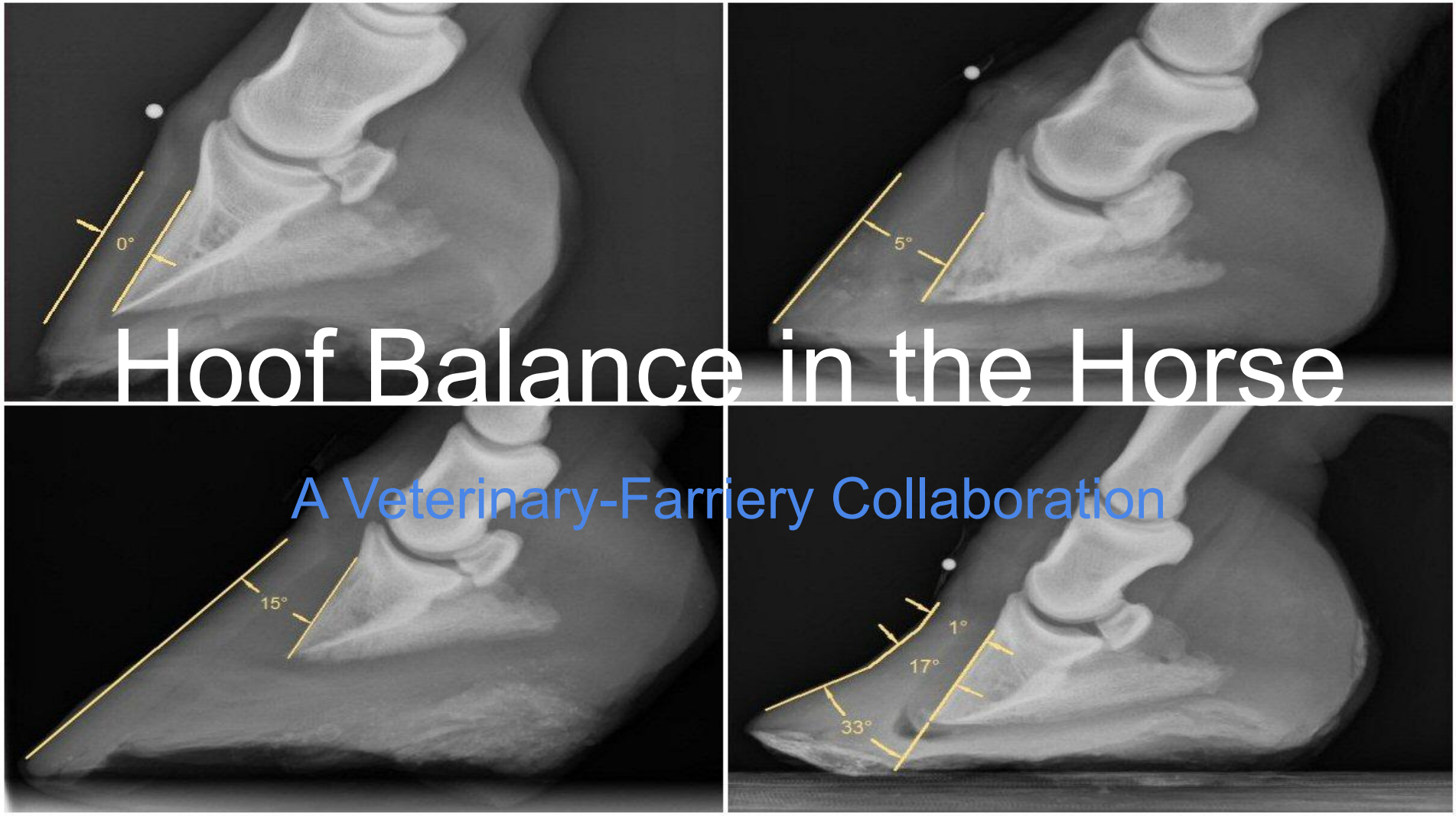
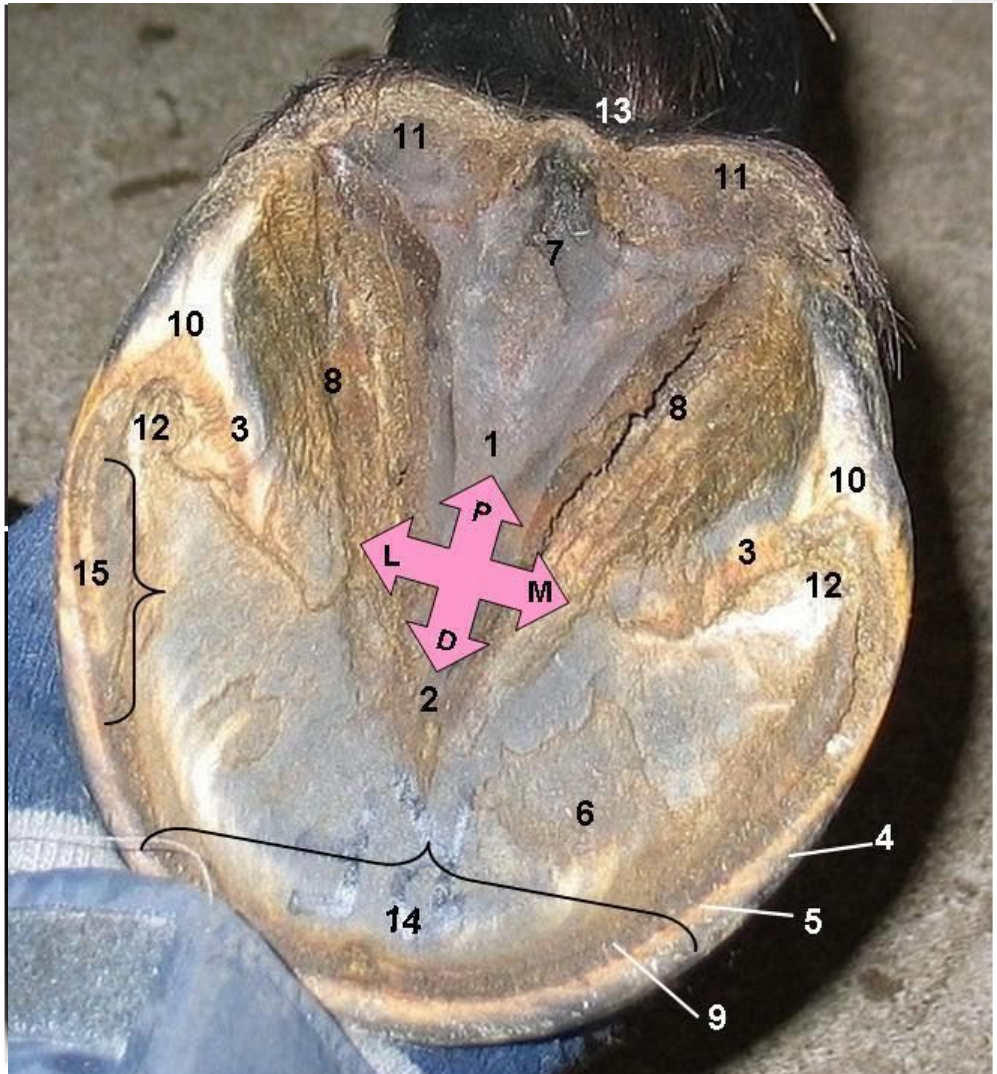


Hoof Balance in the Horse

A Veterinary-Farriery Collaboration



Anatomy of the Equine Hoof:

1. Frog
2. Frog Apex
3. Bars
4. Outer Wall (pigmented)
5. Inner Wall (un-pigmented)
6. Sole
7. Central Sulcus
8. Collateral Grooves
9. White Line
10. Angle of Bar, or "Heel Purchase"
11. Heel Bulbs
12. Seat of Corn
13. Digital Cushion (lies under, and behind frog)
14. Toe
15. Quarters (on both sides of foot)

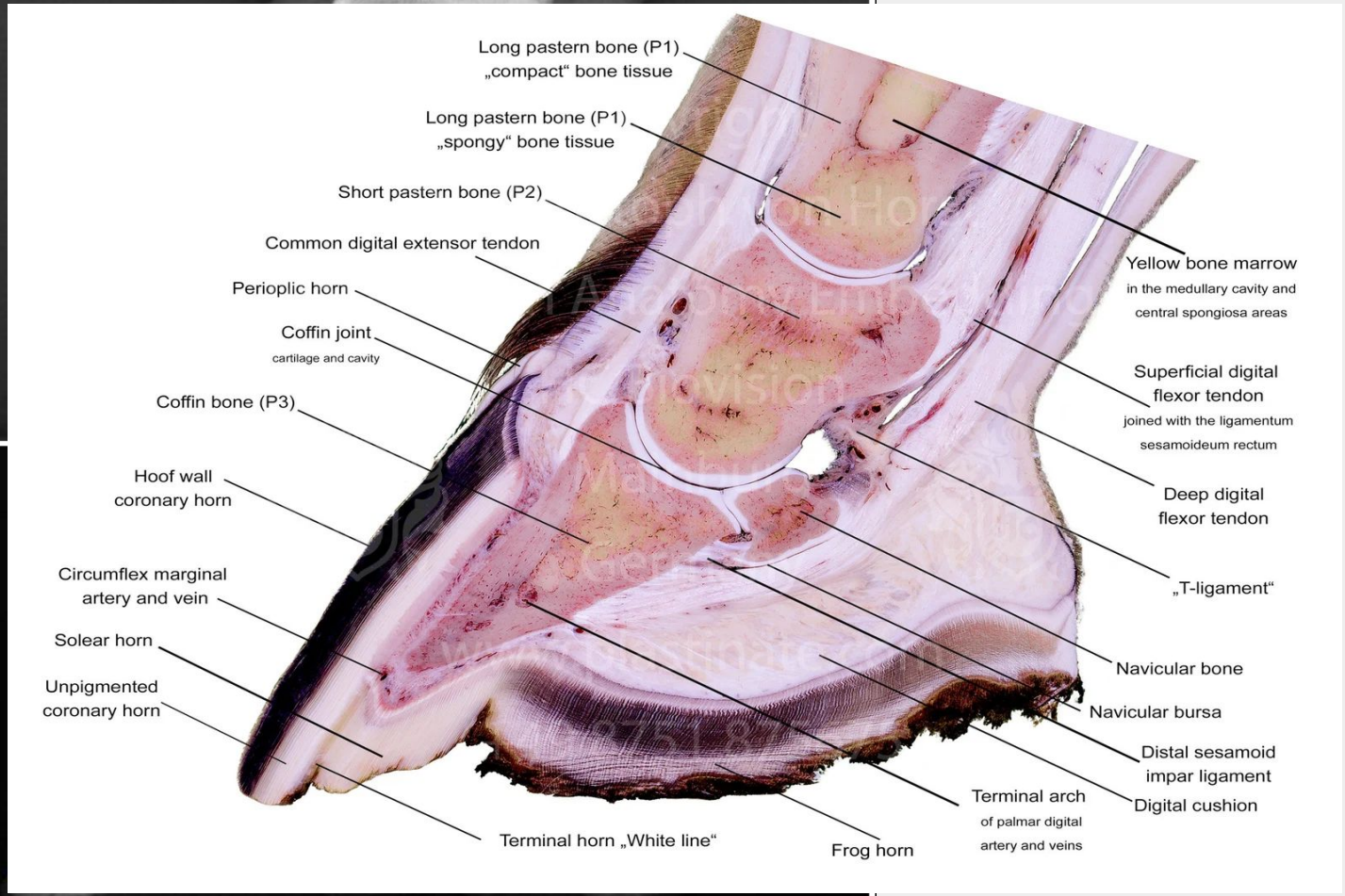
D=Dorsal (front of hoof)

P=Palmar (toward the heel)

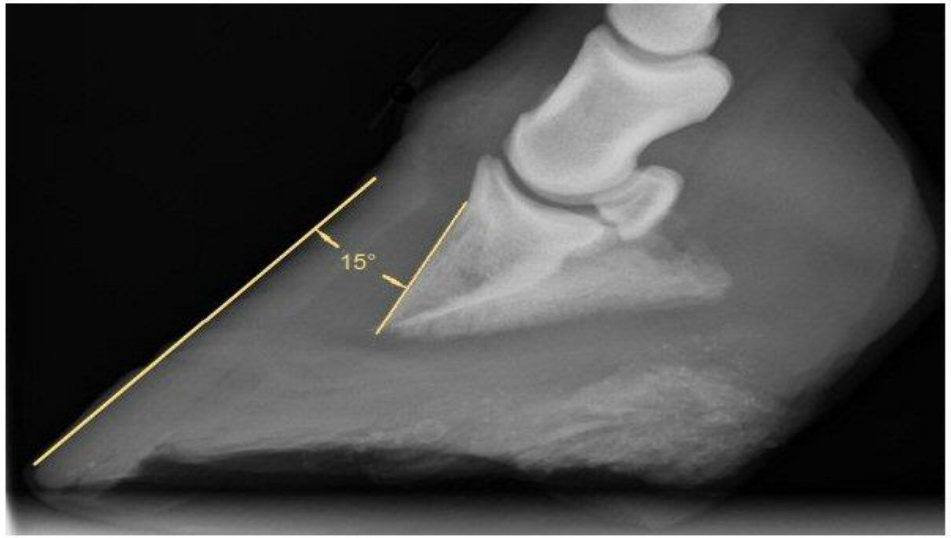
M=Medial (inside)

L=Lateral (outside)

Both vets and farriers see this

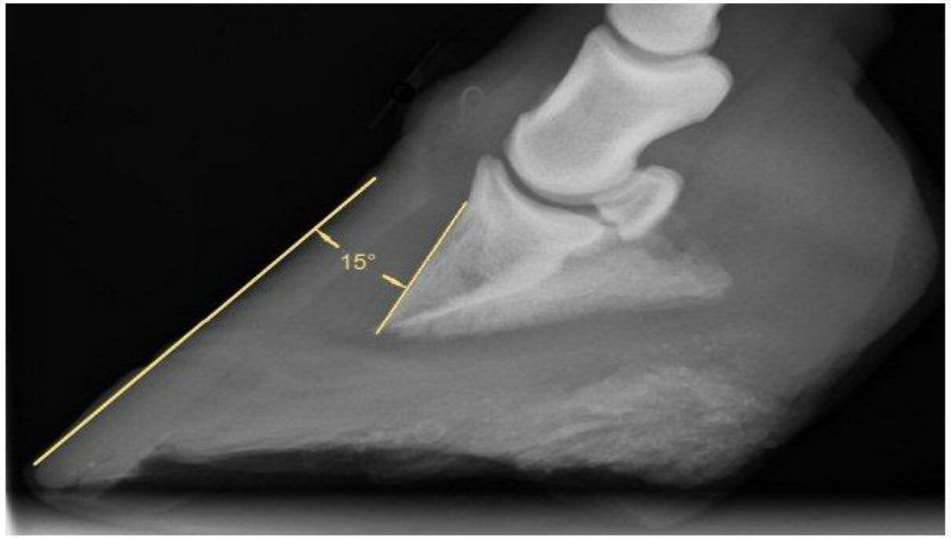


With radiography, MRI and CT we attempt to see this



Radiology is currently the most accessible technology to assess the foot

- “90% of lameness is in the foot”
- Corrective trimming (and shoeing when necessary), utilizing x-rays is the treatment for a large portion of these cases
- Corrective trimming/shoeing is also beneficial any distal limb injury

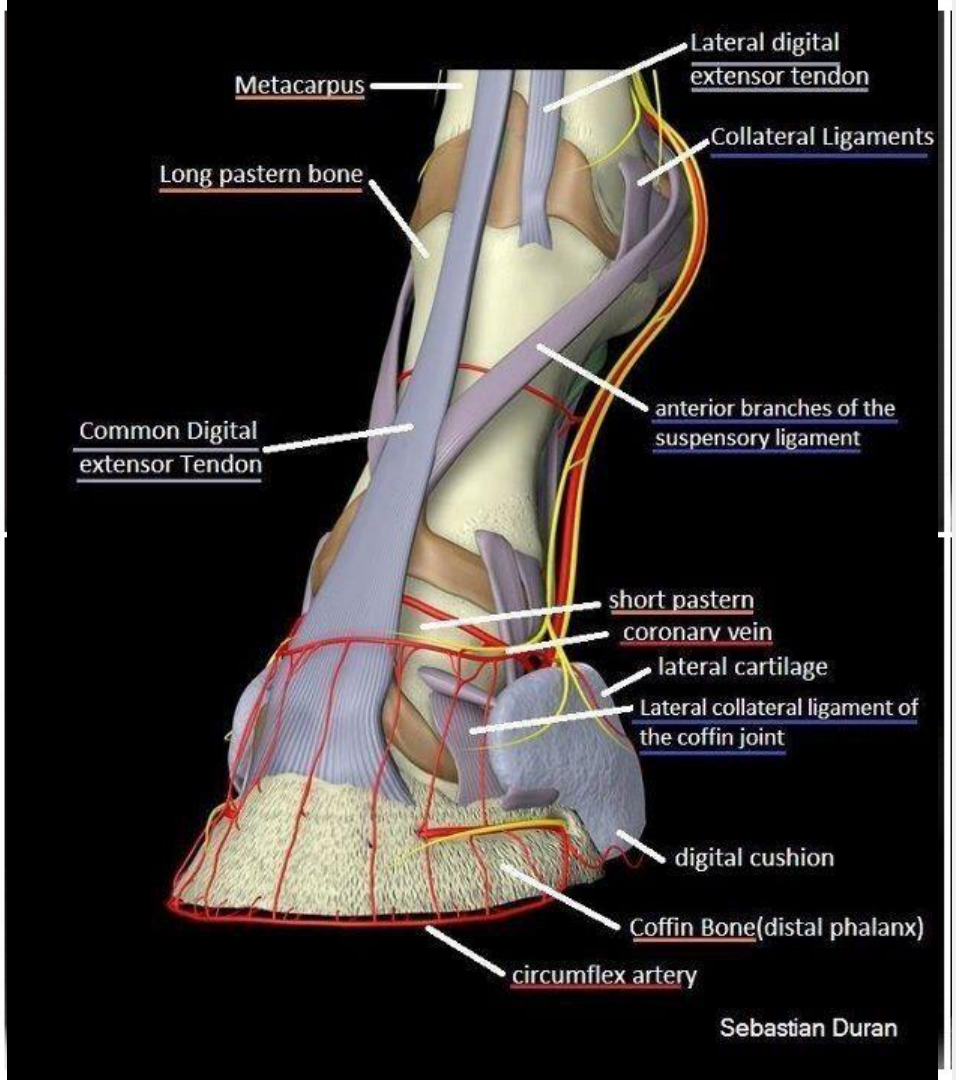


The pillars of hoof balance assessment

- Palmar/plantar angle
- Hoof-pastern-axis
- P3 position within hoof capsule
- Medial-lateral balance
- Breakover
- Sole depth

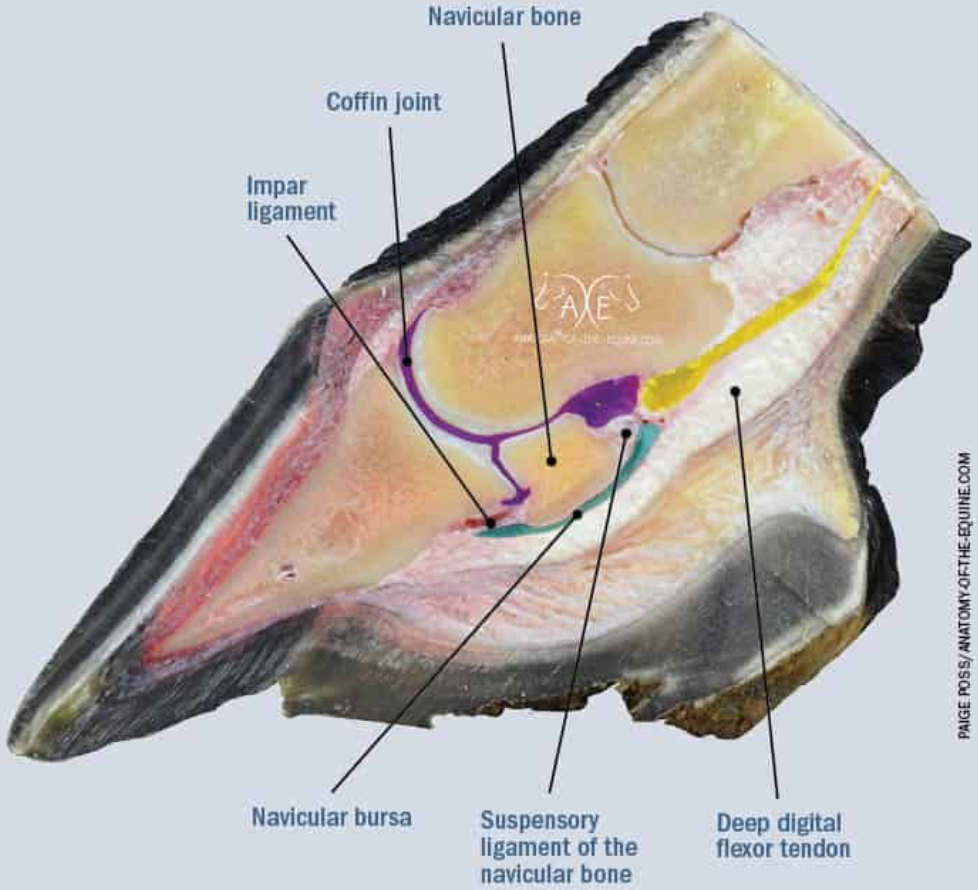
Other things we commonly assess

- Navicular bone
- P3 integrity- remodelling, lysis
- Coffin and pastern joint health
- Mineralization in impar or T ligaments, or DDFT
- Deep subsolar abscess tracts



Limitations/things we can't see with x-rays:

- Collateral ligaments of the coffin joint, extensor tendon, suspensory ligament, DDFT and SDFT insertions in the foot
- Impar and T-ligaments of the navicular
- Deep sole or P3 bruising cannot be definitively diagnosed
- Ungual cartilages
- Laminar inflammation cannot be appreciated unless P3 has moved



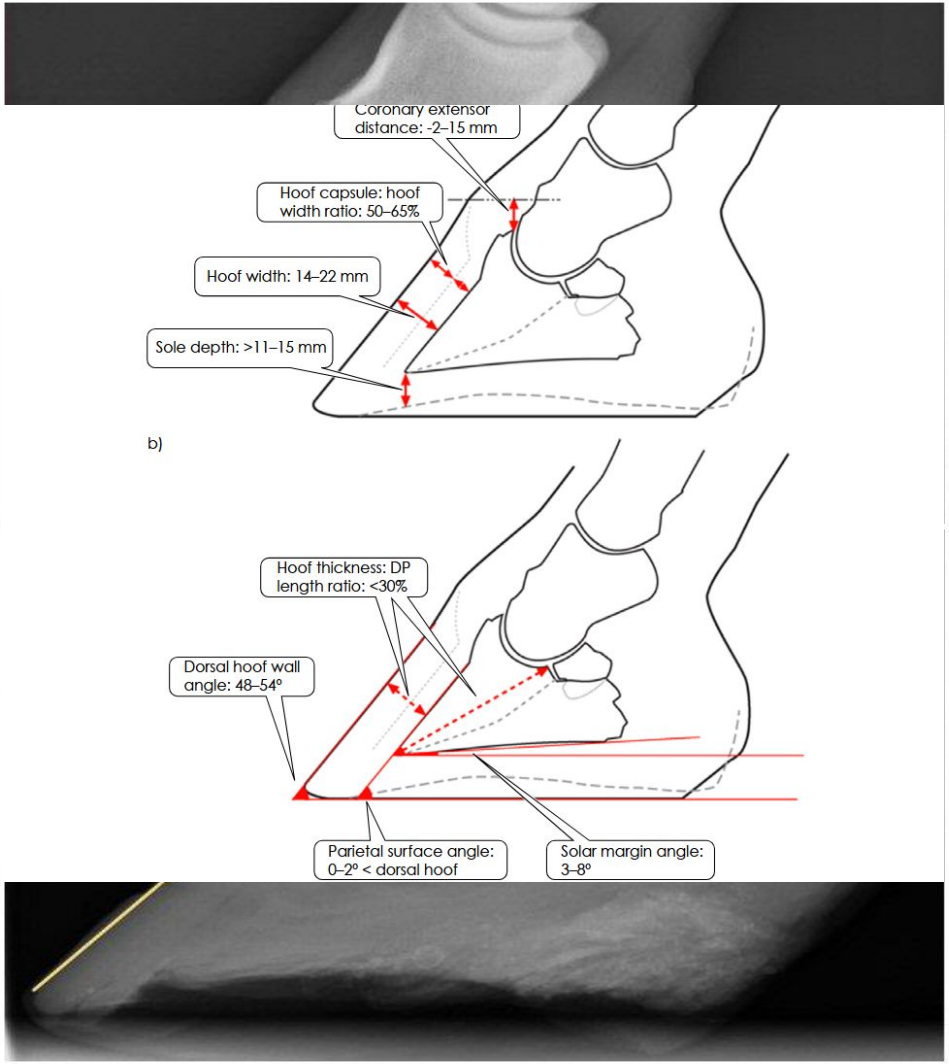
Limitations:

- Soft tissue structures within the hoof capsule (unless they are significantly mineralized)

**“Navicular syndrome” or caudal heel pain commonly involves soft tissue structures of the foot

Limitations:

- Vasculature - cannot be appreciate on standard radiology but with contrast medium = venogram
- Will talk a little more about this later



Ideal angles: Front foot

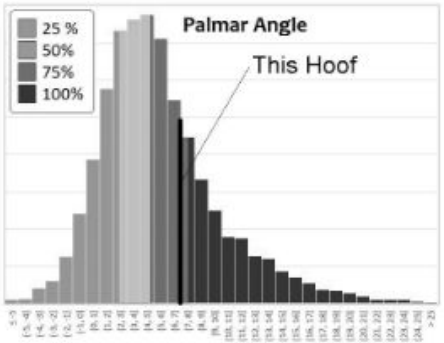
- Palmar angle: 5-7 deg *though >3 and <10 may be acceptable
- Sole depth: >1.1/1.5cm
- The dorsal hoof wall and P3 should be parallel (no P3 deviation)
- Coronary-extensor distance 2-15mm (no P3 sinking)
- The 3 pedal bones should align (HPA)
- ~58-65% of the weight-bearing surface should be dorsal to the middle of the coffin joint
- Dorsal hoof wall angle: 48-54 deg

Ideal angles: Hindfoot

- Very similar to front foot, except the plantar angle can be up to -2 deg and still be normal
- Which also means dorsal hoof wall angles variation of normal is also greater
- The HPA is more acute in HL's, but this is also very dependent on breed and an individual horse's conformation
- Laminitis is a lot less common in hind feet but does occur

***The difference in prevalence is likely due to different biomechanics* (Leise et.al 2012)

The Palmar Angle measurement helps to assess the dorso-palmar balance of the hoof. Horses with low palmar angle tend to be 'low at the heel', and horses with high palmar angle tend to be 'high at the heel'. No one value is 'correct' for all animals, but extreme values are to be avoided.



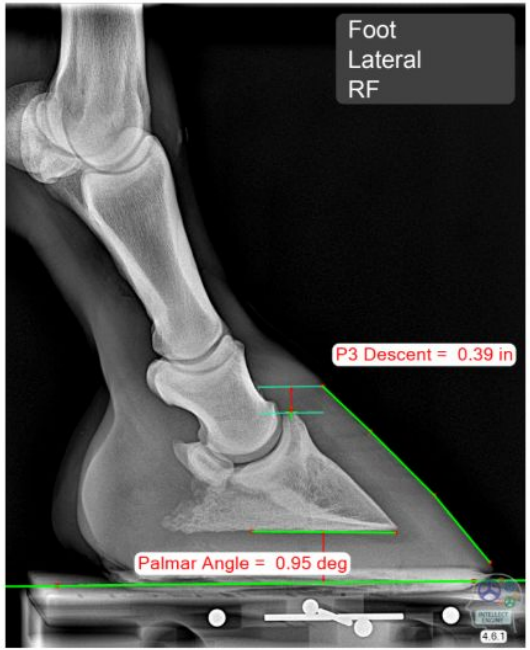
The Palmar Angle for this hoof is 6.9 degrees. This value is indicated on the histogram to the left by the vertical black line labelled 'This Hoof'. Angles substantialy higher or lower than normal are to be avoided, if possible.

The Palmar Angle is in the 3rd quartile when compared to a large group of horses.

Data from 6,968 hooves of mixed breed.

Metron: AI Tech/Angle Assessment

- New radiographic unit
- Designed by a veterinarian
- Software assists in evaluating angles and compares them to data in its system
- This allows vets to compare that horse with many other variations of normal quickly



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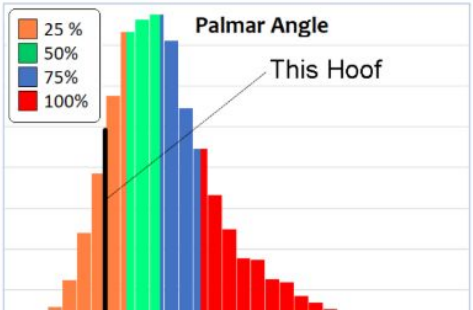
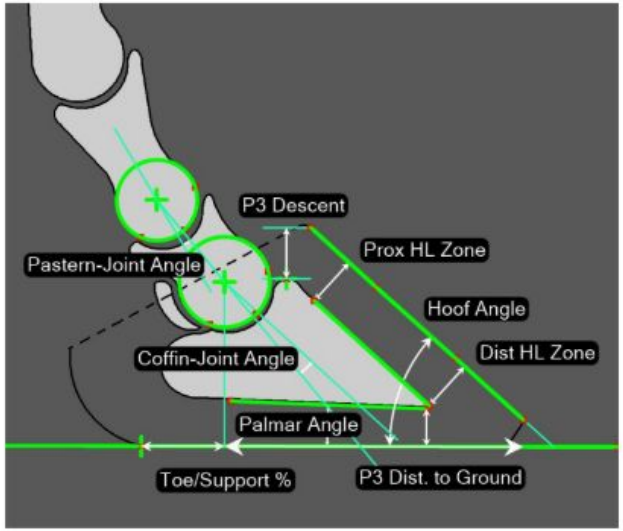


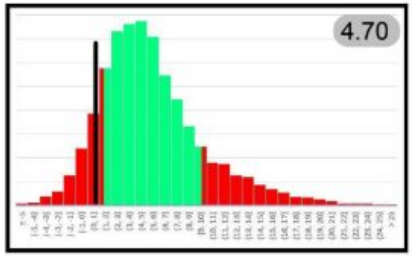
The Palmar Angle for this hoof is 1.0 degrees. This value is indicated on the histogram to the left by the vertical black line labelled 'This Hoof'. Angles substantialy higher or lower than normal are to be avoided, if possible.

The Palmar Angle is in the 1st (low) quartile when compared to a large group of horses.

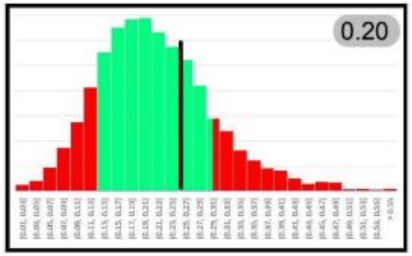
- Foot blocks for Metron system have markers within in them that allow for more accurate calibration
- Angle measurements are more accurate
- AI analysis creates a report

1.	Palmar Angle	0.8 deg
2.	P3 Descent	0.41 in
3.	P3 Dist. to Ground	0.75 in
4.	Hoof Angle	44.2 deg
5.	Prox. HL Zone	0.71 in
6.	Dist. HL Zone	0.73 in
7.	Toe/Support %	70.1 %
8.	Coffin-Joint Angle	15.9 deg
9.	Pastern-Joint Angle	3.5 deg
10.	P2 Length	1.68 in

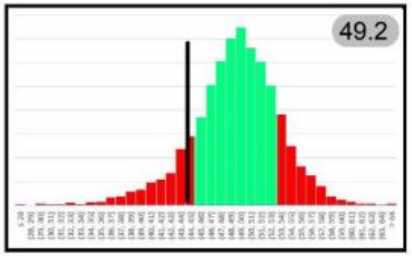




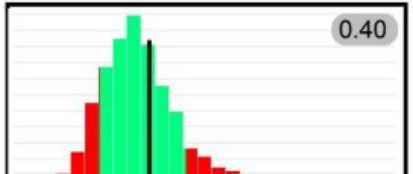
1. Palmar Angle

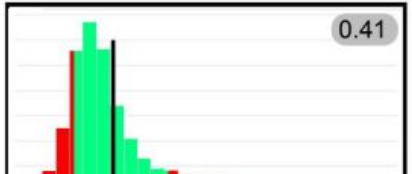


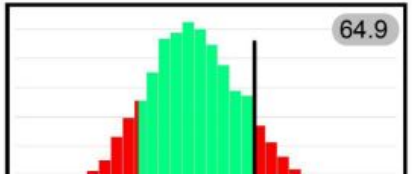
2. P3 Descent



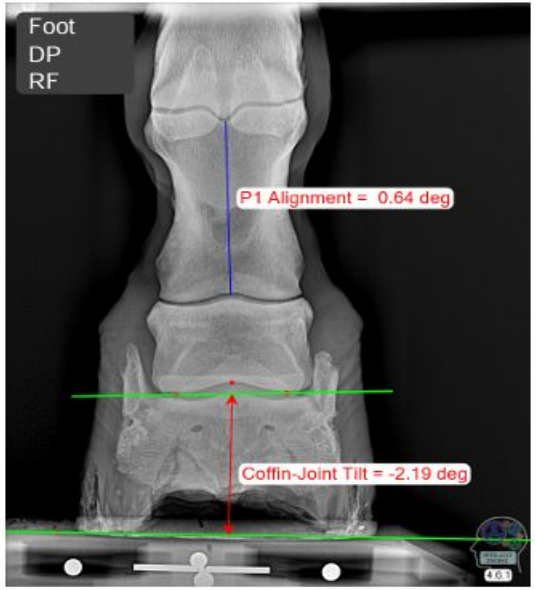
4. Hoof Angle



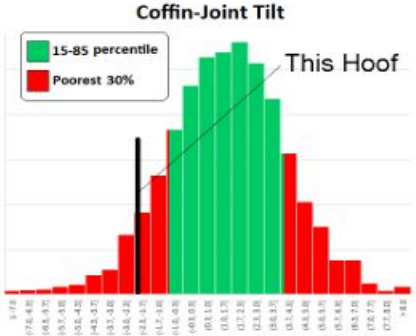




- More of the P3/hoof balance report
- We can ask it to give us more or less data depending on what we're concerned about



The Coffin-Joint Tilt measurement helps to assess the medial-lateral balance of the hoof. A value of zero occurs when the axis of rotation of the coffin-joint is parallel to ground. A positive value means 'medial heel lower'. The P1-alignment value is not related to the conformation of the hoof, but rather, gives a measure of how well aligned the radiographic appartus was. This value should be low (say, within +/- 3 degrees) in order to trust the Coffin-Joint Tilt value.

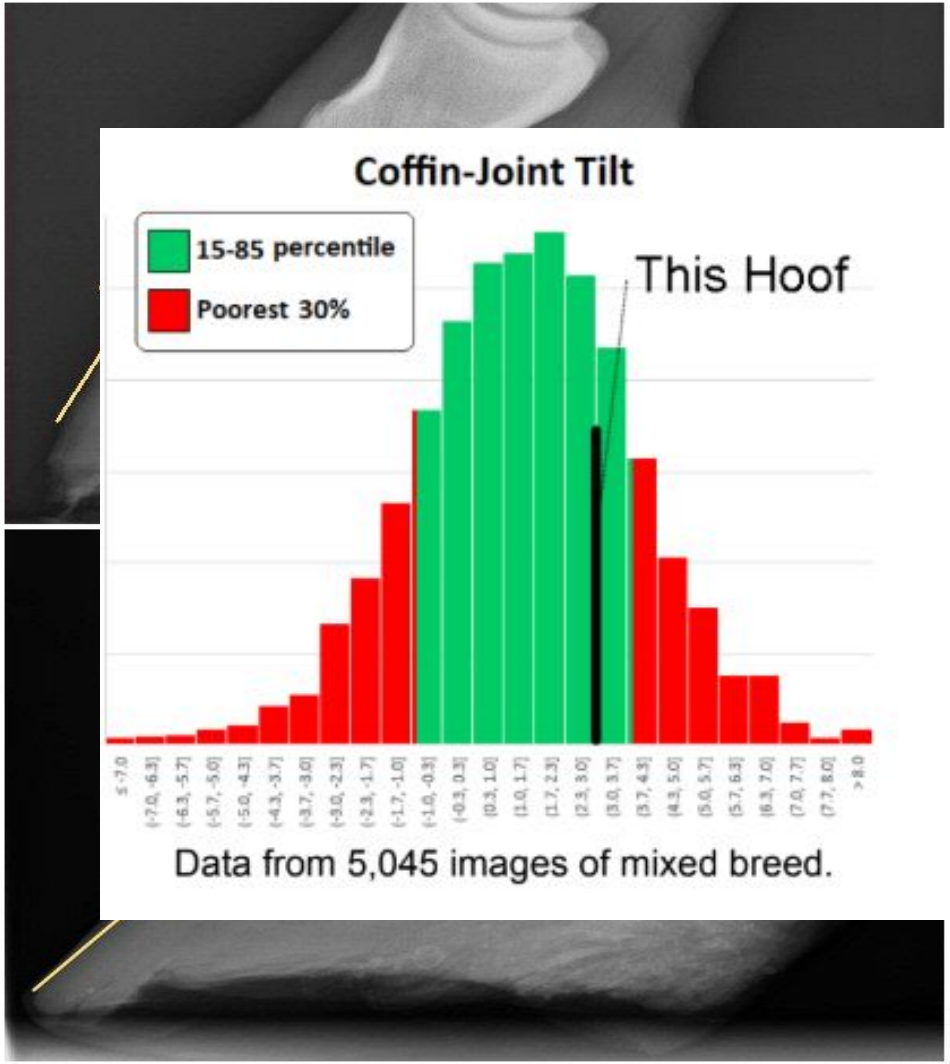


The Coffin-Joint Tilt for this hoof is -2.2 degrees. This value is indicated on the histogram to the left by the vertical black line labelled 'This Hoof'. It is preferred to be in the green zone. The red zone is far away from the norm.

The Coffin-Joint Tilt value is poor. Compared to a large population of horses, more than 70% of hooves have a better value than this hoof.

Link: Explanation of the Measures

- Dorsal-palmar
- Medial-lateral balance Metron analysis

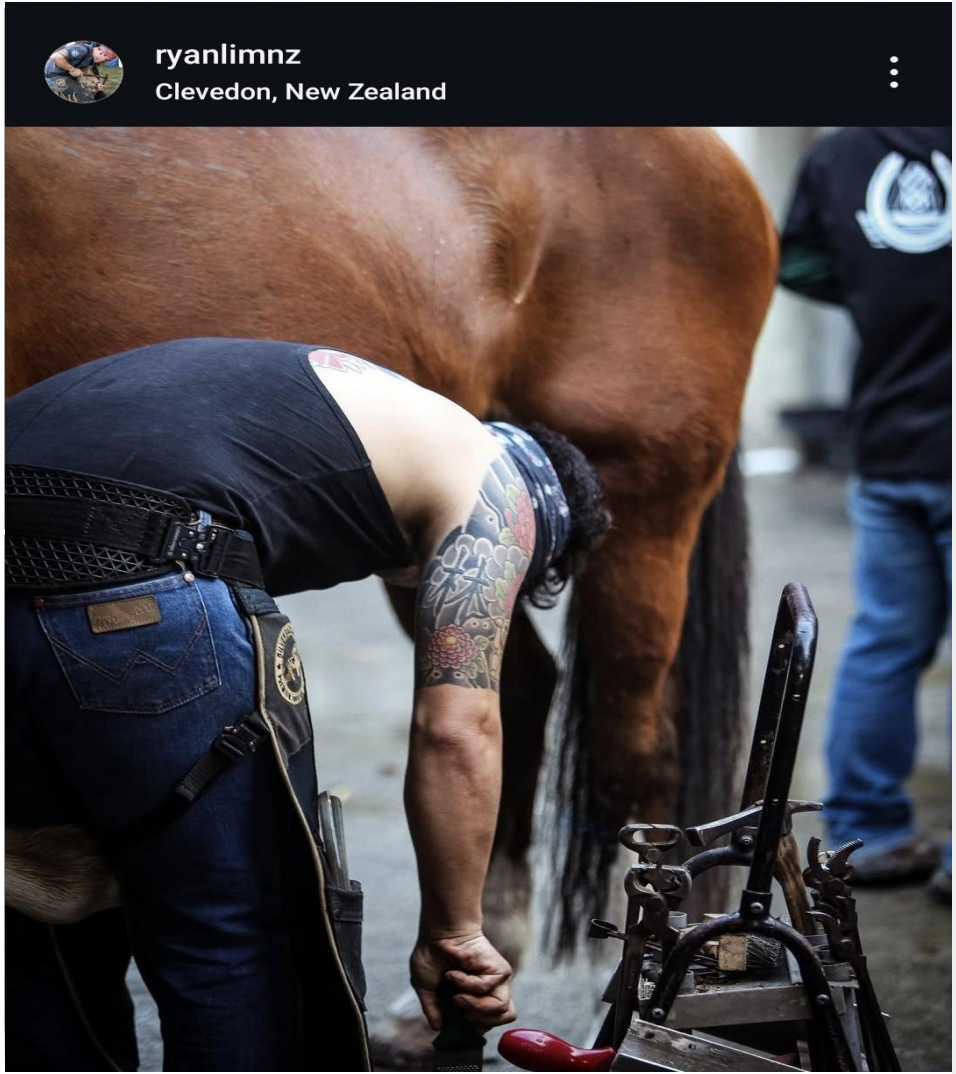


Data from 5,045 images of mixed breed.

The Coffin-Joint Tilt for this hoof is 3.0 degrees. This value is indicated on the histogram to the left by the vertical black line labelled 'This Hoof'. It is preferred to be in the green zone. The red zone is far away from the norm.

The Coffin-Joint Tilt value is reasonable. It is somewhat below average, but in not in the problem zone.

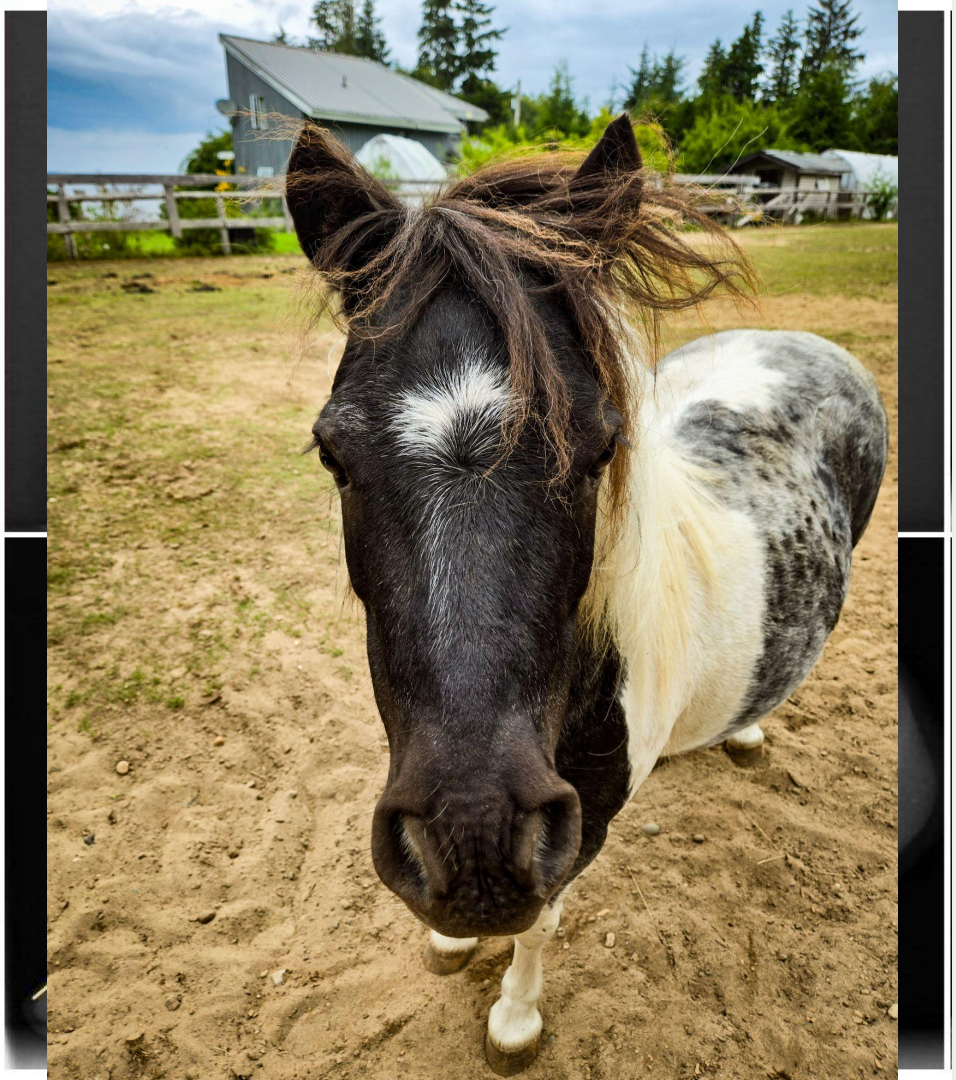
Link: Explanation of the Measures



Common hoof imbalances and foot problems

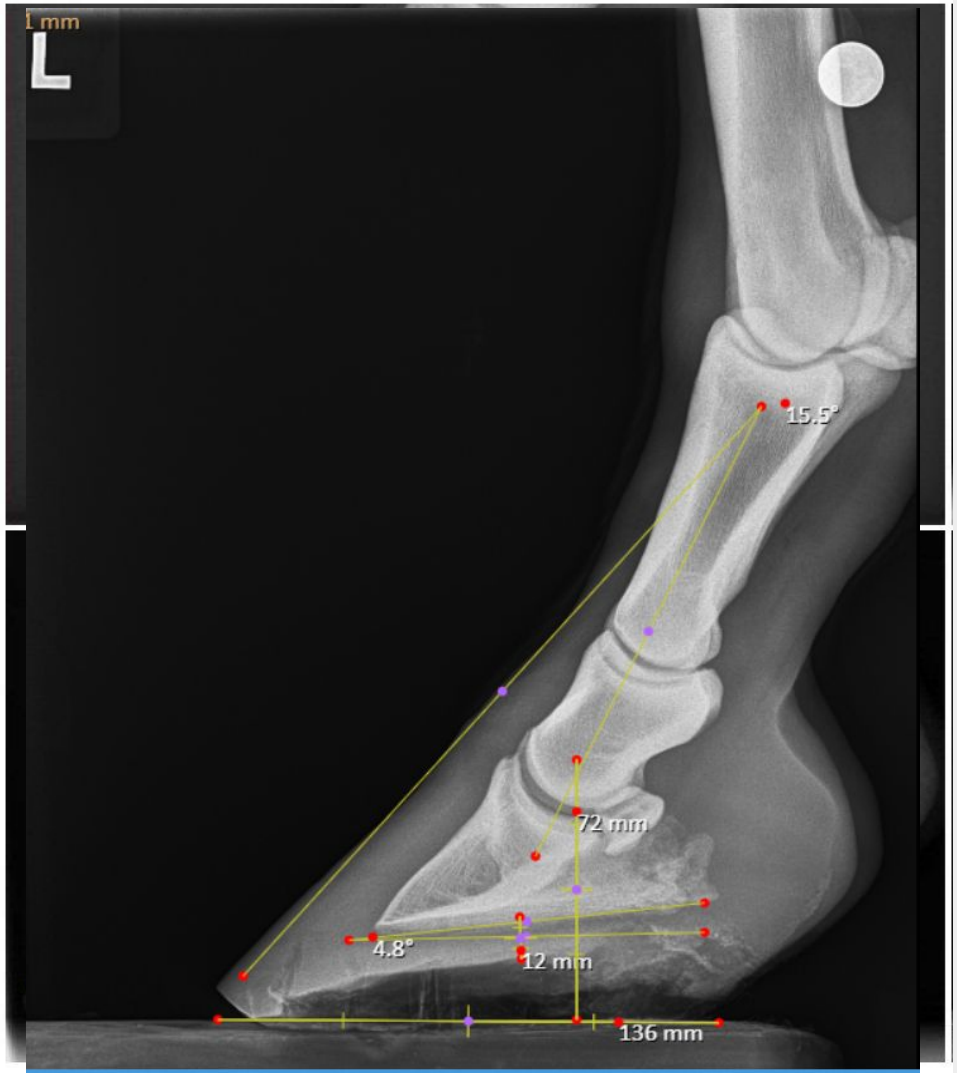
“Low heel, long toe”

- A bigger issue in the forefoot than hindfoot
- ~60% of a horse’s weight are on its forefeet



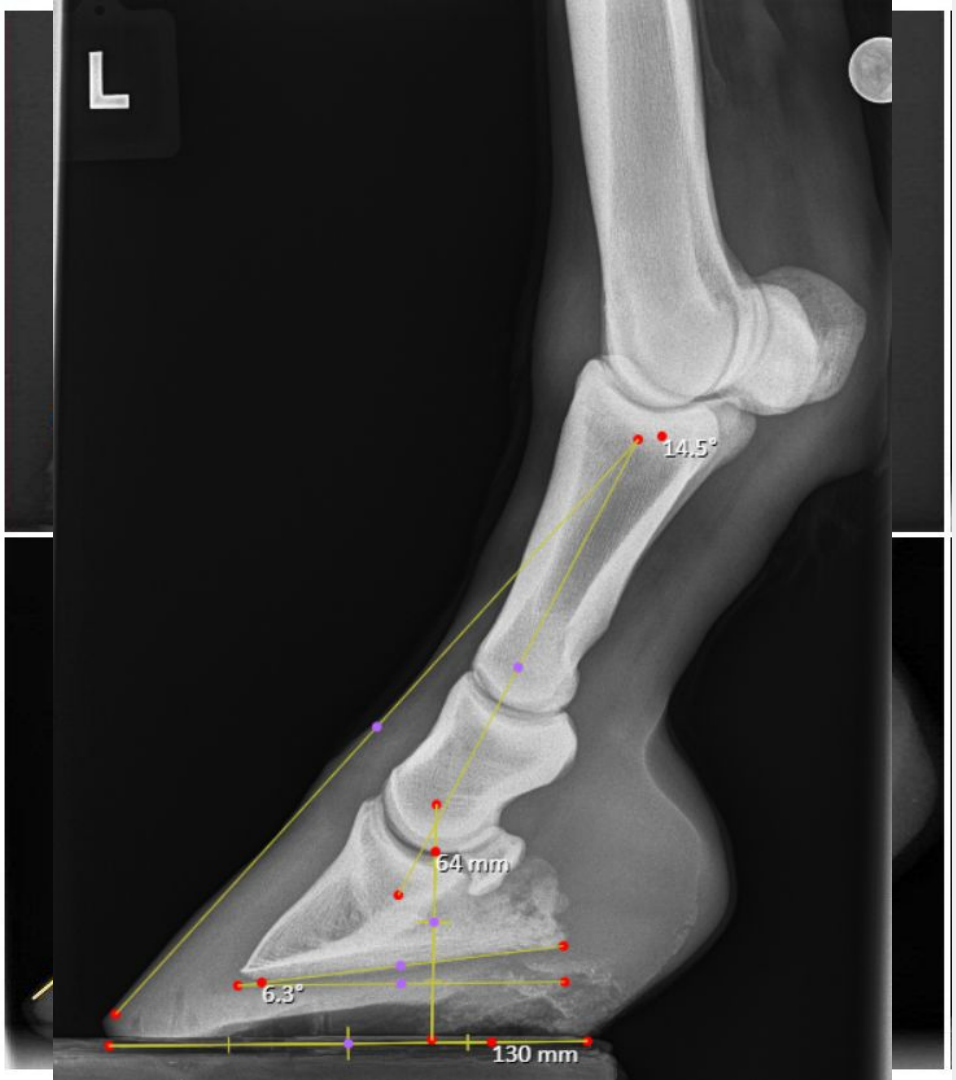
Case example:

- 20 yr old paint gelding
- First developed caudal heel pain in forefeet in 2018
- Corrective trimming and shoeing rec’d
- Horse seen by us when due for recheck hoof balance radiographs fall 2023 after owner had changed veterinarians



Pre-trim

- Horse's hoof balance had come a long way since 2018
- But still had excessive toe and a mildly flat palmar angle bilaterally
- Mild hoof tester positive over left heel



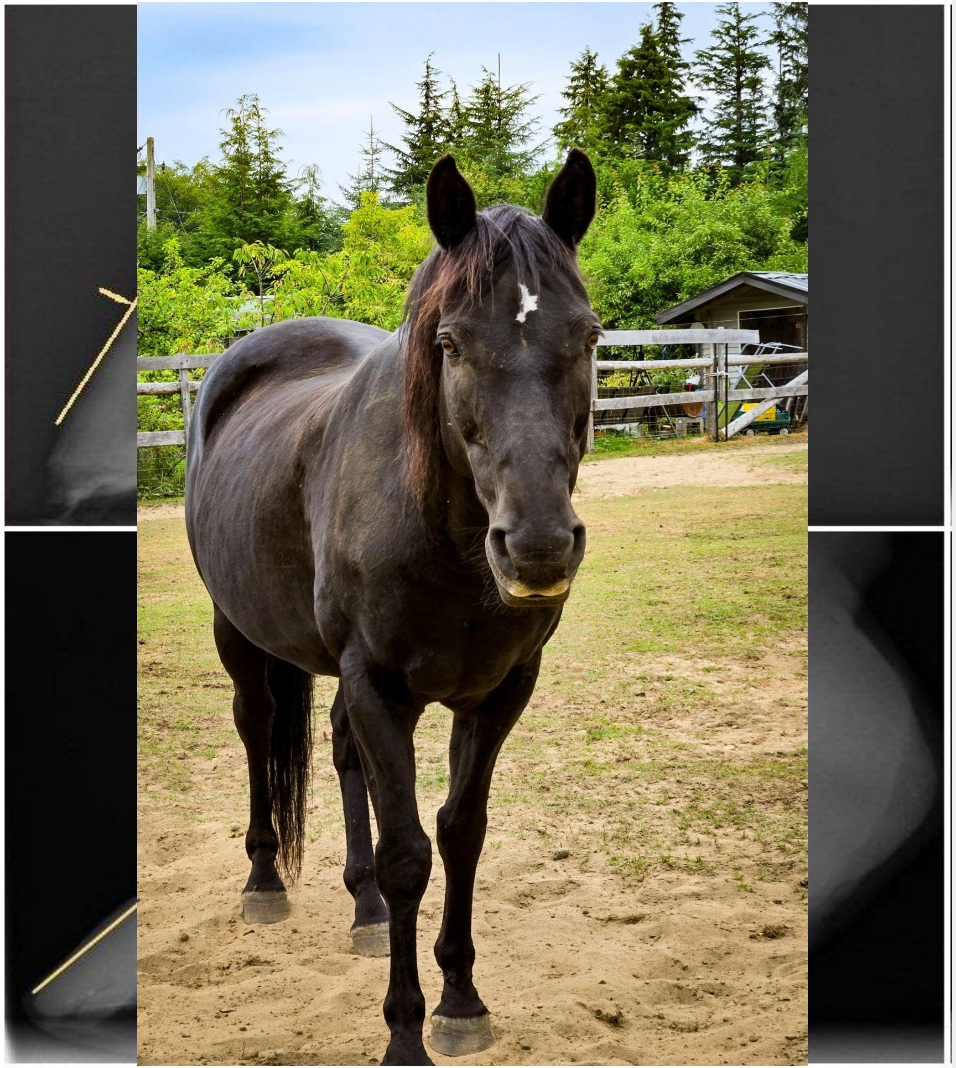
Post-trim

- Improved palmar angle
- Improved breakover
- I rec’d more toe be trimmed after this image, the farrier took another ~3-4mm off and then placed a rockered shoe
- Caudal heel pain hasn’t recurred with a strict trimming cycle and rockered steel shoes

Low heels, long toe: Treatment Goals

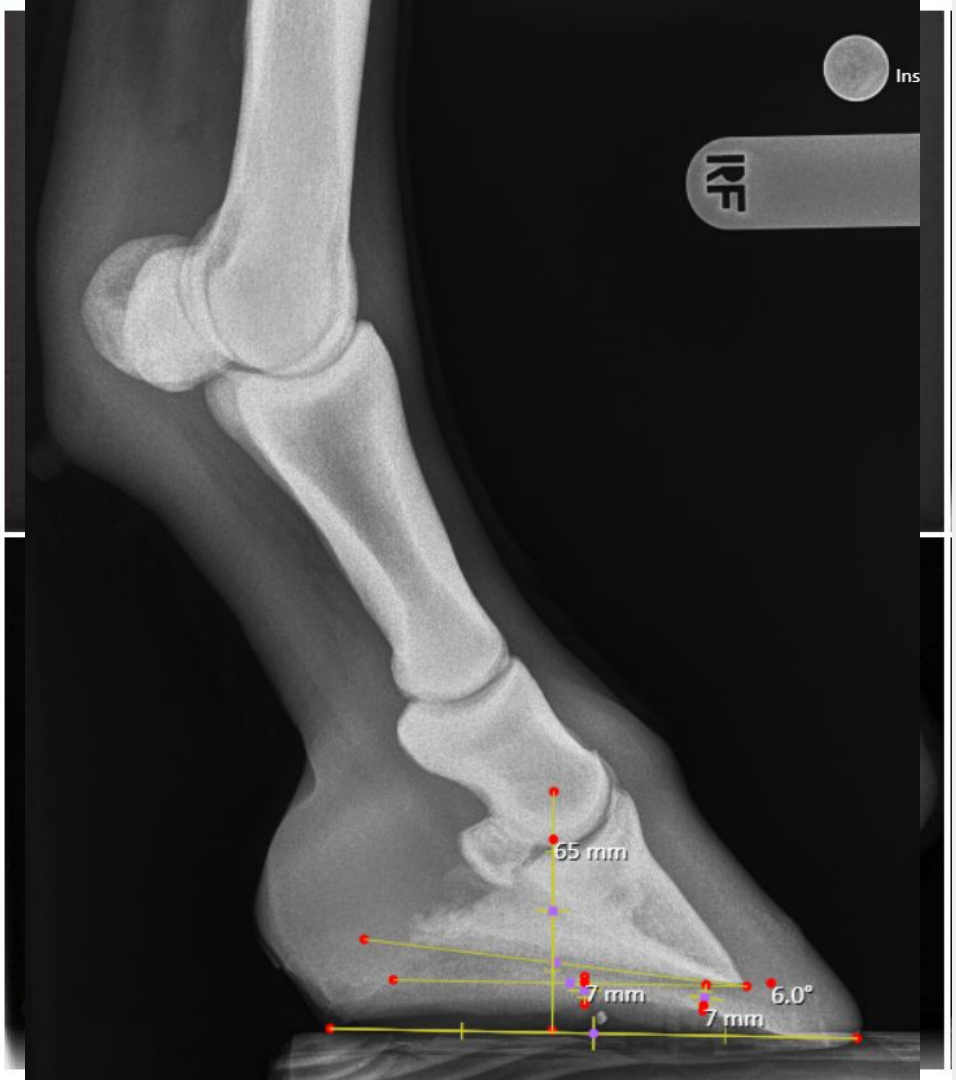
- Improve breakover (often w/ radiographic guided trim, but contributed to with rockered or square-toed shoe)
- Correct broken-back HPA and achieve normal palmar/plantar angles
- Heel support often initially required (pads, caudal heel or full, impression foam, bar shoe)
- If heels are contracted and exhibiting soreness they may need time off and time out of a shoe
- Build heel over successive trim cycles

“Thin soles”/ Sole bruise



Case example:

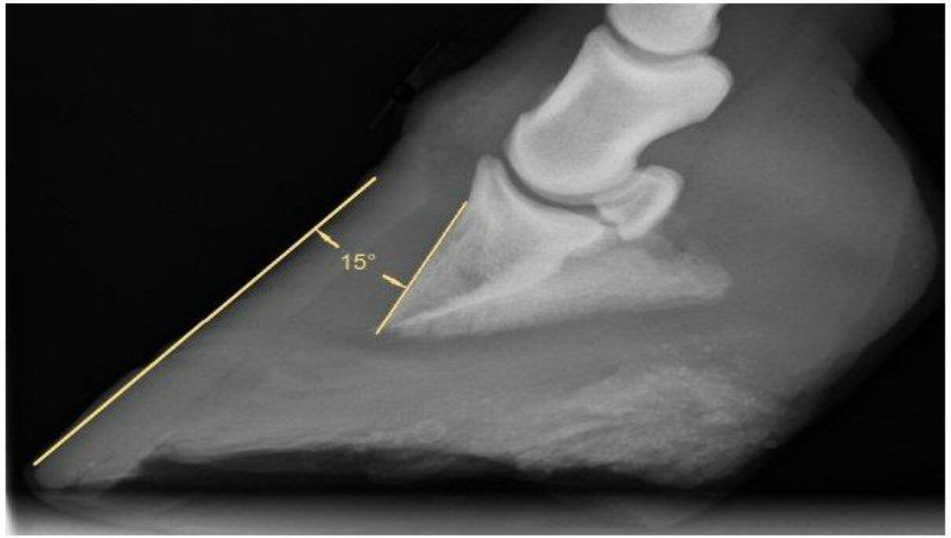
- 8-year-old WB mare
- Threw RF shoe 6-weeks before and jumped out of paddock, came up lame
- It took several days before shoe could be replaced
- Mare continued to be intermittently unsound on RF afterwards
- Lameness evaluation showed 2/5 RF lameness, worse when leg on the inside of a circle and worse on hard ground
- Hoof tester positive over mid-toe
- Mild distal limb edema and warmth in that hoof
- Mare not amenable to blocking even with multiple dose of acepromazine IV



- Sole depth mid-foot and toe of 7mm
- This is REALLY thin
- Foot otherwise reasonably balanced, except for slightly broken forward at coffin jt and a toe that could be shorter
- DP and P3 skyline showed no abnormalities
- Although not definitively diagnosed, I was highly suspicious of a bad sole bruise, potentially a bruise of P3 itself

Thin soles/stone bruise: Treatment goals

- These often require a lot of rest, like 8-12 weeks
- Painkillers/anti-inflammatories initially
- Sole support, full foot pads or boots for a barefoot horse
- Strict trimming cycle so imbalance doesn’t exacerbate soreness
- Environmental control - reduce mud/wet exposure that softens sole
- Checking zinc/selenium status and supplementing with biotin may all be useful (all important for healthy horn and solar tissue, some research support)



Laminitis

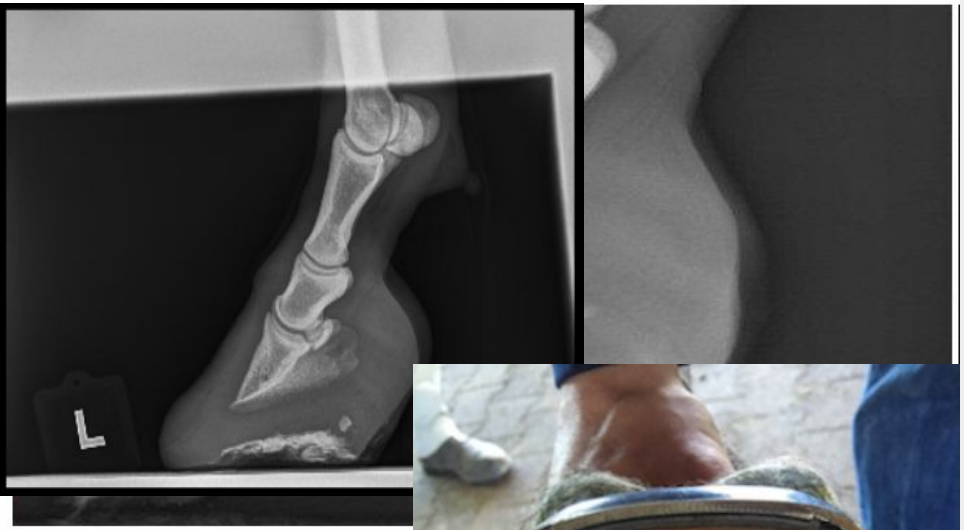
- Laminar inflammation cause by 1) biomechanical overload 2) glucose spike/carbohydrate overload 3) endocrine disease/cortisol & insulin/glucose dysregulation 4) Fever/colitis/sepsis
- These causes can be separate or layered and the pathophys is still not fully understood
- P3 loses its normal attachments to the hoof capsule and can both “sink” and “rotate”

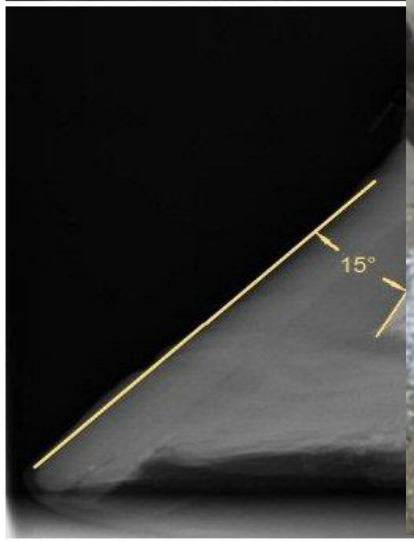
Laminitis: Case example

- Miniature with severe acute on chronic laminitis
- Not seen by a veterinarian a couple years due to remote location of O
- Severe 4/5 bilaterally lame in front, toe-touching LF
- The biomechanical overload on P3 had made it become very lytic
- I recommended euthanasia within the next 2 weeks if no improvement on a high dose of phenylbutazone, foot support, strict box rest and corrective trimming

Laminitis

- Follow-up
- Mini’s soundness drastically improved with phenylbutazone, soft rides and strict box rest
- She was aggressively trimmed by an experience barefoot farrier ~3-weeks later when her pain was more controlled
- I don’t have follow-up images yet but last video update I was sent showed dramatic improvement with the biomechanical correction





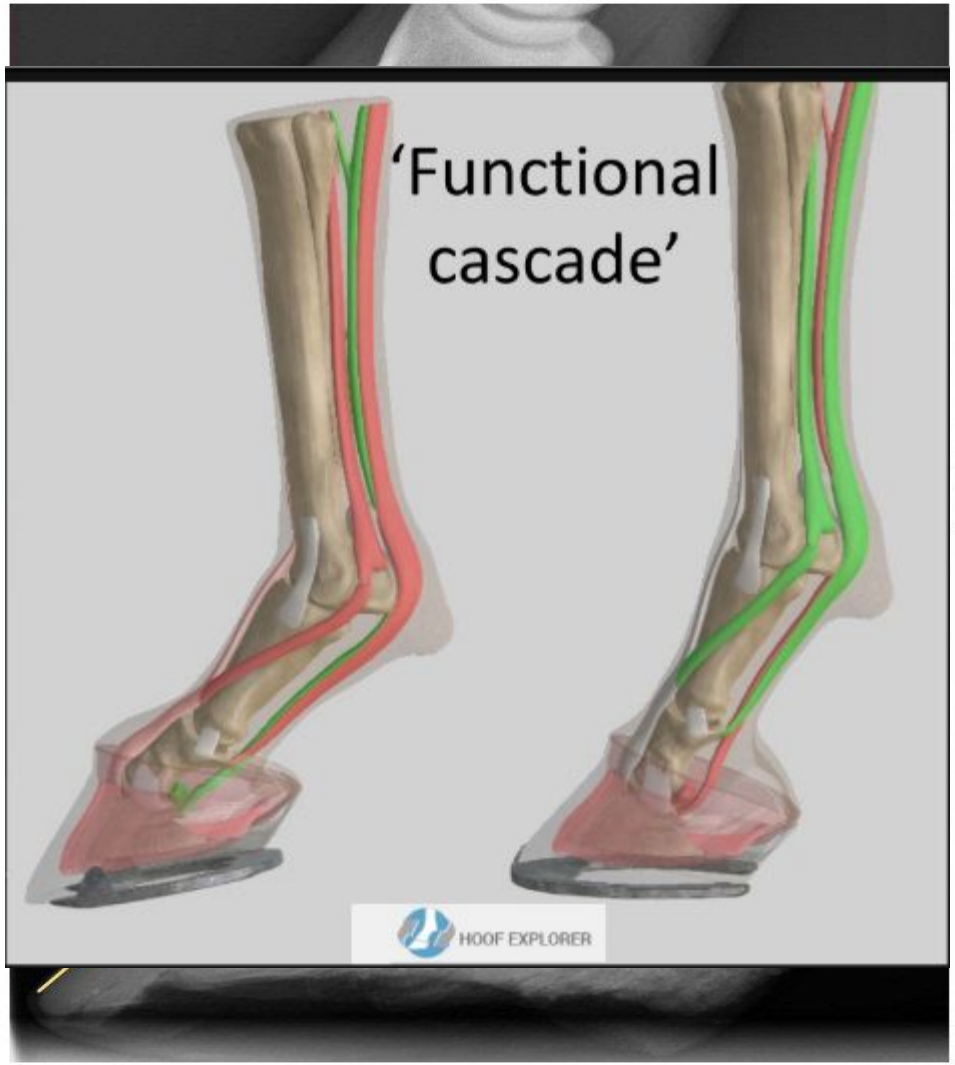
Laminitis: Treatment Goals

- Initially support foot & pain control/anti-inflammatories
- Cryotherapy/ice bath feet
- Strict box rest - reduction of mechanical impact on P3
- Strict breakover control, short cycle trim (q3 weeks even)
- Palmar angle balance, these horses end up too upright
- Sole maintenance and support
- Flare control/med,lat balance
- Shoes: Reverse shoe, square toe - further improve breakover

The Vascular pump

- Chronic laminitis cases or severe acute cases
- Venogram as a diagnostic/prognostic tool
- Monitoring of vascular supply
- Severe compromise to blood flow is associated with a poor prognosis for regaining soundness

A few interesting supportive shoeing situations



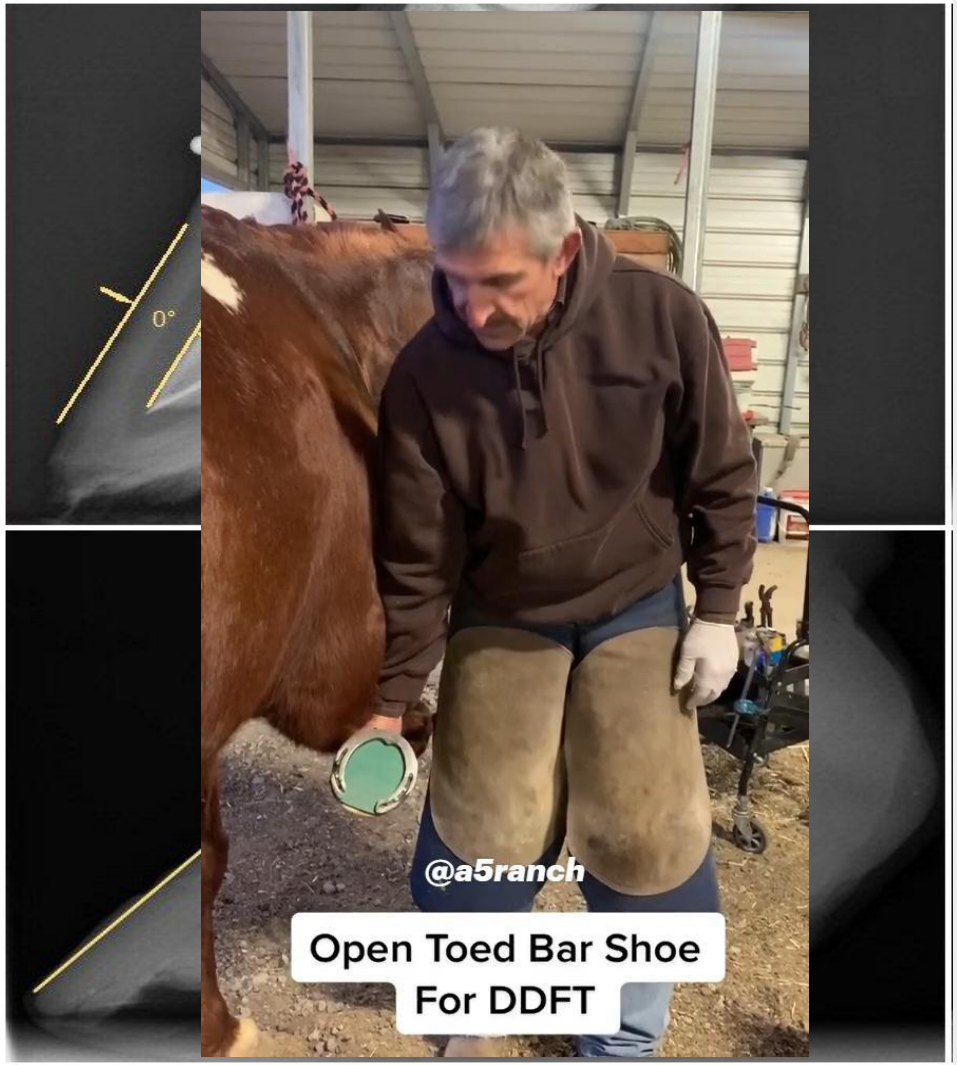
Supporting SL or SDFT injury

- A wide-toed shoe off-loads the suspensory and superficial digital flexor tendons

  *if HPA is normal, evaluating hoof balance important

- The SDFT works more in stance phase
- But loads the deep digital tendon more
- However in acute SDFT luxation aggressive heel elevation is helpful short term

Wide-toed shoe



Supporting DDFT injury

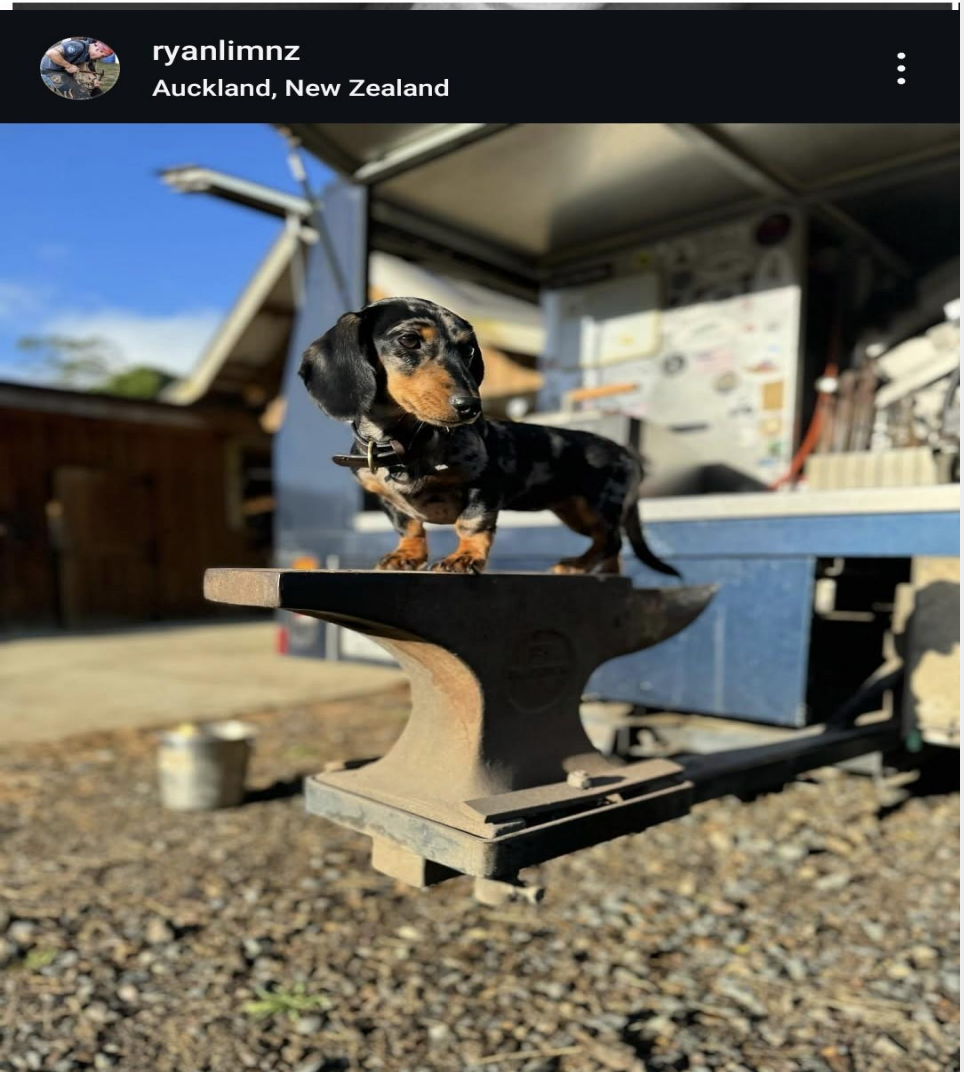
- The DDFT works more when the foot is rotating
- Easing breakover takes strain off of it
- Reactive footing most useful for rehab, not hard but also not soft - optimizes therapeutic biomechanical changes
- Therapeutic shoeing doing ‘what we want’ depends on ideal foot balance, so this should always be evaluated for these injuries

Quarter injury

- Offloading damaged hoof wall/avoiding nailing into it

Closing thoughts

- Research shows the ‘imbalanced’ foot has increased coffin joint pressures associated with osteoarthritis development
- Radiographic diagnosis and monitoring of hoof balance is both diagnostic AND preventative medicine for the most common causes of equine lameness → *Osteoarthritis, laminitis, sole bruising, navicular syndrome/caudal heel pain, deep digital flexor tendon injuries*
- And a good farrier is worth their weight in gold, but you all knew that already :)



This my farrier friend’s assistant, Penelope, she’s pretty important too :)

The End!

References

Hoof title image: Hoof Angles – Part 3 — Enlightened Equine

Hoof anatomy image: Equithrive® Hoof Pellets

Hoof soft tissue structures: 21 Equine Anatomy ideas | equines, horse anatomy, horse health

Long toe, low heel: https://s3.amazonaws.com/wp-s3-thehorse.com/wp-content/uploads/2017/09/22202911/low-heeled-conformation.jpg

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Sherlock, C. and Parks, A. (2013), Radiographic and radiological assessment of laminitis. Equine Veterinary Education, 25: 524-535. https://doi.org/10.1111/eve.12065

Metron AI: Heidi Donaldson laminitis case

Low heels, long toe: Splash Baker case

Laminitis: Bella Harrison case