The Palmar Metric: Assessing the Concavity of the Pedal Bone

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The study of shape and structure of a biological organism is referred to as ***morphology***. As you might suspect, there is a great variation in the shape (aka morphology) of horses' hooves. Understanding the morphology of bones and hooves is important as it greatly impacts trimming and shoe application.

As a scientist I like to have a quantitative means to study and measure shape in a dependable manner. This desire eventually led me to develop software capable of measuring the shape of hooves and bones accurately from radiographs [1].

It is not surprising that morphological patterns start to emerge -- especially after eighteen years of measuring hooves [2]. One pattern I noticed was a bright contour visible on a lateral radiograph (see Figure 1). This bright contour had different curvatures for different pedal bones. I started to wonder if there may be some relationship between the concavity of the pedal bone and the shape of this curve seen in a lateral radiograph. I conducted a few tests on cadaver pedal bones to make sure that I was correct with my assessment (see Figure 2). I had to convince myself that the curve I was seeing was indeed related to the shape of the palmar surface of the pedal bone, and from that curve I could infer something about the shape of the bone (see Figure 3).

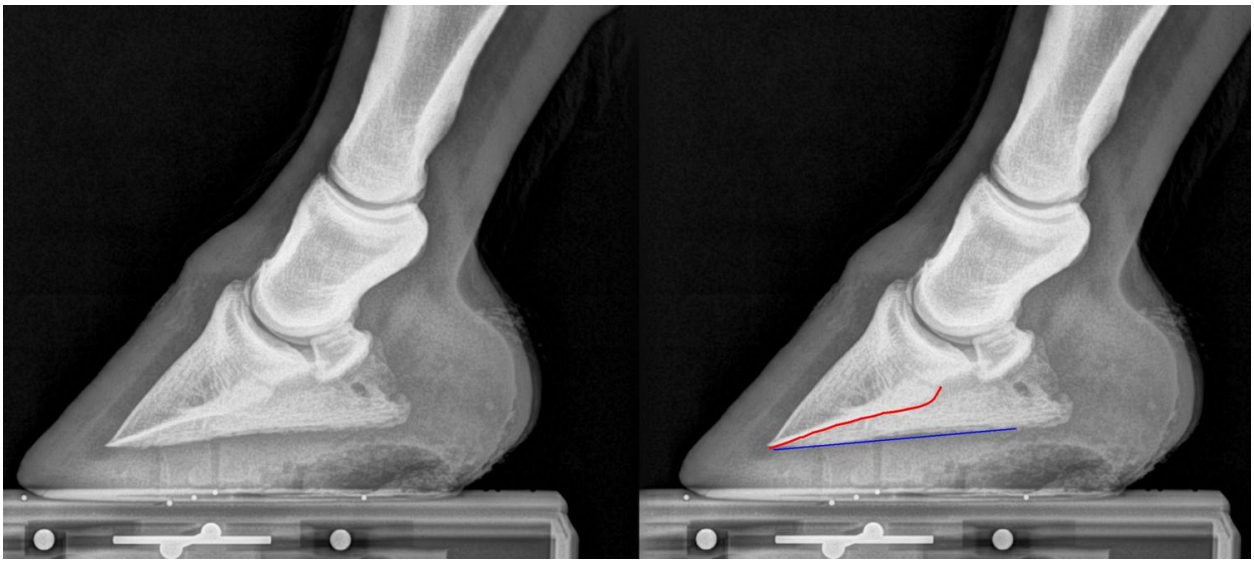

Figure 1: Left and right images are the same, but on the right-hand image I have indicated (in red) the curve that I am calling the “palmar curve”. This curve is on the border of a high-density portion of the bone that images bright white in a radiograph due to its density. It is an area of the P3 bone which must be strong and dense since the deep digital flexor tendon (DDFT) attaches near this area, and imparts large forces on the bone. The blue line is drawn at the distal border of the pedal bone, and is the line used to measure ***palmar angle*** relative to the ground. Roughly speaking, the space between the red curve and the blue curve tell us something about the amount of concavity of the palmar surface of the pedal bone.

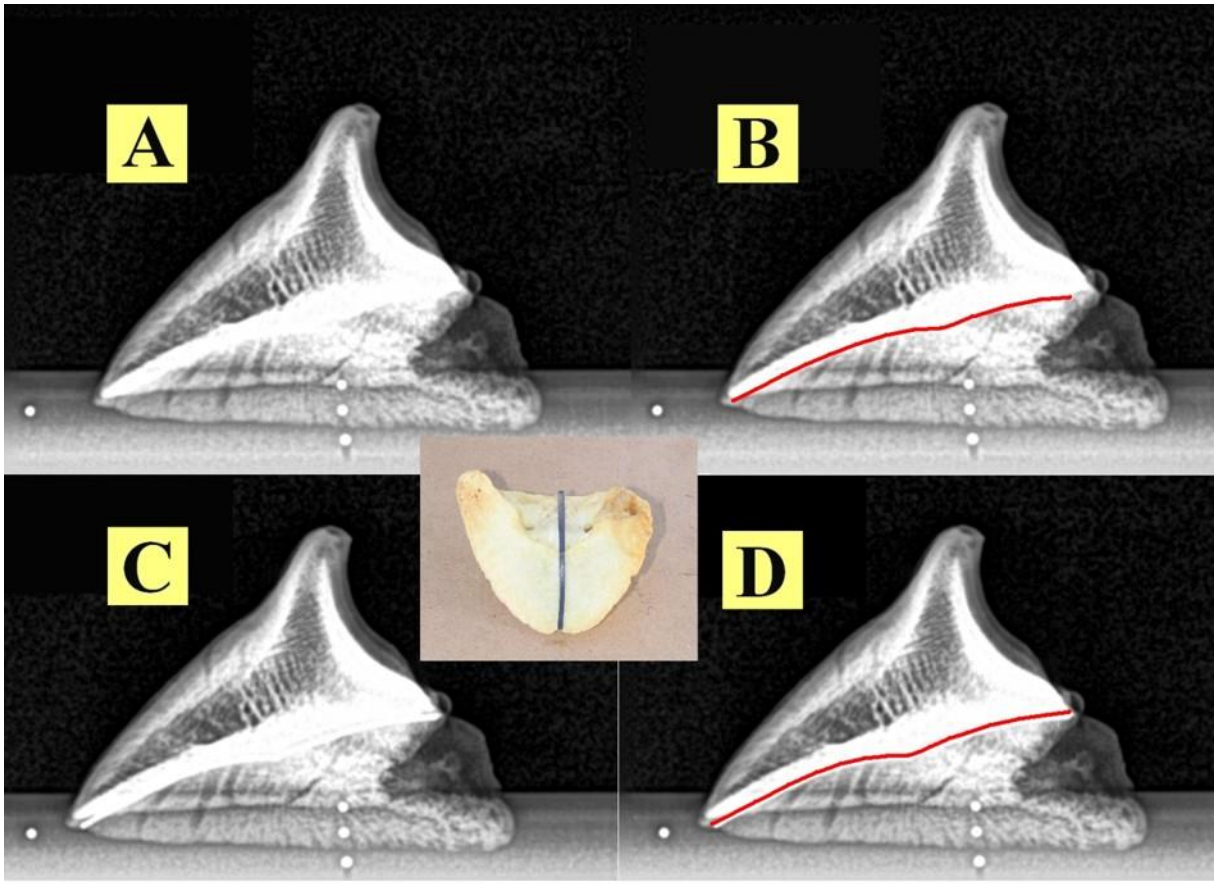

Figure 2: Figure A is the original radiograph of the cadaver bone. In B the palmar curve was traced using a computer program. Figure C shows a radiograph of the same bone after placing a radio-opaque strip of material along the centerline of the palmar surface of the bone and conforming to the surface of the bone (shown in inset photo). In Figure D the upper side of this radio-opaque strip was traced, yielding a very similar curve to that shown in B. Hence, the red line indeed identifies the shape of the centerline curve of the palmar surface of P3 from a high-quality lateral radiograph.

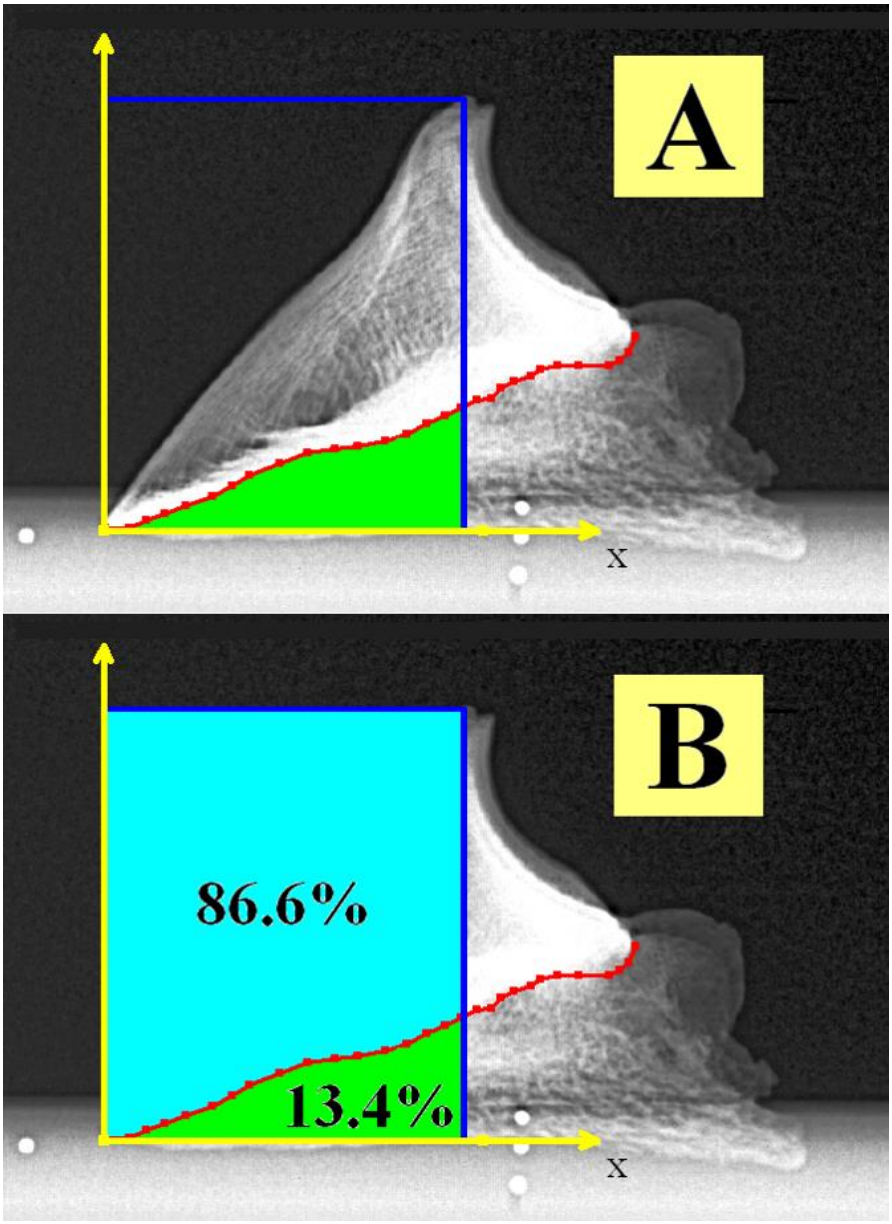

Figure 3: Here is a way to quantify the shape of the palmar curve. Form a rectangle using the most distal point on the palmar-curve, the highest point on P3 (extensor process of P3), and the orientation of P3. State the area beneath the palmar-curve as a percentage of the area of this rectangle. In this example, the 'Palmar Metric' of this bone is 13.4. The higher the number, the more concave is the pedal bone. This measurement is now a standard feature in Metron software [1].

This method computes a measure of concavity of the palmar aspect of the pedal bone from standard practice lateral radiograph. This ***palmar metric*** quantifies the 'flatness' or 'cupiness' of the underside of the pedal bone. This may be a useful measurement in any study that seeks to understand what factors lead to demineralization of the pedal bone throughout the horse's lifetime.

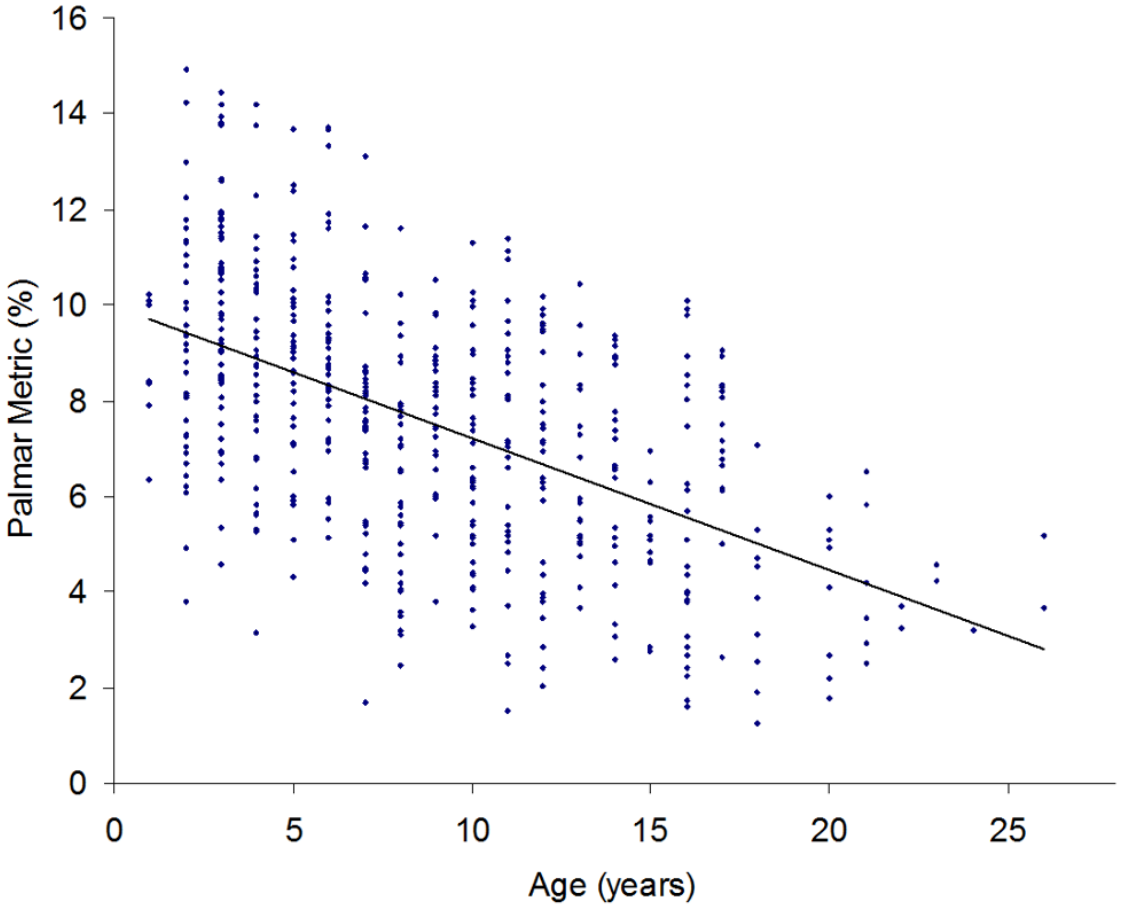

Figure 4: For a mixed breed group of 543 hooves, while there is wide variation among individuals. However, on average, the palmar metric is declining as any given horse ages. I do not think the palmar metric can ever be seen to improve over time – it is a 'one way street' of bone demineralization that all pedal bones undergo as the horse ages. But

some decline much faster than others, which is why it is an interesting measurement to use in future studies.

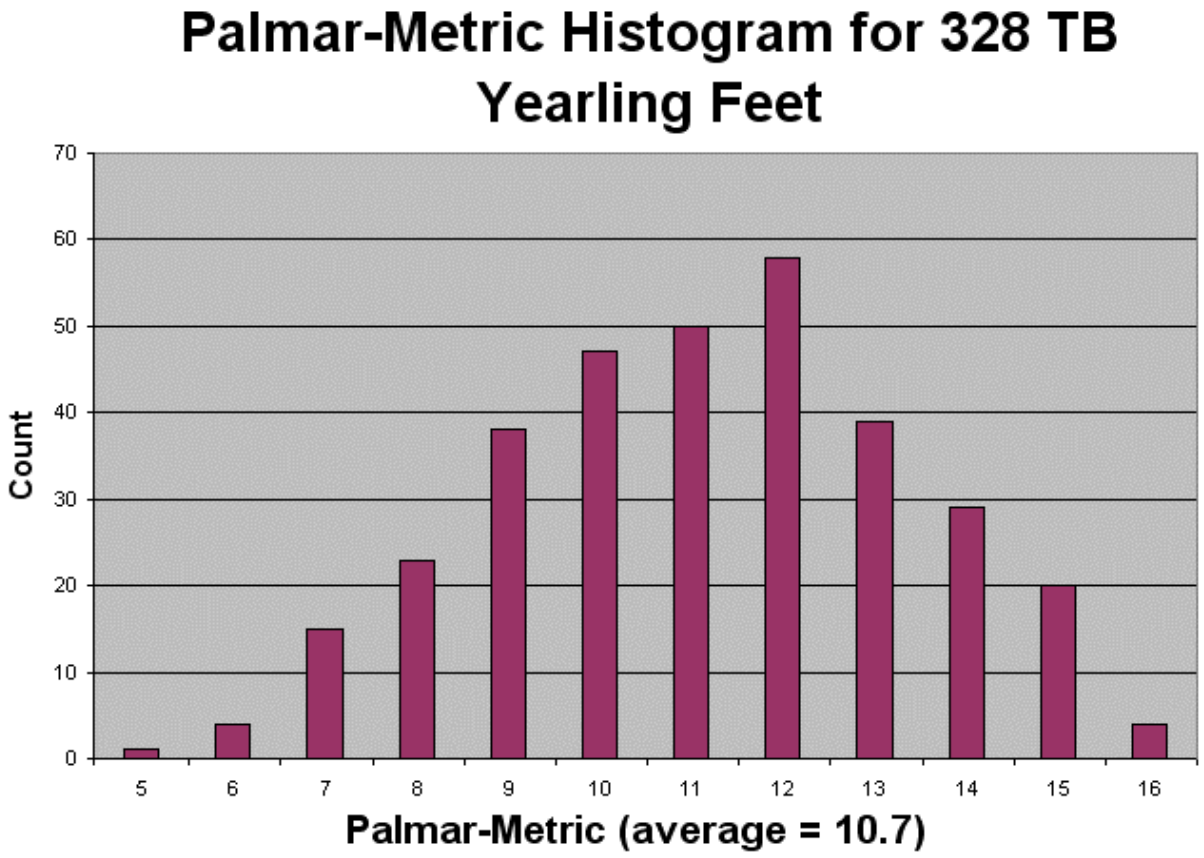

Figure 5: In another study, we measured the palmar metric of 328 hooves from thoroughbred yearlings. The result is this bell-curve. As part of a pre-purchase exam, the palmar metric might be an important measure when considering a young horse with already-flattened palmar surfaces.

This raises the all-important question: What hoof-care practices would minimize the rate of loss of the palmar concavity? What are the most important factors: Breeding? Keeping horses barefoot? Trimming and

shoeing styles? Feeding protocols? Training and usage of the animal? Personally, I feel that the answer to this question would be 'all of the above'.

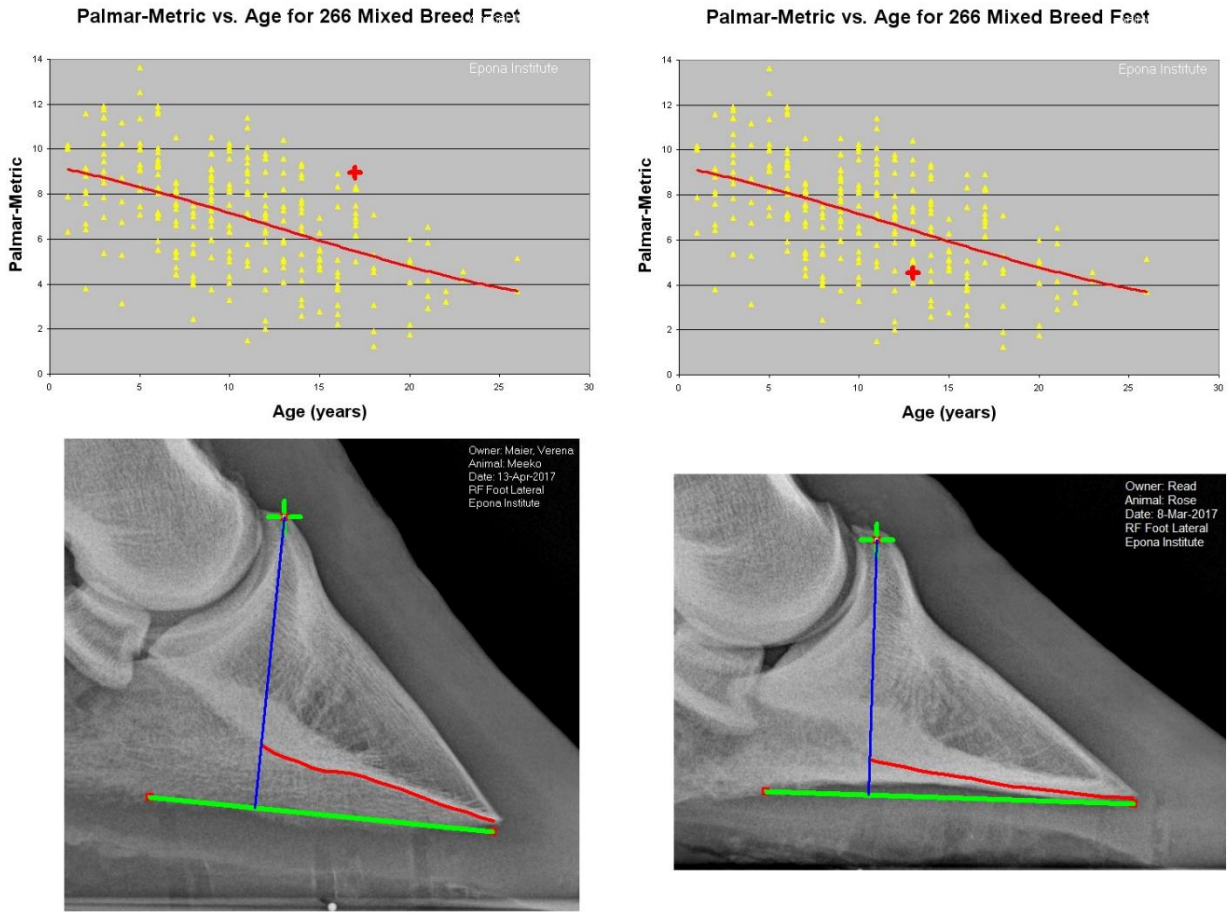

Figure 6: The pedal bone on the left is from a 16-year-old horse and is much more concave than average for its age. On the right is an example from a 13-year-old of a pedal bone that is less concave than average for its age.

In the meantime, the palmar metric provides a new tool for hoof care practitioners and veterinarians to assess quantitatively the shape of the pedal bone. For instance, hooves with a flattened pedal bones may not necessarily be candidates for staying without prosthetics. Raising heels

via wedge pads may not be the best long term solution on flat pedal bones since the load shifts somewhat to the remodeled area. I follow all my clients' horses and my own horses via radiographs and consider the amount of bone loss over the years. This has provided me a method to alter some of my trimming and shoeing methods. I would advise any horse owners to take preventative radiographs yearly.

This article is a condensed version of a more detailed report previously presented [3] and published [4].

References

1) Metron-DVM Users Manual, Version 7.40, EponaTech LLC, 2016.

2) Craig, M., A Modern Look at The Hoof, Outskirts Press, 2015.

3) Craig, M., Craig, J., and Burd, M., "The palmar metric: A novel radiographic assessment of the distal phalanx in the Horse", presented at the 2014 NAEAA conference, Lexington, KY, July 2014.

4) Burd, M., Craig, J., and Craig, M., "The palmar metric: A novel radiographic assessment of the equine distal phalanx." in the Open Veterinary Journal Vol. 4(2) (2014): 78-81.