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# Equine osteoarthritis: A Comparison of type 1 and type 2 conditions

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the degree of Master of Fine Arts.

# Equine Osteoarthritis: A Comparison of Type 1 and Type 2 Conditions

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Signature ..............................

Date 5/22/99

## Contents

## Acknowledgements

There are many people, and one horse, to thank for aiding in the completion of this thesis. Without them I would never have had the curiosity, ability, skill or knowledge to learn and understand all that was required to achieve this level of work. I would like to acknowledge these individuals now.

The largest force (literally) behind my wanting to explore equine osteoarthritis was my traveling equine companion Yankee's Touch and Go, who is currently being treated with limited success for this disease. In my search for answers to her condition I found a wealth of information that was fascinating and frustrating all at once. Keeping this experience in mind, I designed the instructive interface to provide the most information possible in the clearest way I could imagine.

The staff of the Genesee Valley Equine Clinic in Scottsville, NY was tremendously helpful. Being able to participate in the internship program offered through the clinic allowed me to collect valuable information. I would like to extend a special thank you to Dr. Celeste Boatwright for meeting with me to review information, illustrations, and answer any questions I might have had. Dr. Amy Rath was helpful during the internship program, allowing me to ride along, ask questions, and participate in many examinations.

I would like to thank Jim Perkins and Glen Hintz for their support. It was interesting sharing new information with them in regards to veterinary anatomy, and I will never forget the response I got in the first critique of my carbon dusts, "They look great.... What are they?". This opened my eyes to the fact that I needed to make sure that everyone else understood what they were looking at. It was a valuable lesson that I hope will stay with me during the rest of my career. Dr. Richard Doolittle was also helpful in providing insights to key features that I might have overlooked. He also helped me to gain access to skeletal models, which were valuable to completing sketches.

Last but not least I would like to acknowledge my family, my fiancé and friends who supported me on my first venture "out of the nest". Without them I surely would not have achieved this goal. Being away from home was a fun experience, but I am happy to say that I am glad it is almost over.

## Illustrations

## Introduction

In what originally began as research to answer my own questions about osteoarthritis, I learned as much as I could from reading anatomy, veterinary, and physiology books. I had to look in many places to find all the answers I wanted. The books that provided the best visual information lacked text to explain the images, and the books that provided the best text definitions usually provided simplified illustrations or very confusing clinical photographs. While trying to unite the best images with the best text explaining what was going on, an idea was formed. I decided to combine clear images with clear descriptions, comparing the two most common types of osteoarthritis found in horses, types 1 and 2. I wanted to design a system that could be used in veterinarians' offices to explain osteoarthritis to a client in a manner that was understandable as well as informative.

The equine limb is an amazingly complex structure. It allows a thousand pound animal to run at speeds of up to 45 miles an hour, jump over six foot obstacles and sleep while standing. However, this marvel of evolution has come at a cost. The cost is a strict definition of the work expected of the limb. Horses do not have the ability nor the desire to partake in bed rest or stay off an injured limb. With this in mind, veterinarians have often struggled with the best way to manage injuries in horses. Treatments for diseases such as osteoarthritis are still being debated. Equine osteoarthritis is a devastating disease that strikes thousands of horses each year. It can be an inevitable badge of advancing age, or a preventable injury brought on by human demand. It can even result from traumatic injury. Whatever the cause, once it has taken hold it leads to the same end, progressive damage to the joint

In order to discuss the disease process of osteoarthritis I have explored the anatomy of the two joints most frequently involved, the carpus and hock. The relationship of the bones that form these joints is paramount to understanding the forces that are at work when a horse is in motion. I also explored the structure of synovial joints, and the hock and carpus joints in motion. This lesson in anatomy was designed to be accurate enough for use in a teaching environment, yet to be clear enough for use in a clinical environment where often all members involved are not veterinarians.

## Anatomy

### Synovial Joints

Synovial joints are complicated structures. They allow bones to articulate in a practically frictionless environment. Synovial joints contain bones, separated by a fluid filled joint cavity, bounded by a synovial membrane. The synovial membrane attaches to the edges of the articular cartilage on each bone. In the horse, a fibrous capsule and ligaments reinforce the outer layer of the synovial membrane. The fibrous layer and ligaments serve not only to reinforce the synovial membrane, but also to hold the bones in place and limit the direction and degree of mobility in the joint.[1]

The actual components of the synovial joint sound complicated, but they do not compare with the delicate biological balance that must be maintained for the joint to remain healthy. The covering of the articular surface of the bones is important. It is covered with hyaline cartilage, which is translucent and pliant in a healthy joint. It is insensitive and avascular, and all of its metabolic requirements are fulfilled by diffusion from the joint fluid, blood vessels at the periphery of the articular cartilage, and vessels of nearby bone marrow cavities. [2] Any disruption of this diffusion has dire consequences for the cartilage. The synovial membrane is very thin, vascular, and sensitive. It is responsible for forming synovia or synovial fluid that provides both lubrication and nutrition for the cartilage. An important component of synovia is aminoglycans that help lubricate the joint.[3]

Anything that causes a disruption in any of the components of a synovial joint will indirectly effect the entire joint. The effects of this disruption are hard to predict, sometimes they can be reversed, sometimes they are permanent yet stable, and sometimes they will continue to progress even with treatment.

The presence of insensitive tissues within the joint complicates matters, since damage can be occurring, yet not produce any clinical signs in the patient. Keep the structure of the synovial joint in your mind while you read the following sections discussing the bony structure of the carpus and hock.

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[1] K.M. Dyce, W. O. Sack, C.J.G. Wensing, *Textbook of Veterinary Anatomy*, 2nd Edition, (Philadelphia, PA, W. B. Saunders Co., © 1996), p. 15.
[2] Ibid, p. 15.
[3] Ibid, p. 15.

## Anatomy of the Carpus

The carpus is composed of several bones, which are arranged in two rows between the radius of the forelimb and the metacarpals of the lower leg. The proximal row contains the radial, intermediate and ulnar carpal bones as well as the accessory carpal bone which projects posteriorly from the carpus. The distal row contains the second, third and fourth carpal bones. On occasion there will also be a first carpal bone located in this row.[1] The first carpal bone was not evident in the sources I used to illustrate the carpus, therefore it has been omitted from the illustrations (See Figures 1–4).

The entire carpal joint is covered with a fibrous capsule, and the synovial compartments are separate from one another. There is some communication between the middle and distal levels. The carpus is designed to function primarily as a high motion shock absorber. It carries up to sixty percent of the total body weight, and is capable of carrying much more during such activities as jumping, racing or ranch work. There are three areas of articulation. The highest amount of movement is found at the radiocarpal level, which can normally flex from 90 to 100 degrees. The midcarpal joint can flex up to 45 degrees, while the carpometacarpal level does not allow for any significant movement[2] (See Figure 5).

Although the carpus is designed to absorb shock, it has limitations. Factors such as poor conformation, improper shoeing practices or strenuous exercise on less than desirable surfaces can cause problems in the carpus. Most of these problems arise when the joint is overextended, causing the anterior margins of the bones to strike one another. While the equine limb is designed to take such insults, repetitive trauma will likely have dramatic effects on the joint. These effects can range from pain and swelling to complete reshaping of the bones involved in the trauma.

[1] Ibid, p. 583.
[2] Ibid, p. 583.

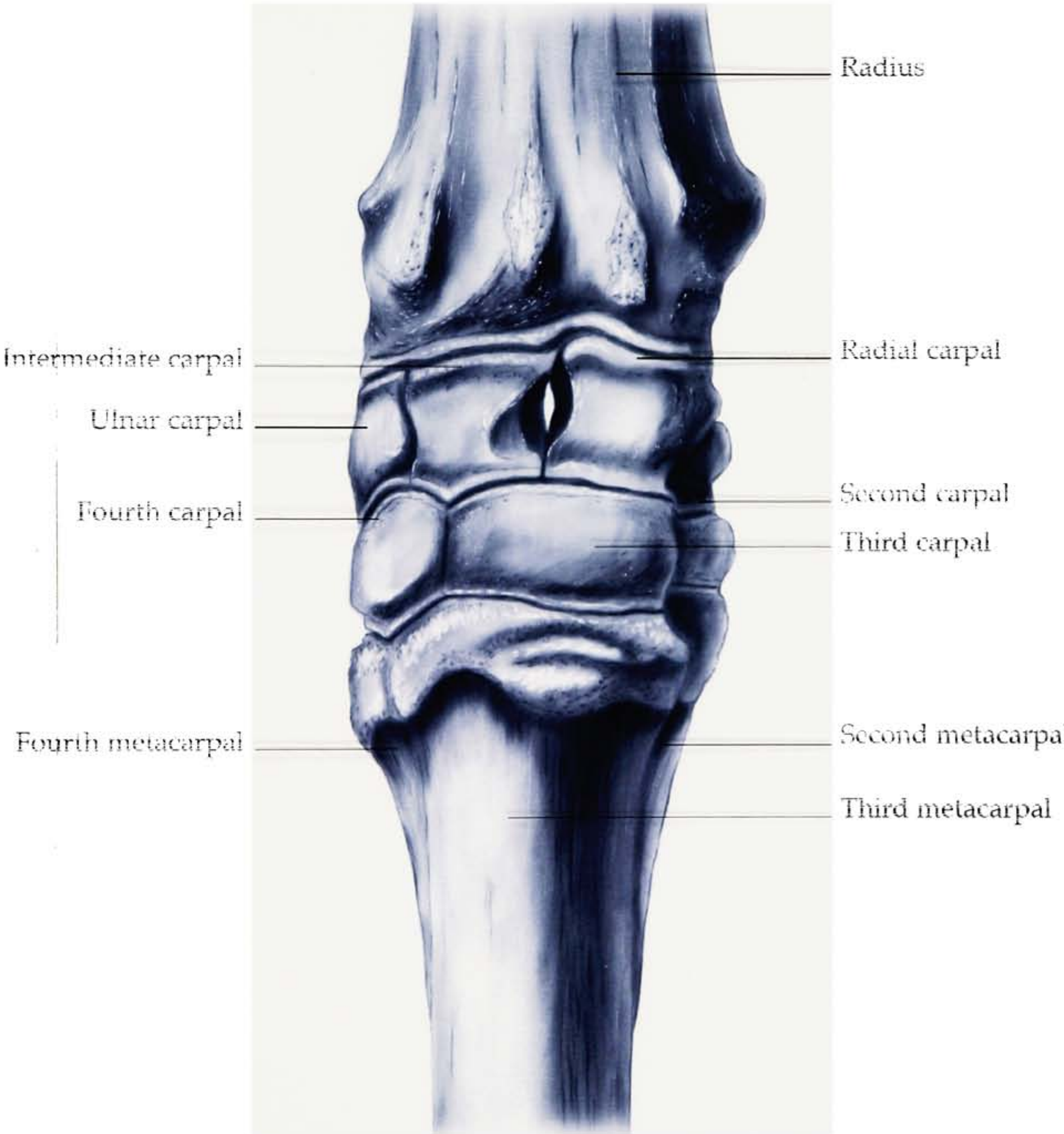


**Figure 1. Anterior view of the carpus.**

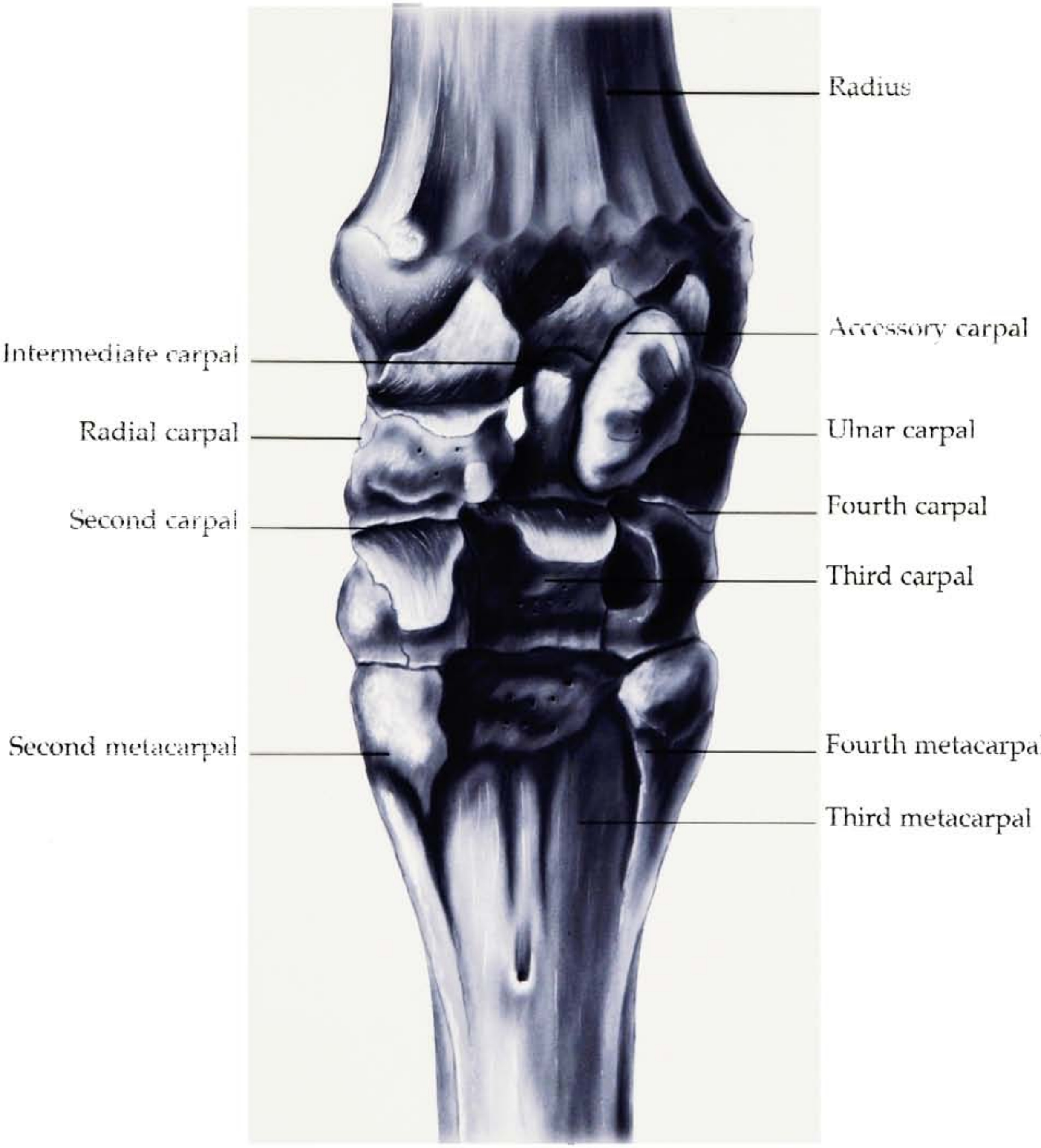


**Figure 2. Posterior view of the carpus.**

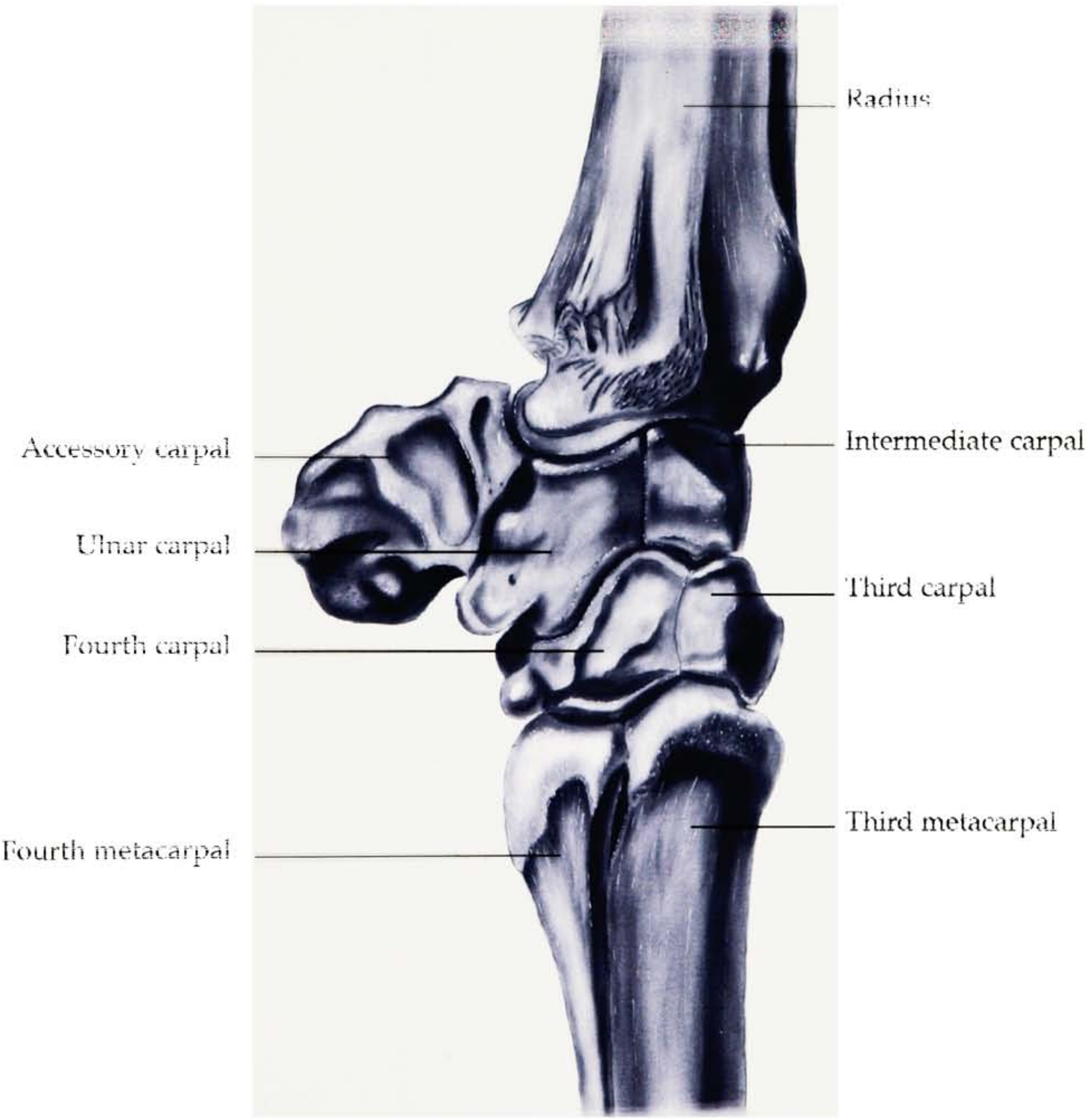


**Figure 3. Lateral view of the carpus.**

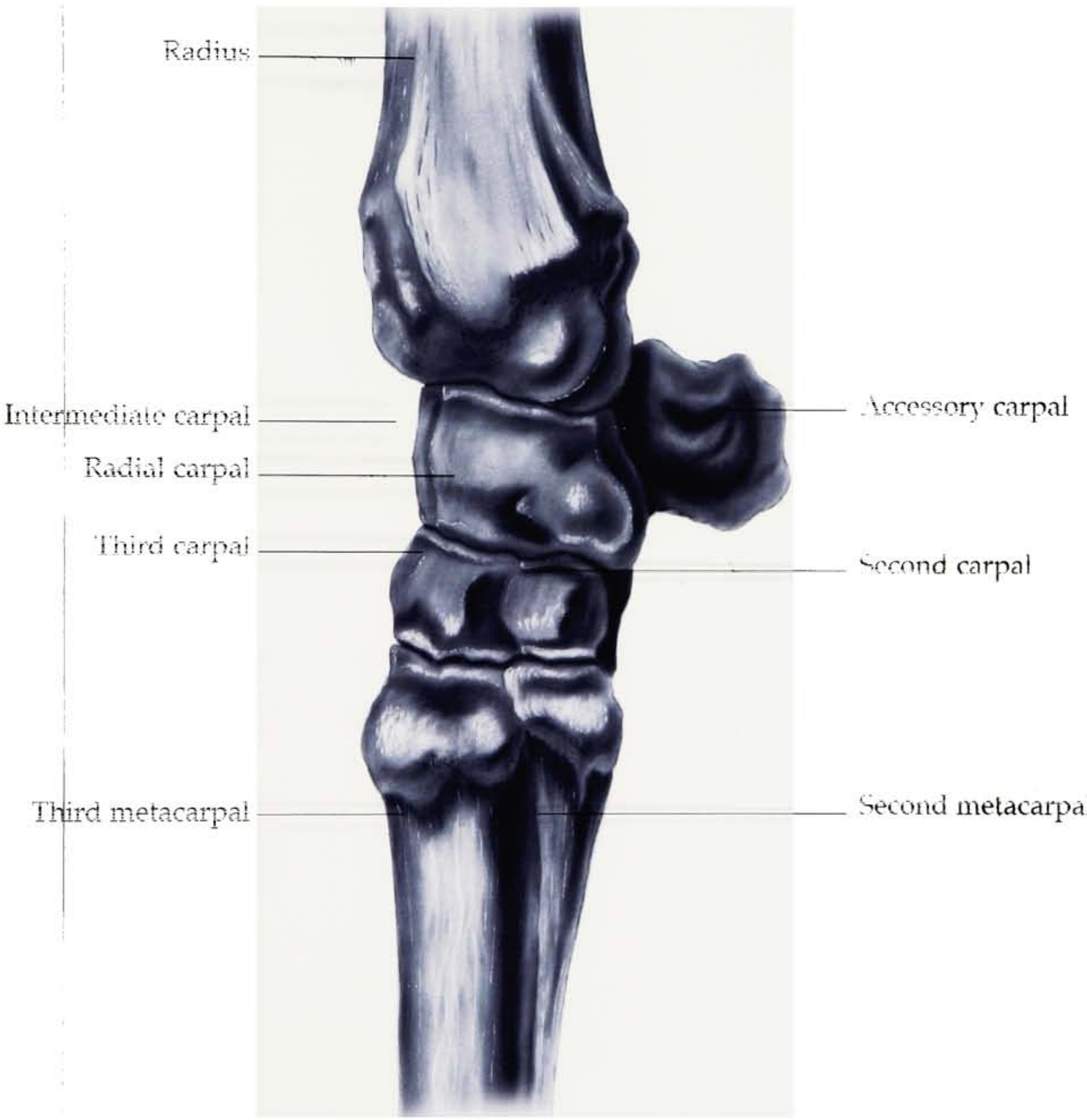


**Figure 4. Medial view of the carpus.**

**Figure 5. Carpus in flexion.**

## Anatomy of the Hock

There are four levels of articulation in the hock, yet only one of the levels is capable of significant movement. This area is between the tibia and the trochlea of the talus. The rest of the bones should not have any movement between them. The proximal row of bones consists of the talus and the calcaneus. The oblique angle of the trochlea of the talus ensures that the lower leg travels outward and forward simultaneously, preventing interference with the other leg.[1] The calcaneus forms the point of the hock with its prominent calcanean tuber. The next row contains the central tarsal bone. Distal to the central tarsal are the fused first and second tarsal bones, along with the separate third and fourth tarsal bones. Further distal are the second, third and fourth metatarsals (See Figures 6-9).

The hock functions primarily as a low motion/high load joint, designed to propel the body forward at all gaits. The fibrous capsule covering the hock is quite extensive and complicated. There are three synovial joint sacs present. The first synovial joint sac services the two most proximal joints. The other two sacs service the two most distal components and there is some communication between them.[2] The structure of the joint can both aid and complicate a diagnosis. Its structure can mask certain symptoms or resemble other conditions.

The hind limb of the horse carries approximately forty percent of the horse's body weight at rest, yet it must be capable of withstanding the heavy loads placed on it as the limb returns to the ground and pushes the body forward into the next stride. Arthritic changes are most often noted in a region called the "seat of spavin" where the third and central tarsal and third metatarsal meet. Similar to problems in the carpus, factors such as conformation, shoeing that prohibits the normal sliding of the hoof, and activities that include a lot of jarring motion can contribute to arthritic changes in the hock. Most notable are activities, such as that found in working quarter horses, that require jarring motions to the hind limbs causing luxation or subluxation of the joints and result in injury to the soft tissues of the joint.[3]

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[1] Ibid, p. 619.
[2] Ibid, p. 619.
[3] T. S. Stashak, *Adams' Lameness in Horses*, 4th Edition, (Philadelphia, PA, Lea & Febiger, © 1987), p. 390.

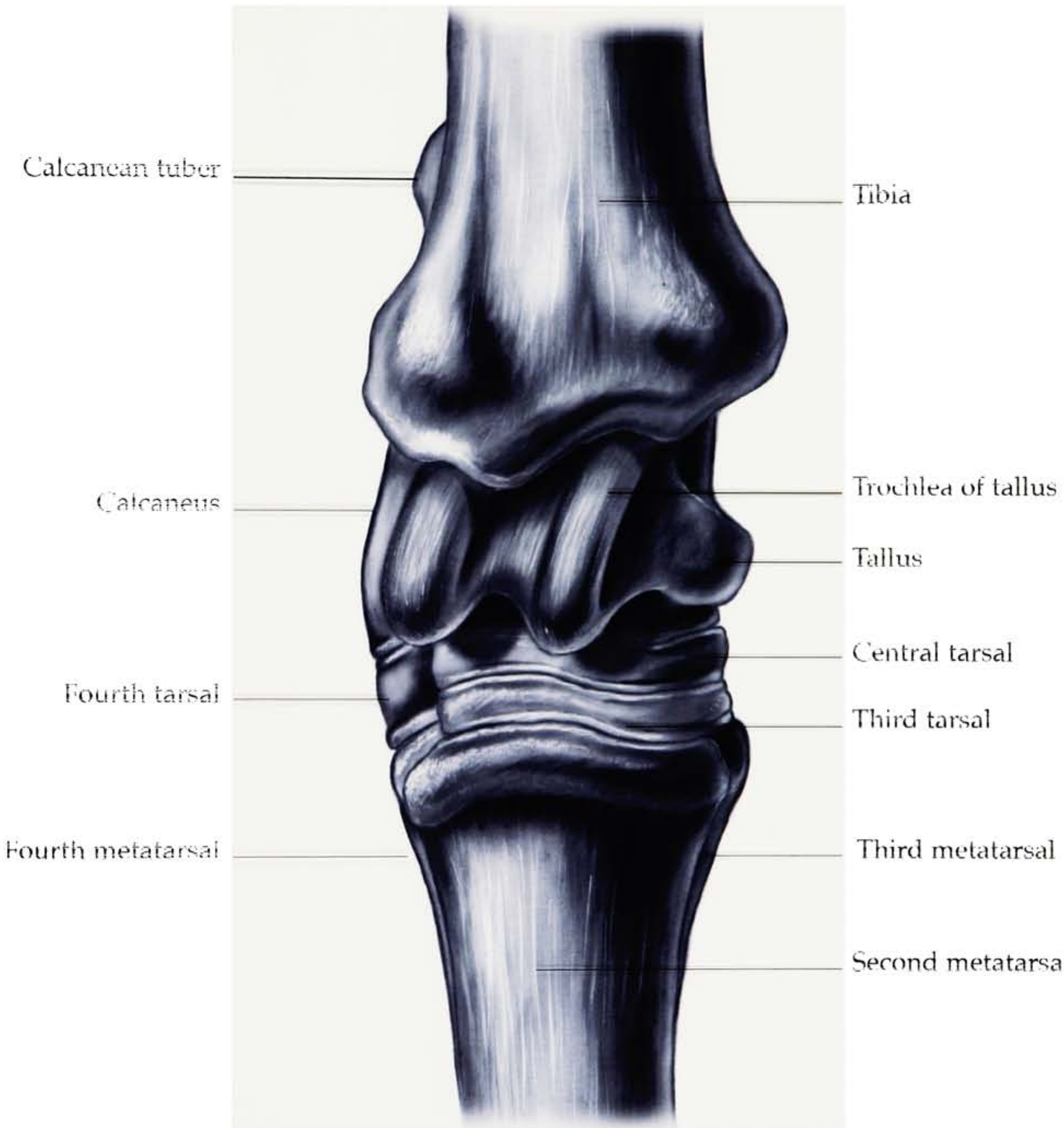


**Figure 6. Anterior view of the hock**

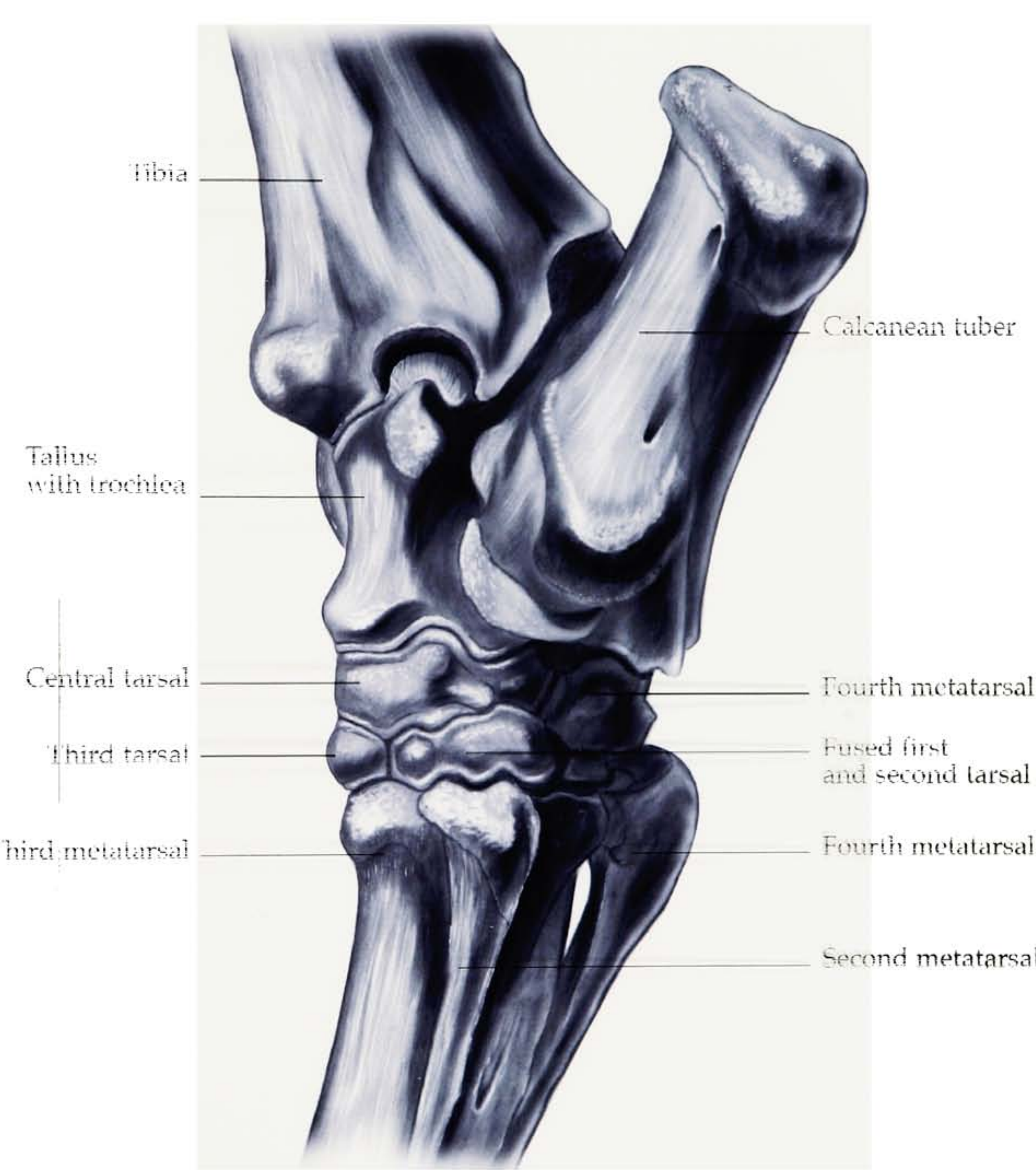


**Figure 7. Medial oblique view of the hock**

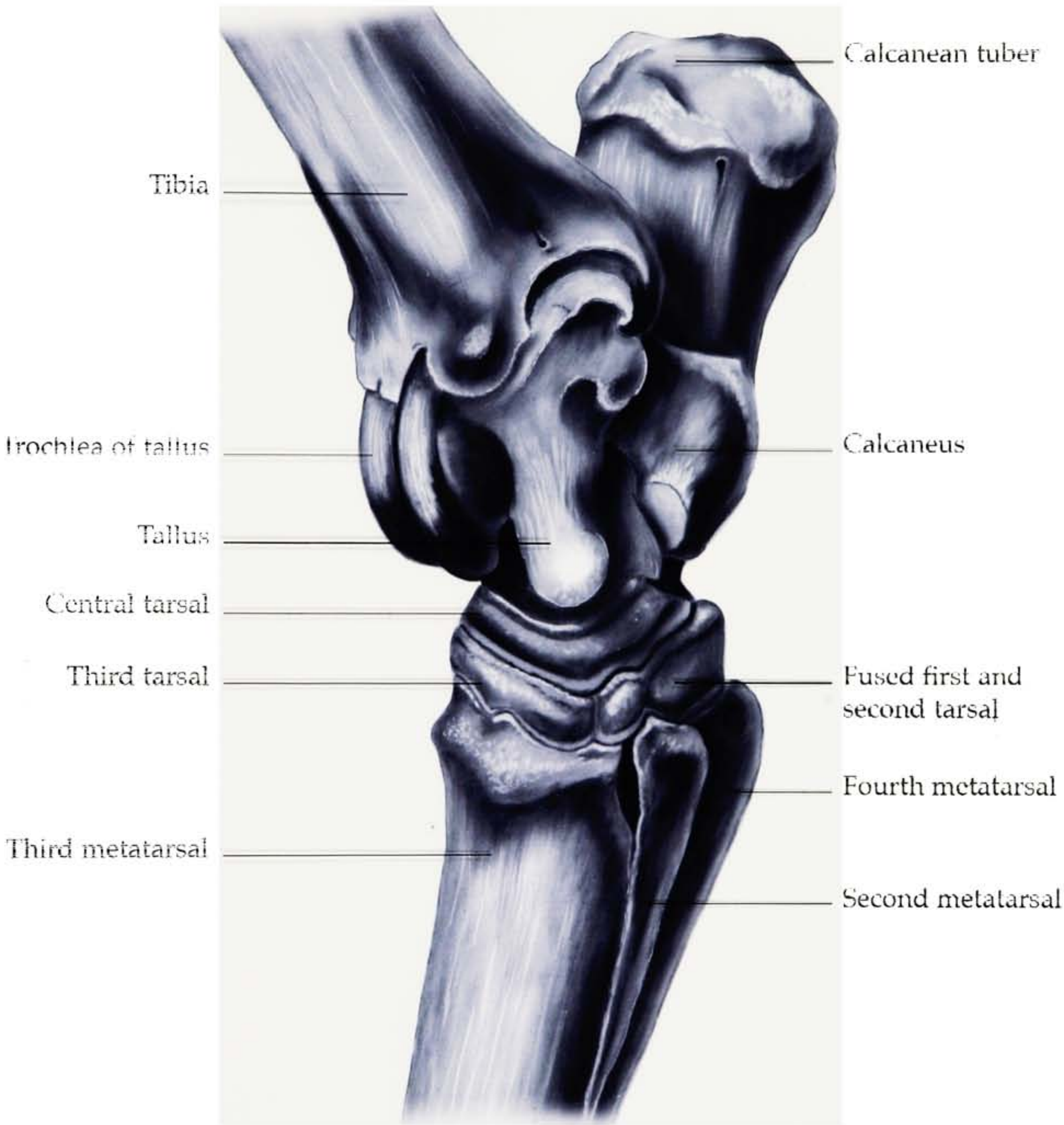


**Figure 8. Medial view of the hock**

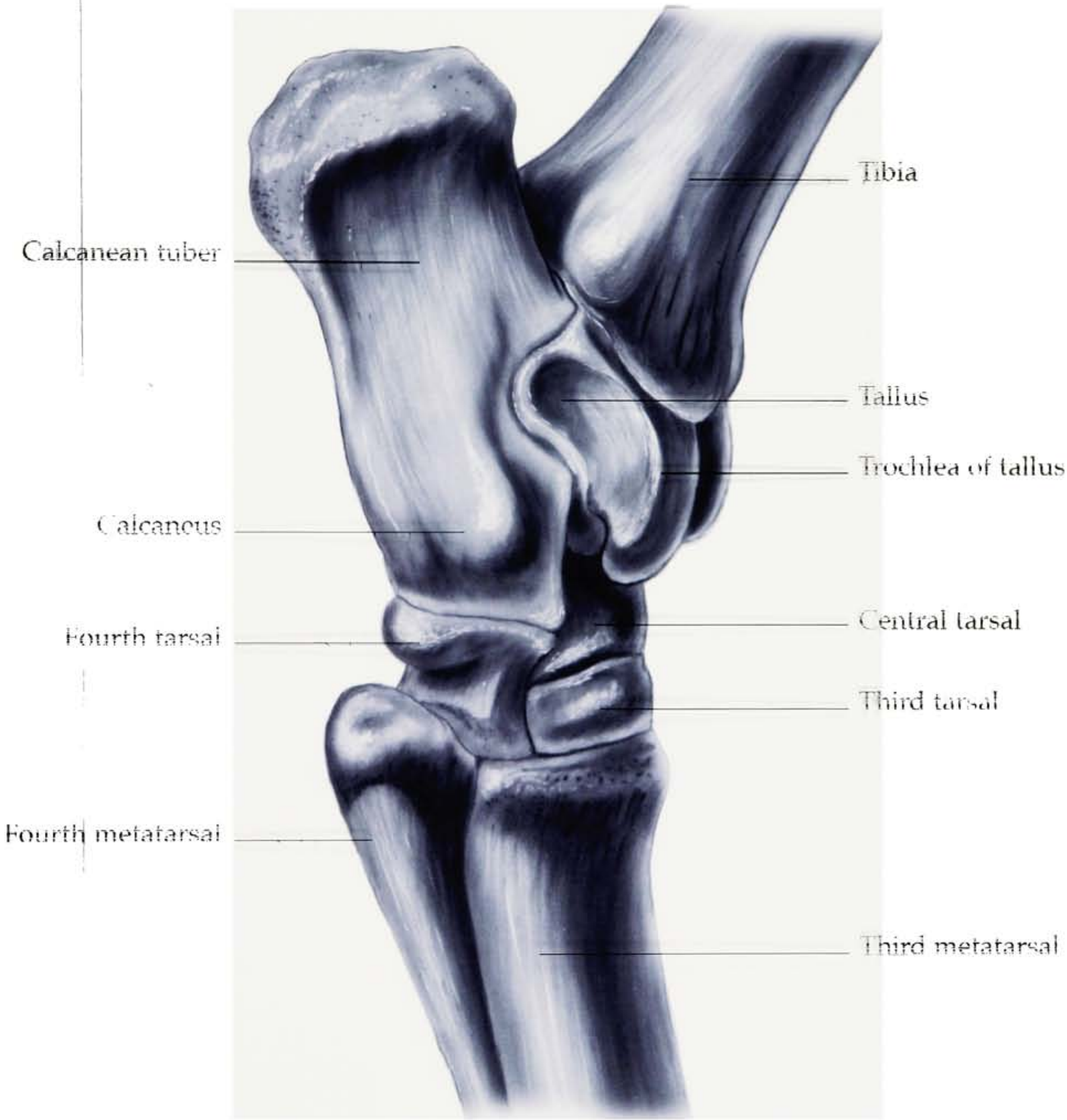


**Figure 9. Lateral view of the hock**

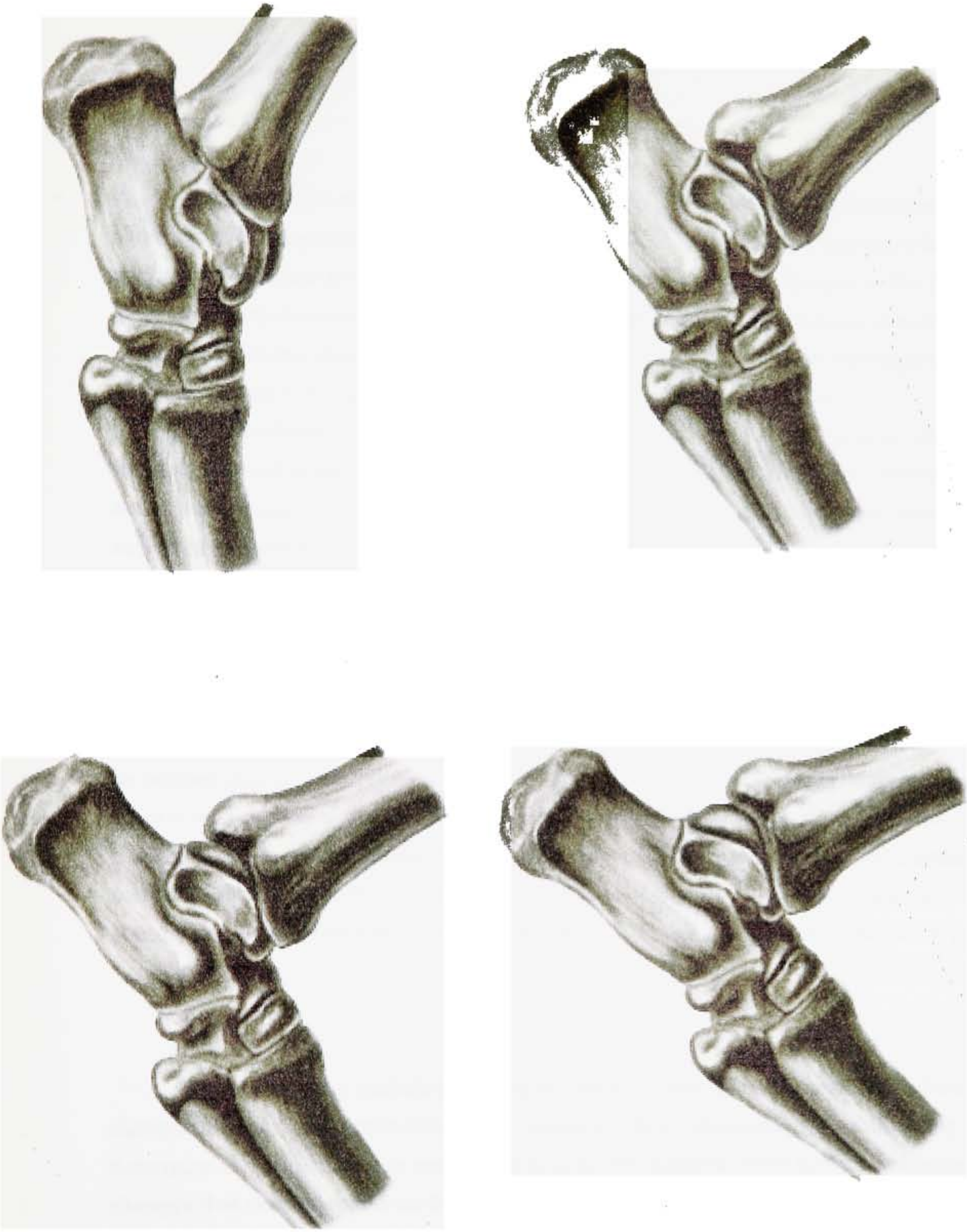

**Figure 10. Hock in flexion.**

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## Osteoarthritis: an overview

### Types of Osteoarthritis

Osteoarthritis or degenerative joint disease (DJD) is a group of disorders with a common end: progressive deterioration of the articular cartilage accompanied by changes in the bone and soft tissues of the joint.[1] Morphological changes in the joint have been well documented, but the clinical significance of these changes has not been determined. I have decided to focus on what might be causing the morphological changes, not on how clinically significant they might be to the disease.

Osteoarthritis is divided into five categories based of the type of joint affected, the structures affected, length of time from onset of symptoms, age of the individual, activity level, and related secondary problems. Type 1 is an acute condition that usually strikes high motion joints in young competitive horses; it is often associated with synovitis. Racing horses are most commonly affected. Type 1 is perhaps one of the most preventable conditions. Type 2 is an insidious chronic condition usually affecting high load/low motion joints of older horses. It is often referred to as being a result of "wear and tear" of the cartilage that takes place over time. However it will occasionally strike young competitive horses. Type 3 is incidental articular cartilage erosion and may only be noticed during a necropsy. The clinical importance of type 3 erosion is questionable, since it may or may not cause any degree of lameness in the horse. Type 4 is erosion that is secondary to other problems such as fractures, dislocations, wounds, septic arthritis or osteochondrosis. Type 5 is restricted to chondromalacia of the patella exclusively.[2] Types 1 and 2 are the most widespread, from this point on I will expand on these two types.

### Pathologic Changes

There are many pathologic changes that take place in an arthritic joint. Some changes are more noticeable than other changes. Most veterinarians are still trying to determine the importance as well as the causes and possible cures for these changes. The changes that occur depend on the joint involved. Specific changes will be mentioned in the following sections describing type 1 and type 2 osteoarthritis.

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[1] T. S. Stashak, *Adams' Lameness in Horses*, 4th Edition, (Philadelphia, PA, Lea & Febiger, © 1987), p. 384.

[2] Ibid, p. 384.

Destruction of cartilage is the most significant characteristic of osteoarthritis, regardless of the type. Gross examination of normal articular cartilage was discussed in the section about synovial joints. Cartilage that is beginning to degrade loses its normal appearance, changing from a translucent resilient white to a yellow color with a softer, less resilient consistency. Blisters can form on the surface during the early stages of degradation and will eventually lead to superficial pits and fraying of the surface.[1] Cartilage erosion is known by many terms, each of which describes the type of damage occurring. Thinning, wearing, and ulceration are a decrease in the overall thickness of the cartilage. These types of degradation are usually localized to particular areas of the articular surface. Erosion is a loss of the full thickness of the cartilage and can be either widespread or localized. If erosion has completely removed cartilage there are terms to describe the underlying subchondral bone as it is worn. Eburnation is used to describe the polished appearance of sclerotic bone. Eventually grooving of the eburnated subchondral bone will occur, running in the direction of joint movement.[2]

The cartilage matrix is formed in layers. Histologic lesions progress in stages, determined by the layers involved. When only superficial layers are involved it is called flaking or early fibrillation. As deeper layers become involved, fibrillation becomes full thickness erosion and fragmentation. Fibrillation is known as a morphological endpoint and can be related to either abnormal or normal environmental factors.[3]

Bony lesions can also occur. One type is a bony proliferation found within the joint capsule and ligaments. These are a direct result of stretching and tearing of the attachments. Another type occurs at the joint margins where bone, synovial membrane and articular cartilage meet. The causes of these proliferations are not well understood. They are believed to be an attempt to either extend the joint surface, by reducing concussion, or to limit the mobility of the joint, by reducing the amount of additional injury to the site.

Radiographs are perhaps the most reliable method for diagnosing osteoarthritis. The actual changes to the cartilage are not observable on the radiograph. However, there are signs that accompany cartilage destruction. A loss of joint space between adjacent bones is common. Another change is in the profile of the margin of the bone. Healthy bone should have smooth surfaces; arthritic bone has rough, sometimes chipped surfaces. Another change is the presence of subchondral sclerosis; this dense bone shows up as a bright white feature, far brighter than normal bone (See Figure 11).

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[1] Ibid, p. 385.
[2] Ibid, p. 385.
[3] Ibid, p. 385.

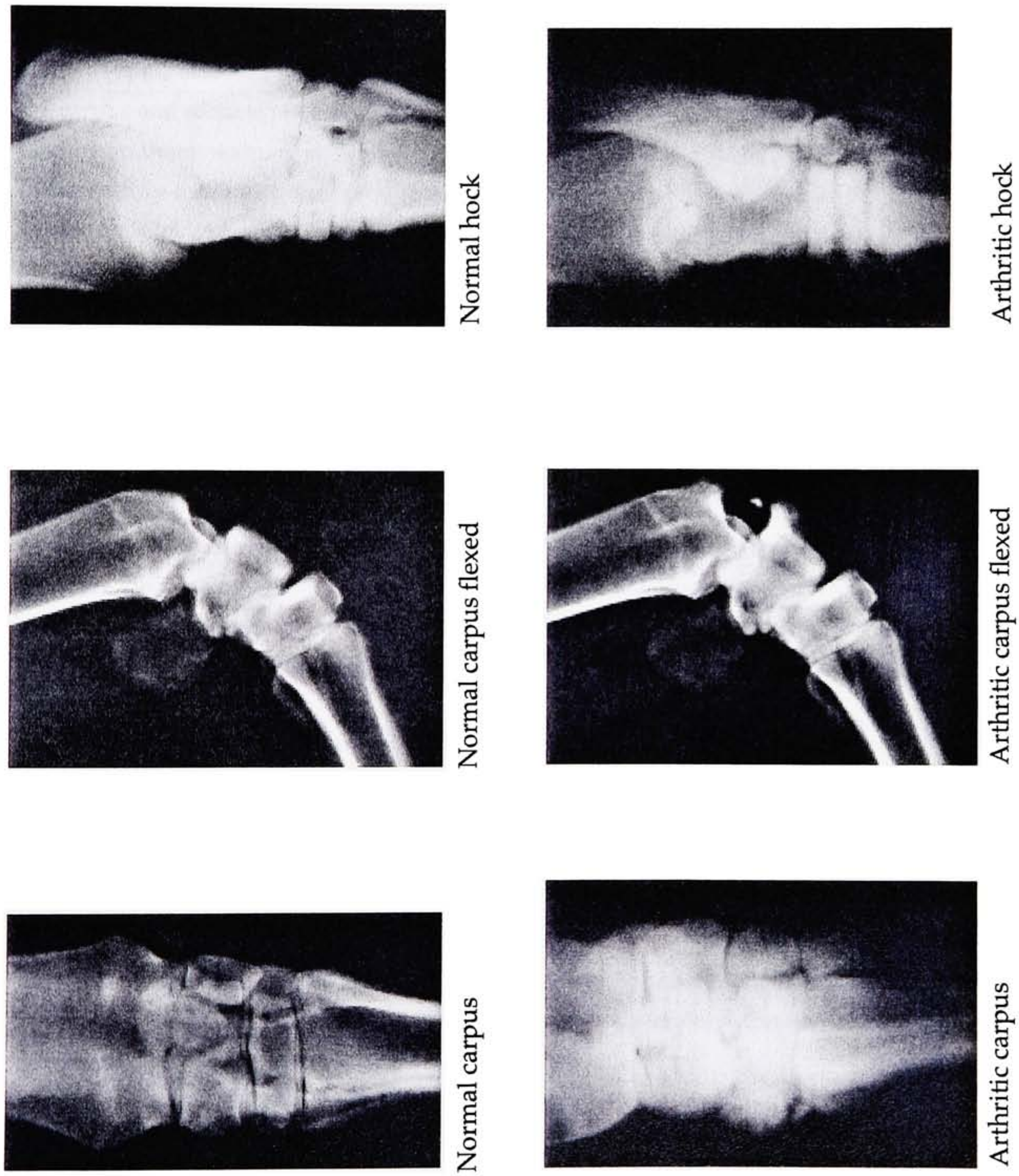


**Figure 11. Radiographs of arthritic joints.**

## Comparing types 1 and 2 osteoarthritis

### Description of Type 1

Type 1 osteoarthritis targets young athletic horses. High motion joints, such as the carpus and metacarpophalangeal joints are commonly effected. It is a disease that often gives many warning signs about the damage that is taking place. Acute inflammatory conditions such as synovitis and capsulitis are often associated with type 1 osteoarthritis.[1] Attention to these early warning signs determines the progression and severity of the disease.

Type 1 often results from damage to the bones as they are compressed together during strenuous activity. Racing is the most notable source of this concussion. As a horse gallops at top speed for long distances the fibrous capsule and ligaments are fatigued and can no longer prevent the carpus from overextending. This loss of control of the joint flexion can cause the anterior edges of the bones in the carpus to crash together. It also allows stretching and tearing of the joint capsule. This trauma at first causes synovitis, or irritation of the synovial membranes. Since these structures are sensitive they will often serve as a warning that trauma to the joint has occurred. The concussion of the bones can cause trauma to the articular cartilage as well, causing discrete patches of discoloration, fraying, erosion and ulceration primarily at the joint margins.

The synovitis and capsulitis are very important warning signs. During these inflammatory reactions lysosomal enzymes break down essential proteoglycans and glycosaminoglycans.[2] This breakdown causes changes in the articular cartilage making it lose its resiliency and become more vulnerable to concussive damage. The sources of these enzymes are controversial. They could be released by damaged chondrocytes, the inflamed synovial membrane, the fibrous capsule, or by the prostaglandins formed within the inflamed joint.[3] Whatever the source of these enzymes, their effects are devastating if treatment is not begun shortly after synovitis or capsulitis has been diagnosed.

If the synovitis warning is not heeded, subsequent concussions can further damage the structures of the joint. Progressive damage to the articular cartilage allows it

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[1] Ibid, p. 384.
[2] Ibid, p. 390.
[3] Ibid, P. 390.

to lose its elasticity and shock absorbing properties. This transfers the stress of the concussions directly to the bones of the joint. The stress over time can cause changes in the actual shape of the bones, as they remodel to better distribute the forces being exerted on them. These are called kissing lesion, and appear as extensions of the bone at the joint margins. These extensions are not as strong as the original bone and can fracture causing moderate to severe debilitation. The concussions between the bones can interrupt the bloodflow to the bone. Without this vital bloodflow, subchondral sclerosis sets in within the ischemic tissue. Subchondral sclerosis is a formation of bone that is denser than the original bone, but it is also more brittle and prone to fracture (See Figure 12).

## Description of Type 2

Type 2 osteoarthritis generally targets older horses, giving it a reputation of being a wear and tear disease brought on by old age. In some ways this is true, since it has been proven that articular cartilage does degrade with age. Type 2 however, is due to more than just advancing age. It also affects young athletic horses. The largest contributing factor to type 2 is what is referred to as "use trauma". Use trauma includes activities that have a jarring motion on joints. It can be found in a wide range of activities and is especially prominent in working quarterhorses, racing standardbreds, and jumping horses. These horses perform movements that cause the joints of the hind limb to withstand large, repetitive stresses to the intertarsal and tarsometatarsal joints of the hock as well as the interphalangeal joints. Poor conformation and shoes that do not allow the hoof to slide naturally can increase the stress of these motions. The repeated stresses on these joints cause damage to the articular cartilage, often without any accompanying synovitis or capsulitis. Since the articular cartilage is insensitive and avascular, damage is often extensive before any clinical signs are visible. In fact, it is most often diagnosed through radiographs. There may be accompanying lameness which can range from moderate to severe, but the degree of lameness is not a good indication of how far the damage has progressed. [1]

As mentioned in the section of the anatomy of the hock, the most commonly affected region is the "seat of spavin". Manifestations of the disease are usually seen as bony proliferation and osteophytes. A noted loss of joint space is also commonly seen (See Figure 13).

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[1] Ibid, p. 390.

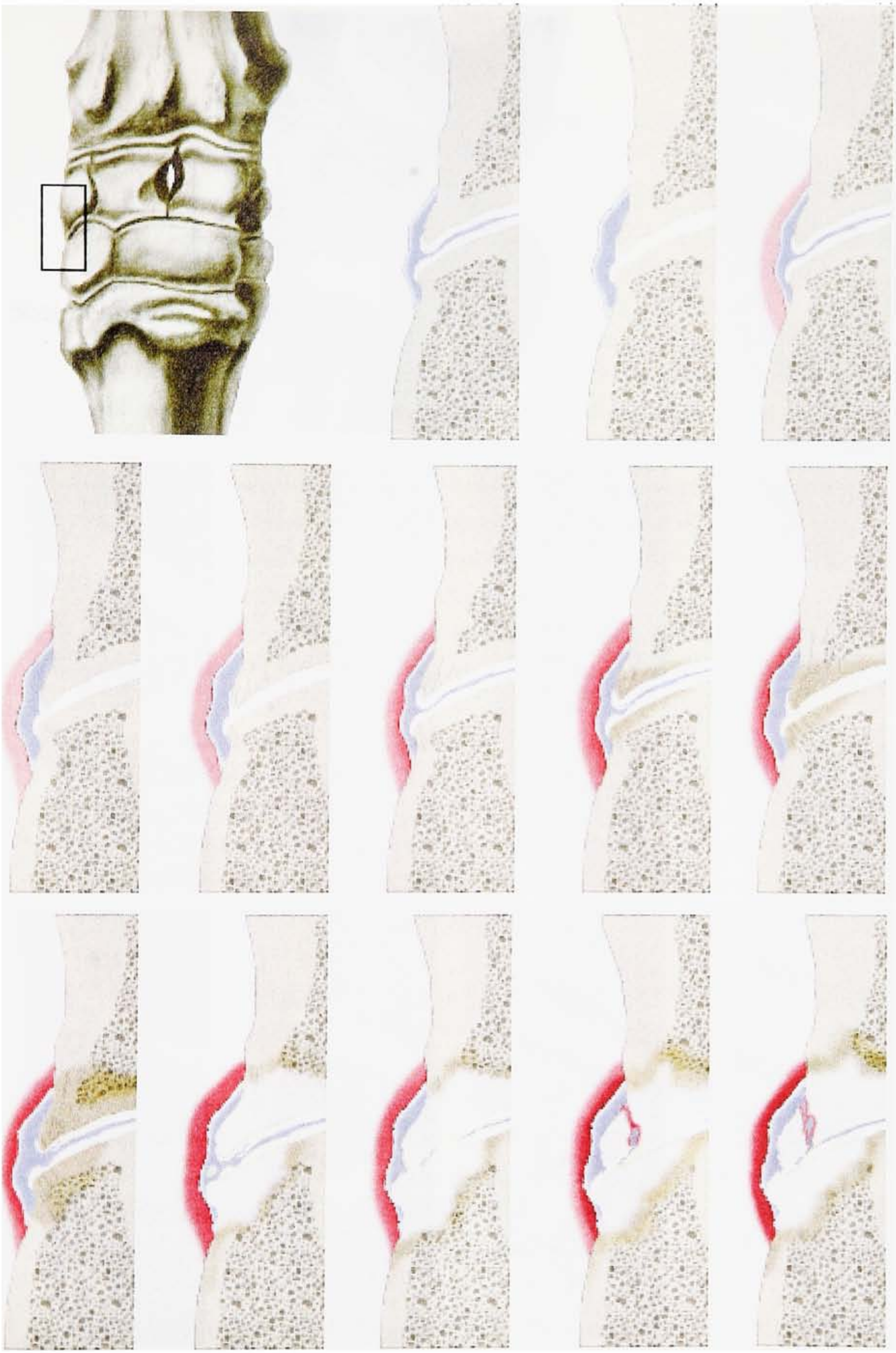

Figure 12. Type 1 Animation Cells

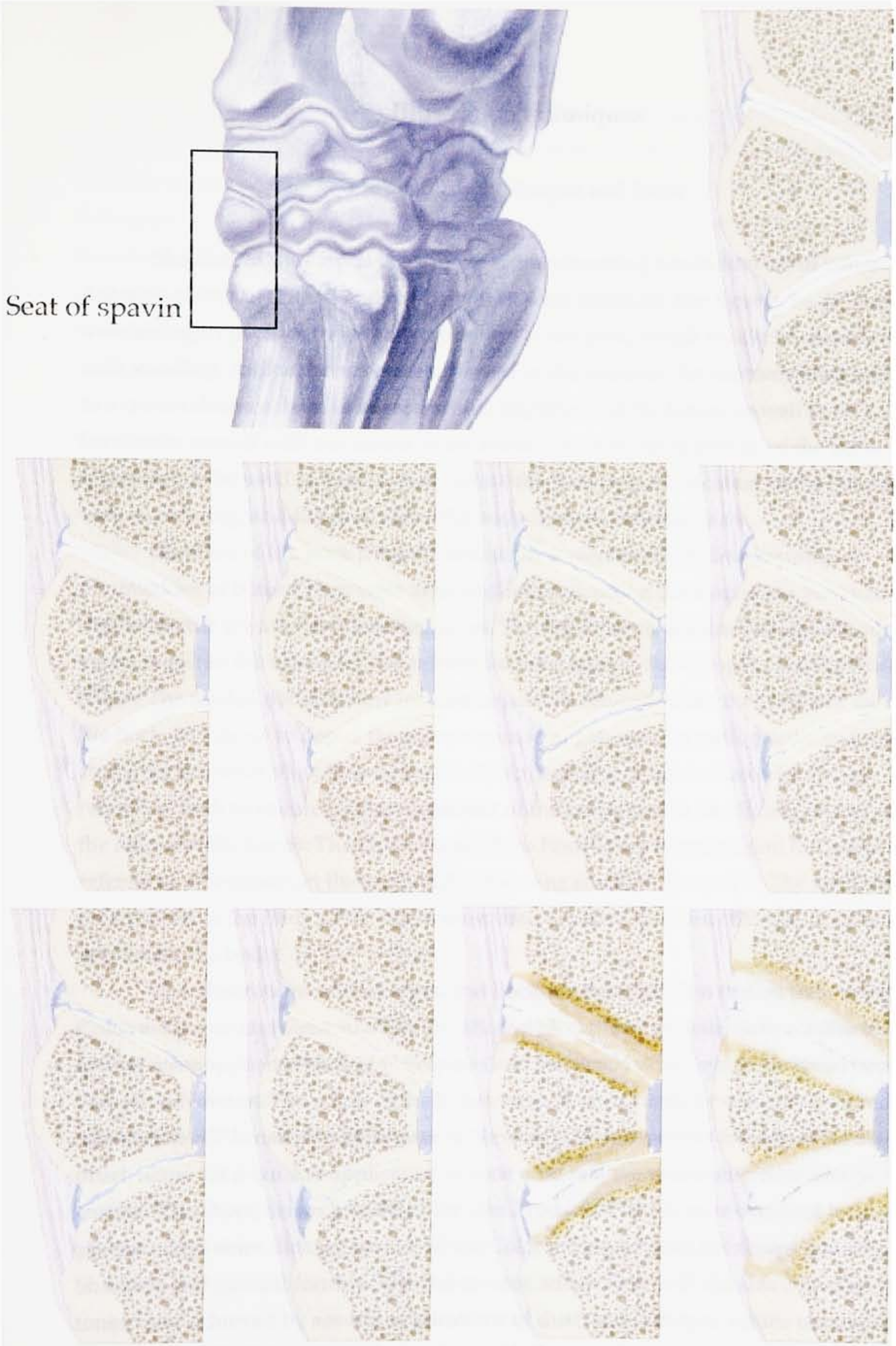


**Figure 13. Type 2 Animation Cells**

## Illustration techniques

### Carbondust: the Carpus and Hock

Sketches of the carpus were made while observing a mounted set of bones. Anterior, posterior, lateral and medial views were obtained (See figures 1 – 4). They were arranged in the fully extended position of the joint, which would be associated with standing. All four views were achieved in this manner. An anatomy atlas was used as a cross-reference, both to ensure proper alignment of the bones, as well as to familiarize myself with the names of the bones. Pen and ink drawings of the horse were completed to be used as keys, to help orient the viewer to the location of the body they were examining, and the position of the body in that particular view.

Sketches of the hock from the lateral view were made while observing a mounted set of bones. They were arranged in the standing position of the joint in a case that restricted the available viewing areas. The anterior, medial and medial oblique views required the use of several references from atlases, radiographs, and individual bones. The medial oblique view is more important clinically than the posterior view of the hock, so I chose to depict the more common angles used in radiographs and not study the posterior view (See figures 6 –9). An anatomy atlas was used as a cross-reference, both to ensure proper alignment of the bones and to familiarize myself with the names of the bones. The illustrations of the hock relied heavily upon the use of references to reconstruct the joint while observing small portions of it. The same ink illustrations of the body of the horse were used to orient the viewer to the location and position of the body.

The illustrations of the carpus and hock were rendered in carbon dust using Color aid paper and General's HB, 2B, 4B, and 6B charcoal pencils. Base washes of 4B carbon were applied with a 1/4" Sceptre Gold series 606 sable/synthetic blend brush by Winsor & Newton. The edges of the bones were defined carefully using a size 2 red sable series 807 brush also by Winsor & Newton. The long, softer bristles of the 606 brush allow for a quicker application of tone with relative uniformity over a large surface. The short, firmer bristles of the size 2 red sable brush were excellent for defining precise edges since the clay surface of the Color aid paper does not accept erasures well. Shadows and general forms of structures were added next with the size 2 brush. Deep tones were achieved by several applications of dust, and if deeper values were needed, carbon was added directly to the surface with the pencil and rubbed in with a

small drawing stomp, taking care not to damage the surface or polish it to a high gloss. Bright highlights were added initially with a kneaded eraser, and if finer details were necessary, a scratchboard tool was used to apply these marks by scoring the clay surface. Care must be taken to avoid damaging the paper with the scratchboard tool, and this step should be completed when all other steps have been done to satisfaction. Smudges and oil marks should be avoided at all costs when working with Color aid paper, as it is an unforgiving surface and any blemish will show up just as clearly as your work. Spray fixative was applied to preserve the work and prevent smudging of the dust.

These illustrations were scanned at 400 dpi into Adobe Photoshop. I kept one set of these scans at their original size and made them into Duotone images in Adobe Photoshop. I used a full, framed set of these Duotone images to display in the thesis exhibit. The images printed for the anatomy sections in this thesis are copies of the Adobe Photoshop Duotone images. The resolution for the images used for the Macromedia Director projector was dropped to 150 dpi. I also had to scale the images down to fit on the screen. Once this was done, the bones were colored using the color mode in Adobe Photoshop. Both of these methods provided excellent color application and preserved the quality of tone and detail in the carbon dusts.

## Computer Animations for the Instructive Interface

A disease process is very difficult to understand just by reading about it, or looking at static pictures. The use of animations can explain many complicated processes in a manner that is clear yet detailed. I used animations in the instructive interface to show a wide range of subject matter.

Images of the horse in motion helped to show the natural motion of the joints in relation to the entire animal. To show the diverse ability of these athletic creatures I selected three different working horses: racing, jumping, and pulling. The subjects were taken from Eadweard Muybridge's *Animals in Motion*.[1] These photographic references provided detailed images of the various stages of a single stride. Using these as references, I created pen and ink illustrations. These illustrations were then scanned into Adobe Photoshop at 200 dpi, scaled as needed, and arranged over a textured background. Each cell was kept in an individual layer so that it could be moved if necessary. Changing the layer properties to multiply then modified the layers containing

[1] E. Muybridge, *Animals in Motion*, Edited by Brown, Lewis. New York, NY. Dover Publications, Inc. © 1957. Plates 7, 68, 76.

the ink illustrations. This made the white in the background transparent, and allowed the textured pattern to be seen. Each collection of animation cells occupied a certain horizontal band of the canvas background. This was important when the images were brought into Macromedia Director. The entire stage was covered with a textured background so it was important to line up the block of corresponding background that was imported with the horse to the background of the stage. If done correctly, it gives the illusion of a pen and ink illustration moving across the screen. Limiting the illustrations to black and white allowed the reducing of the images from sixteen bit color down to four bit color, which cut down not only on the file size, but also the loading time and the characteristic "chugging" of Macromedia Director when it is handling large files.

Another place animations became important was in studying joint movement. The sections in the interface on anatomy were arranged to identify the bones, and to identify the locations of high and low motion joints. The next section, showing the joint in motion, was included to put additional clarity on which were high motion and which were low motion joints. The result was satisfactory as well as exciting for the users of the interface. These animations were done in Adobe Photoshop and Macromedia Director. The lateral view of each joint was cut into pieces and each section of bones which moved together was placed in the same Adobe Photoshop layer. After the joint had been divided up, each layer could be copied, rotated a certain number of degrees, and reoriented with the other members. After the pieces had been repositioned, they were flattened into new files containing the new positions of the bones. Each of these files was arranged one after the other in Macromedia Director, which gave the same illusion as the ink illustrations, allowing the joint to move in a smooth fluid like manner.

The last use of animations was in the illustrations of the mechanical forces that are present in type 1 and type 2 osteoarthritis. These animations were generated in Adobe Photoshop from ink illustrations sketched out from enlarged portions of the completed carbondusts. The rendering was done in a detailed yet simplified manner, depicting the structure of the bones, the articular cartilage, the synovial spaces and membranes. Blood vessels and detailed rendering of the fibrous capsule and ligaments were not included for the sake of clarity. Each part of the illustration was kept in a separate layer, which was later manipulated to show concussion, stretching, swelling and remodeling of the joint in the various stages of disease. These animations were useful in combining all the information introduced in the first parts of the interface, and explaining what exactly was happening, without going into too much detail.

## The instructive interface for the Macintosh ®

The instructive interface I designed in Macromedia Director was primarily designed to be a teaching device for use in either a clinical setting or a veterinary school setting. I wanted to have a format that was content rich, and not cluttered with unimportant information.

The instructive interface is actually two movies. The first is essentially a splash page. It loops through three animations, while showing the title and other credit information. From this movie, you can move into the second movie. Any time the second movie is exited, either by user interaction or the programmed timer, it will return to the first movie. This design was important since I wanted to have the movie be able to reset itself if left in the middle of the program so the next user would be able to start from the beginning.

The navigation system was designed to be text driven. I wanted to not have buttons cluttering the screen, so I made buttons that were text only, responding to mouse rollovers by changing font size and opacity. After a particular section had been visited, the text remained the larger size, but was kept at a lower opacity. This kept the layout simple and easy to navigate and helped the user keep track of where they had been in the program. Behavioral rollovers helped to indicate the active buttons.

The artwork was scanned and imported into the program after being colored in Adobe Photoshop. Pen and ink illustrations of the body of the horse were added to help orient the viewer to the particular location of the horses' body being discussed. Labels were added to identify the individual bones of the joints. Separate subtopics were included to identify high motion joints, low motion joints, and show the joint in motion.

I then added a section discussing osteoarthritis. Animations accompanied descriptions of both types 1 and 2. I feel the use of these animations helped bring about a greater sense of understanding of a complicated disease process. The animation sequences started with a full view of the joint. To develop a type of ease in for the animation, a small portion of the joint was represented in cross section within the entire joint. As the cross sectional view expanded, the view of the entire joint faded until the cross sectional view filled the screen. A smaller view of the entire joint with the inset of the cross section was placed on the far side of the screen to remind the viewer of the location the animation was coming from.

I ended the comparison with a study of radiographic images comparing normal and arthritic anatomy. The image for the normal carpus in the extended position was scanned from the *Atlas of Radiographic Anatomy of the Horse.*[1] A comparitive radiograph of an arthritic carpus in the same position was scanned from *Adams' Lameness in Horses.*[2] I selected a radiographic image of a normal carpus in a flexed position from the *Atlas of Radiographic Anatomy of the Horse.*[3] The view for the arthritic carpus was created by altering the radiographic image of the normal carpus. This is the only image that I modified, by comparing the normal radiograph with arthritic radiographs that I was not able to duplicate.

The image for the normal oblique hock was taken from *Adams' Lameness in Horses.*[4] The image for the arthritic oblique hock was taken from the same book.[5] The images of the hock were difficult to work with, since the normal radiograph was very bright. It made it very difficult to see the structures used for diagnostic purposes, even with a large adjustment of brightness and contrast. Compared to the arthritic radiograph of the hock, it almost appeared that I had placed the images in the wrong places on the screen. I tried to make the distinction between them as clear as the images of the carpus. I would have liked to had better quality images, but these were what I had available to me.

I scanned all these images at 300 dpi and adjusted the brightness and contrast to make the image clearer. They were scaled down to fit on the screen in Macromedia Director. I then placed the images side by side so the viewer could compare the normal radiograph with the arthritic radiograph. I think this presentation worked rather well and presented the viewer with a chance to apply the information they had just learned.

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[1] H. Schebitz, H. Wilkens, *Atlas of Radiographic Anatomy of the Horse.* 3rd edition. Philadelphia, PA. Verlag Paul Parey / W. B. Saunders Co. © 1978. Figure 82.

[2] T. S. Stashak, *Adams' Lameness in Horses,* 4th Edition, (Philadelphia, PA, Lea & Febiger, © 1987), Figure 7-63.

[3] Ibid, Figure 80.

[4] Ibid, Figure 4-70.

[5] Ibid, Figure 7-63.

## Conclusion

Type 1 and type 2 osteoarthritis have many similarities and differences. They both arrive at the same physiological endpoint, yet take different paths to get there and encounter different problems along the way. To me, the most striking difference between the two types is the joints they effect. This was an interesting study of the movements of these joints, the stresses they are designed to endure, and the overloads that are often placed on them. It is also a study of the biochemical balance that is crucial to joint health. I only touched briefly on this, since it was more complicated than I wanted to get into at the time, but it would have made an interesting research topic in and of itself.

Equine osteoarthritis is a disease that is still being explored. Veterinarians have learned much about this disease. Yet with each discovery there is another question revealed. While there are many different tools used to diagnose this disease, the treatments are still largely successful only on a trial and error basis. Part of the reason for this is the relative lack of knowledge about the intricate balance that must be maintained to ensure proper joint function. If more could be learned about this balance, then perhaps better treatments could be made to counteract the imbalance. There are new drugs and therapies on the horizon, but there is no guarantee that they will work on every horse. I did not discuss the treatment options of osteoarthritis; there are many of them, which have been unpredictable at best in treatment programs. I did want to help owners at least learn as much about the two most common types of osteoarthritis. I think the instructive interface performs this task well and would make a useful addition to any veterinary practice.

As for my traveling companion, I will continue to learn all that I can about her condition, attempting to prolong her useful years keeping her active and as pain free as possible.

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