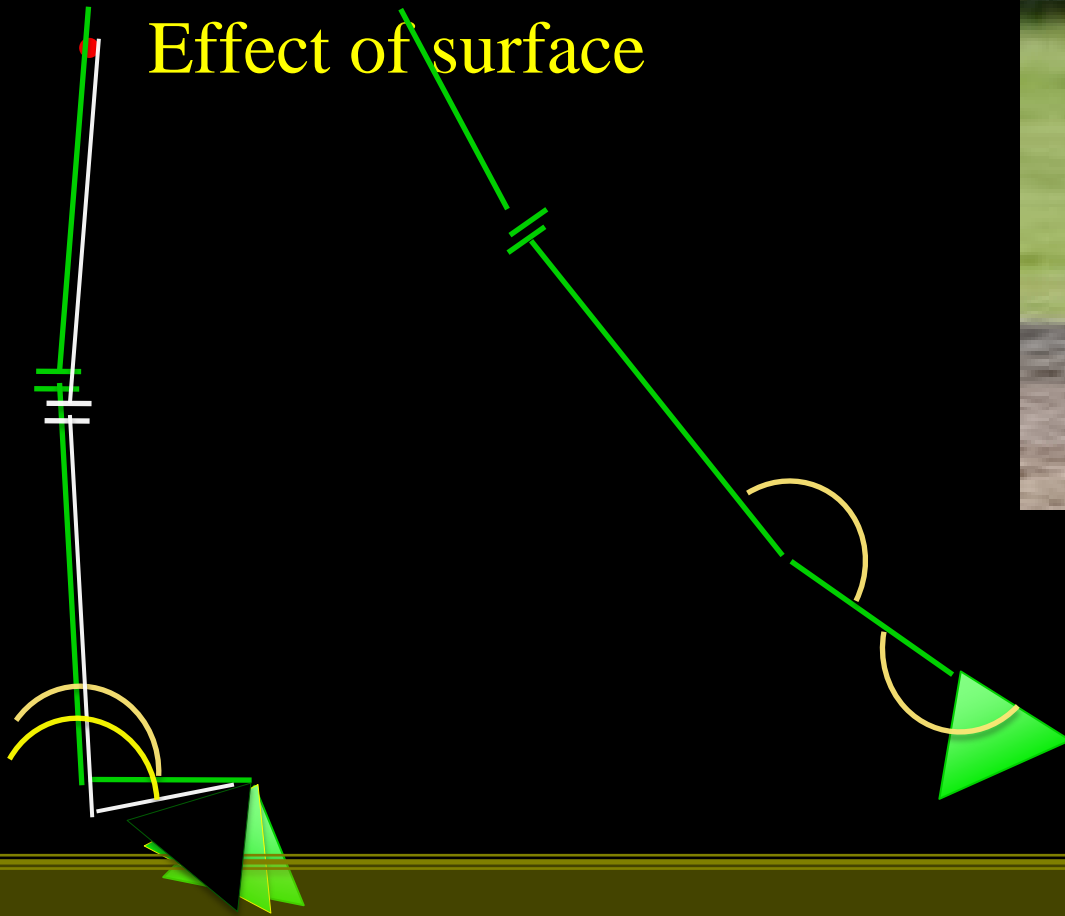
Effects of angle changes





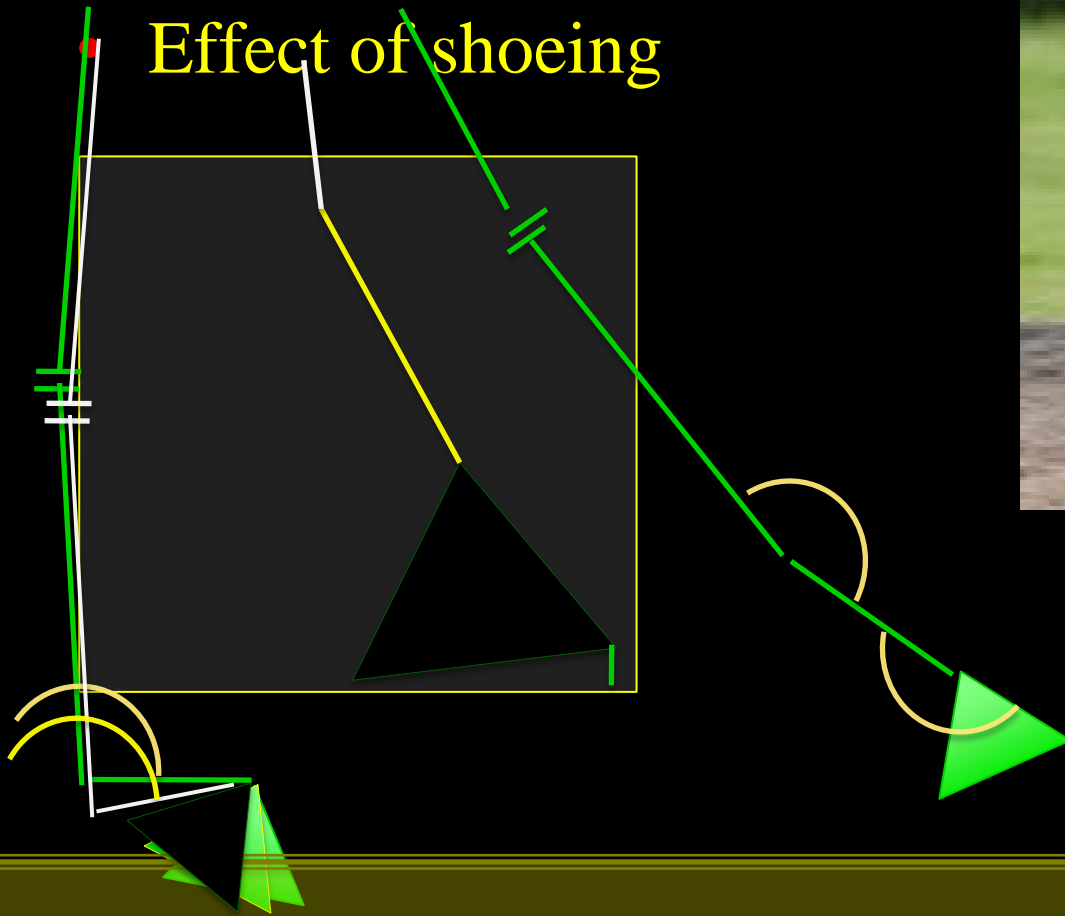
# Man-made predilection to distal cannon bone injury

Effect of surface



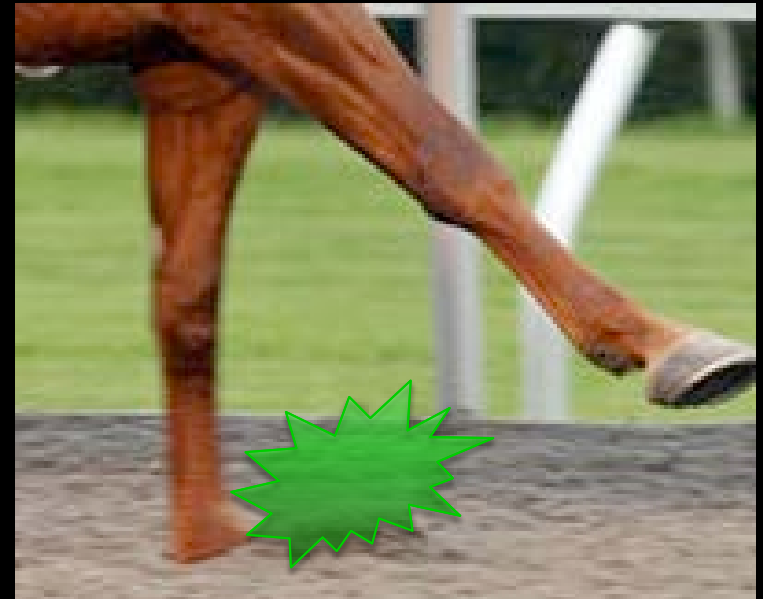
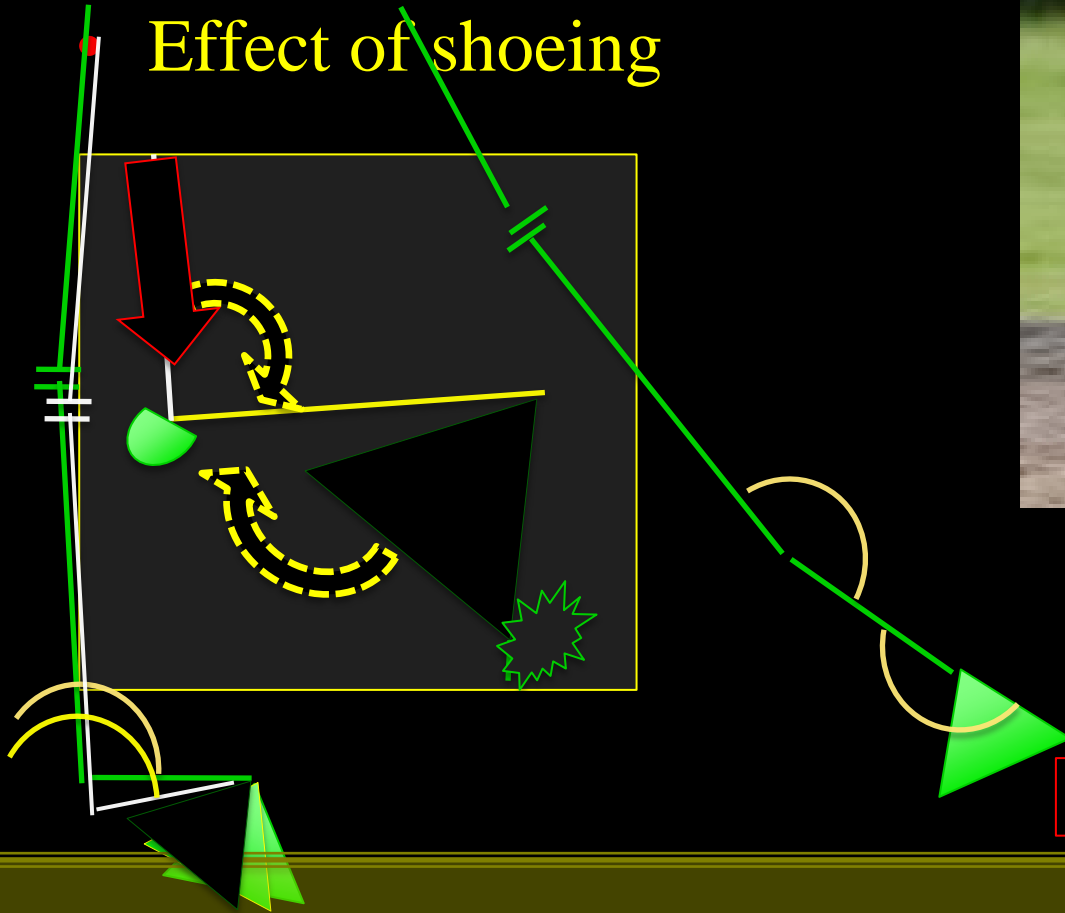
# Man-made predilection to distal cannon bone injury

Effect of shoeing



# Man-made predilection to distal cannon bone injury

## Effect of shoeing



Increased braking  
Increased "plow down"

Fatal injuries are 95% fetlock injuries

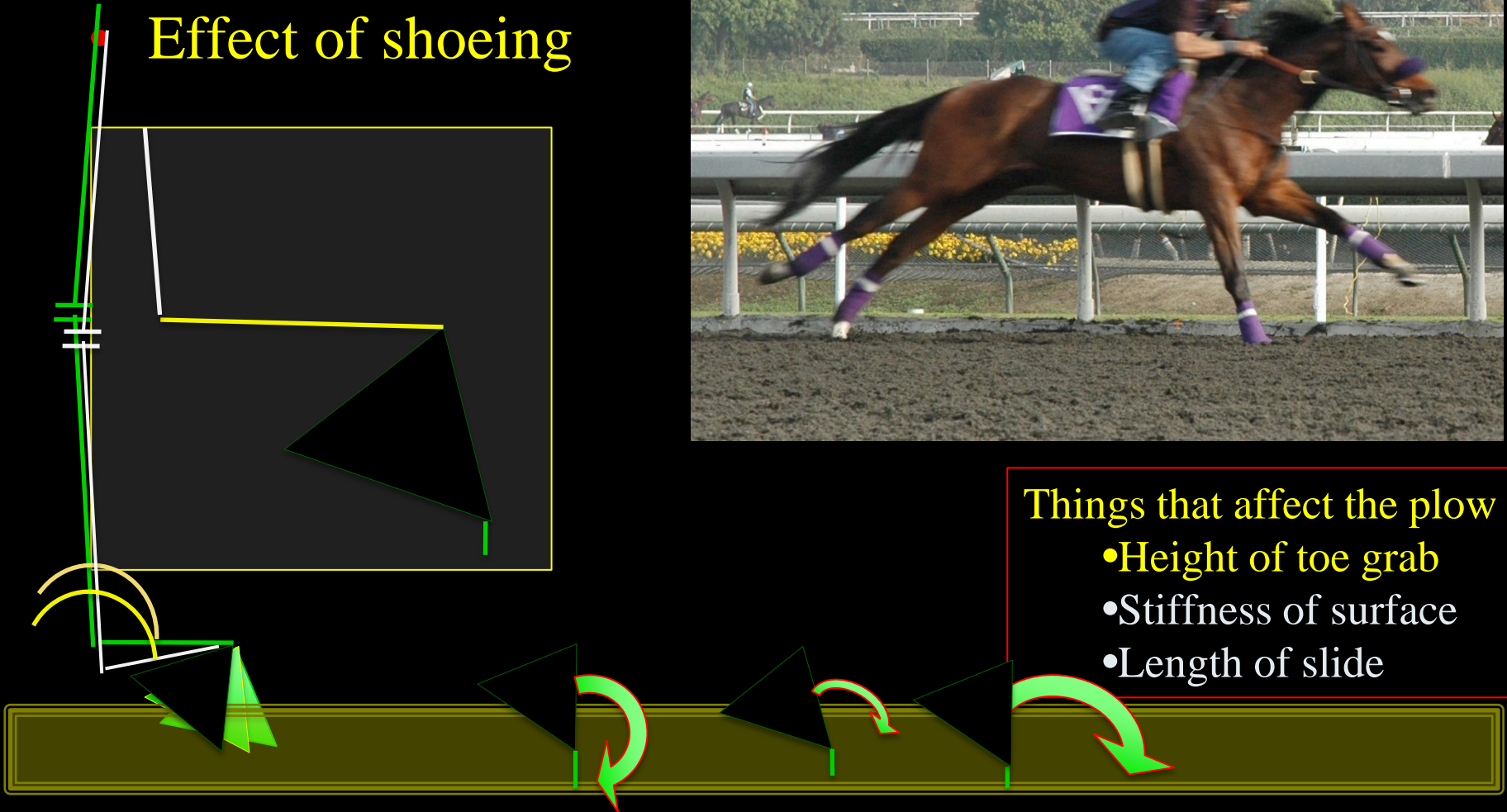
# Man-made predilection to distal cannon bone injury

## Effect of shoeing



## Things that affect the plow

- Height of toe grab
- Stiffness of surface
- Length of slide





So when a horse is lame, it is a sign that something is going on.

- Not all lameness is related to bone, but the dangerous ones are
- The ones that are are dynamic
- Just because radiographs are negative doesn't mean they will not change
- Many, most?, joint inflammation problems have bone components in the racehorse.
- The most painful problem is often not the most important problem

# Cautions

- When you start accumulating lots of high speed furlongs in short periods of time the skeleton gets behind.
- Few horses can stay in high level training continuously
- Be aware of the bone's role in causing joint inflammation
- Recurrent lameness is often the secondary problem, look for the root cause
- Lameness, especially multiple site lameness is a big cause of decreasing performance
- Attitude changes are very important

