RADIOLOGY OF THE EQUINE LIMBS

Lameness is one of the most important clinical abnormalities in horses - both in frequency and in economic impact. Radiography is often the first method of diagnostic imaging used in the evaluation of lameness.

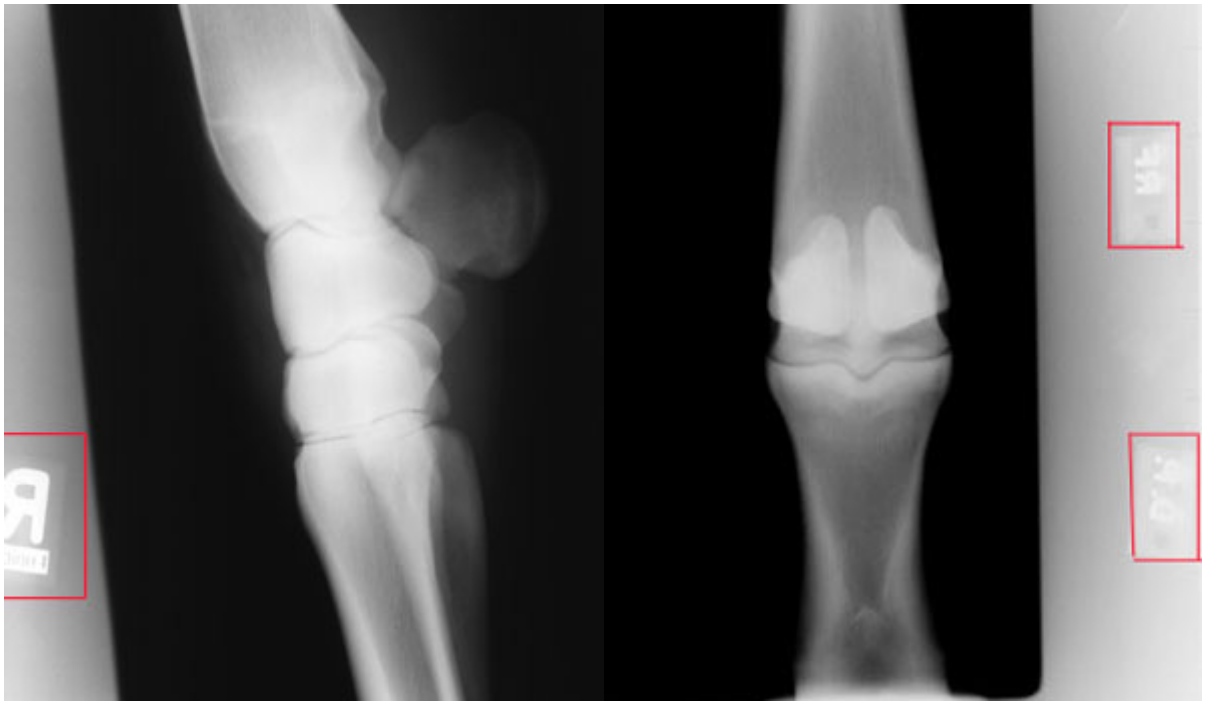
The majority of radiographs of the distal portions of equine limbs are obtained with portable x-ray units. These units are small and relatively lightweight. These are low output units, typically in the range of 10-30 mA and 70-90 kVp. X-ray units at the lower end of this range are suitable for distal limb radiographs only. Units in the higher end may be used for radiographs of the stifle, proximal cervical spine and head. These units may be hand-held (dependent on applicable radiation safety regulations) or may be used with a portable stand. The stand decreases radiation exposure to personnel and increases the quality of the radiographs by limiting motion.

This is a typical portable x-ray unit produced for equine practitioners. This unit is capable of 10 mA and 80 kVp so is suitable only for the distal limbs.

Although radiographs of some proximal limb structures may be obtained with portable x-ray units, better quality films will be obtained with the use of a unit capable of higher x-ray output. Radiographs of the shoulder, caudal cervical spine and pelvis will require the use of a high output machine. Such units are capable of 300-1000 mA. These units are generally large mobile units or fixed units found in large referral practices or universities.

FILM LABELING

The correct labeling of equine radiographs should be understood since this may have diagnostic and legal consequences. Correct labeling includes permanent identification of the patient and the owner (or purchaser in the case of a pre-purchase examination) and an indication of the limb that is being radiographed. By convention, the limb markers should be placed along the dorsal or lateral aspect of the limb (red boxes).



However, not everyone follows this convention and mistakes in placement can be made - this can lead to confusion in oblique radiographs. The most exact method of labeling is the use of markers that clearly indicate the radiographic projection. These are easy to obtain and are inexpensive.

In this radiograph markers (red arrows) are used to indicate the limb (RF) and the view (DLPMO).

STANDARDIZED NOMENCLATURE FOR RADIOGRAPHIC PROJECTIONS

A standardized system of nomenclature should be concise and understandable so that

1. Given only the name of the radiographic projection, a person familiar with veterinary anatomic nomenclature and radiography should be able to produce that projection with x-ray equipment
2. Given the relative positioning of the x-ray equipment and body part a person familiar with veterinary anatomic nomenclature and radiography should be able to derive the proper name for the projection produced.

In order to fulfill these requirements the following rules have been proposed

1. Radiographic projections should be named using only proper veterinary anatomic directional terms. Any abbreviations listed should correspond with these terms.

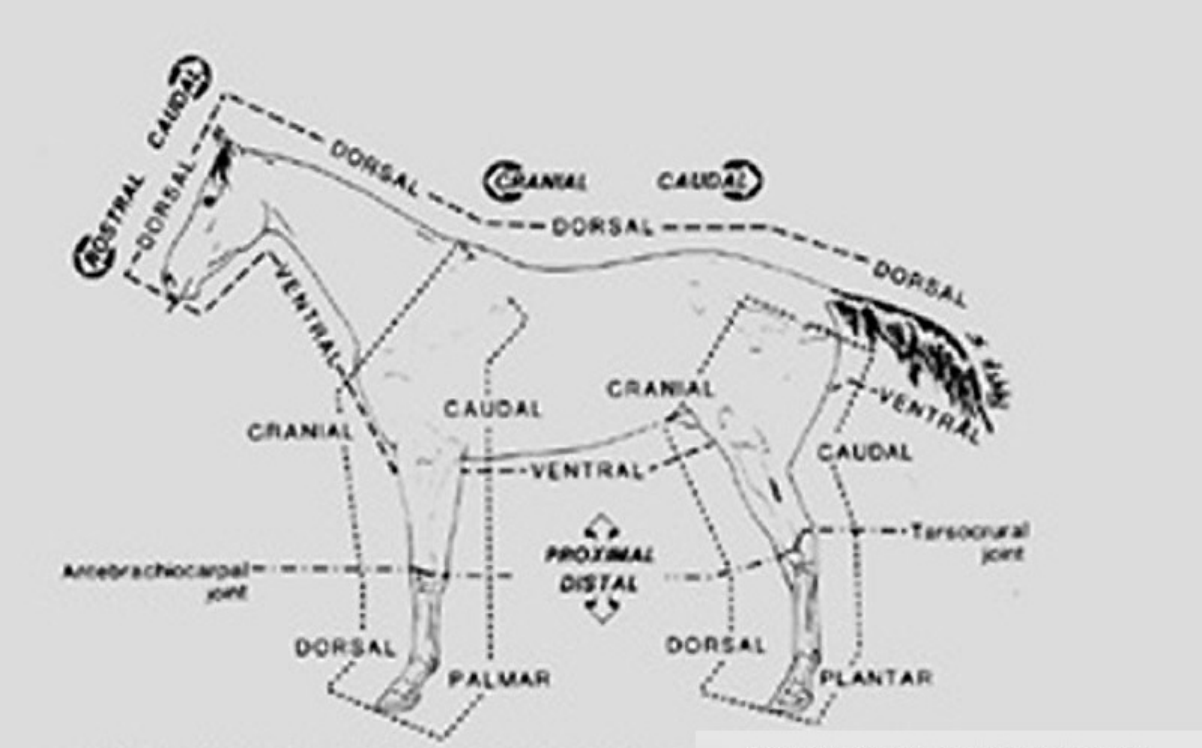


FIG. 1. Proper anatomic directional terms

TABLE 1. Directional Terms and Abbreviations Used to Describe Radiographic Views

Left (Le)	Medial (M)
Right (Rt)	Lateral (L)
Dorsal (D)	Proximal (Pr)
Ventral (V)	Distal (Di)
Cranial (Cr)	Palmar (Pa)
Caudal (Cd)	Plantar (Pl)
Rostral (R)	Oblique (O)

2. Radiographic projections should be described by the direction that the central ray of the primary beam penetrates the body part of interest, from "point of entrance to point of exit."

Many projections require combinations of basic directional terms to accurately describe the point of entrance and point of exit of the primary beam. It is recommended that these terms be combined in a consistent order to increase standardization of the nomenclature.

1. The terms "right" and "left" are not used in combination and should precede any other terms. Example: right cranioventral

2. The terms "medial" and "lateral" should be subservient when used in combination with other terms. Example: dorsomedial

3. On the head, neck, trunk and tail, the terms "rostral," "cranial," and "caudal" should take precedence when used in combination with other terms. Example: craniodorsal

4. On the limbs the terms "dorsal," "palmar," "plantar," "cranial," and "caudal" should take precedence when used in combination with other terms. Example: dorsoproximal

5. The term "oblique" is added to the names of those projections in which the central ray passes obliquely (not parallel to one of the 3 major directional axes - medial/lateral, dorso/palmar or cranio/caudal) through the body part.

6. The "tangential" or "skyline" views require no special designation since the point of entry to point of exit method describes these views concisely.

7. In those views requiring a combination of directional terms a hyphen should be inserted to separate the point of entry and point of exit. Example: Palmaroproximal-palmarodistal

TABLE 3. Standardized Combination of Terms

Head	Neck, Trunk, and Tail	Limbs	
rostrodorsal	craniodorsal	cranioproximal	cranioproximomedial
rostroventral	cranioventral	craniodistal	cranioproximolateral
caudodorsal	caudodorsal	craniomedial	craniodistomedial
caudoventral	caudoventral	craniolateral	craniodistolateral
(left) right rostrodorsal	(left) right craniodorsal	caudoproximal	caudoproximomedial
(left) right rostroventral	(left) right cranioventral	caudodistal	caudoproximolateral
(left) right caudodorsal	(left) right caudodorsal	caudomedial	caudodistomedial
(left) right caudoventral	(left) right caudoventral	caudolateral	caudodistolateral
dorsomedial		dorsoproximal	dorsoproximomedial
ventromedial		dorsodistal	dorsoproximolateral
dorsolateral		dorsomedial	dorsodistomedial
ventrolateral		dorsolateral	dorsodistolateral
rostrodorsomedial		(plantaro)palmaroproximal	(plantaro)palmaroproximomedial
rostroventromedial		(plantaro)palmarodistal	(plantaro)palmaroproximolateral
rostrodorsolateral		(plantaro)palmaromedial	(plantaro)palmarodistomedial
rostroventrolateral		(plantaro)palmarolateral	(plantaro)palmarodistolateral
caudodorsomedial			
caudoventromedial			
caudodorsolateral			
caudoventrolateral			

Angle designations are not an inherent requirement of the descriptions for oblique views. However, in complex views the use of specific angle designations helps to define exactly how the radiograph was obtained. These angle designations will be needed for exact reproduction of the desired image.

1. When deemed necessary, angles of obliquity are indicated by inserting the number of degrees between the directional terms involved. Even for complex oblique projections, the angle designations can be inserted so as to indicate the angle of obliquity in each plane.

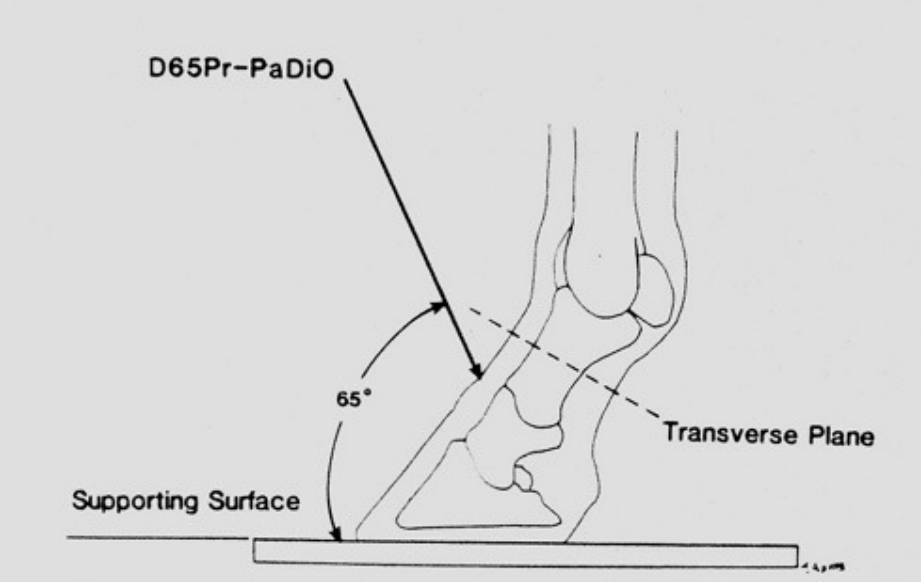


FIG. 5. A dorsoproximal–palmarodistal oblique (DPr–PaDiO) view of the equine distal phalanx and distal sesamoid bone made at 65° proximal to the supporting surface. This projection could be described more accurately as a D65Pr–PaDiO.

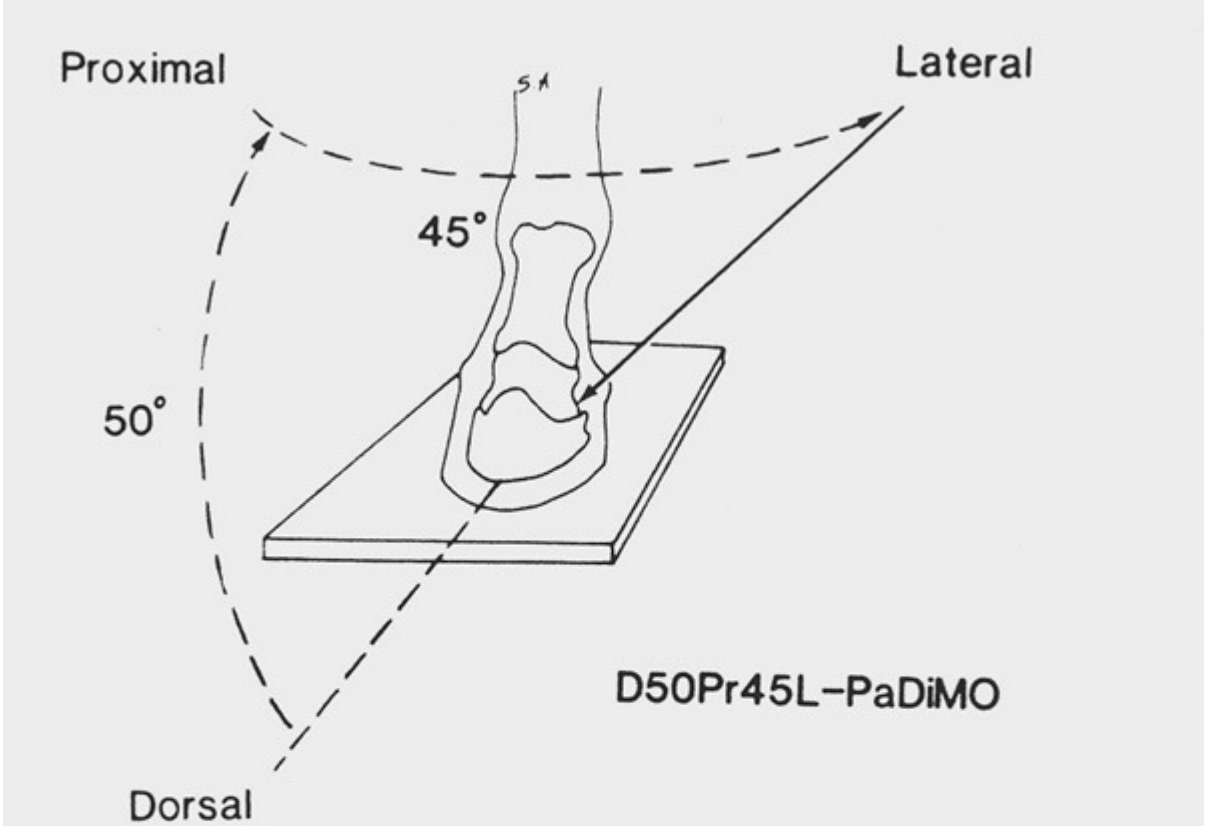


FIG. 4. A dorsoproximolateral–palmarodistomedial oblique (DPrL-PaDiMO) view of the equine distal phalanx made at 50° proximal to the supporting surface and 45° lateral to the dorsopalmar line. If deemed necessary, this projection could be specifically described as a D50Pr45L–PaDiMO. This designation would allow accurate reproduction of the desired projection.

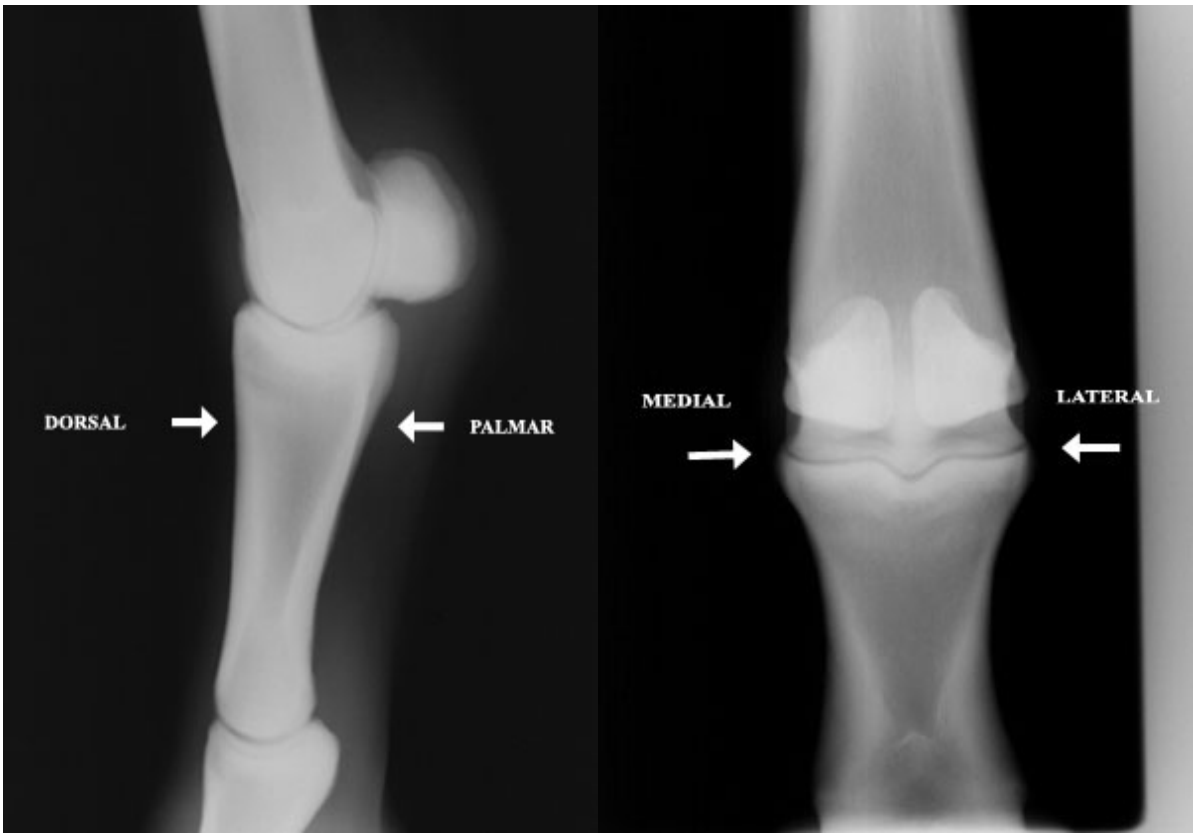
The recommendations above for standardized nomenclature at first appear very confusing. However, the rules are logical and will begin to make sense with continued use.

In the following section oblique radiographic projections will be further described. As you work through this section try to keep the rules of standardized nomenclature in mind. You will notice that in many cases we use a "simplified" version of the standardized nomenclature. The one rule that always applies however is that of "point of entry to point of exit."

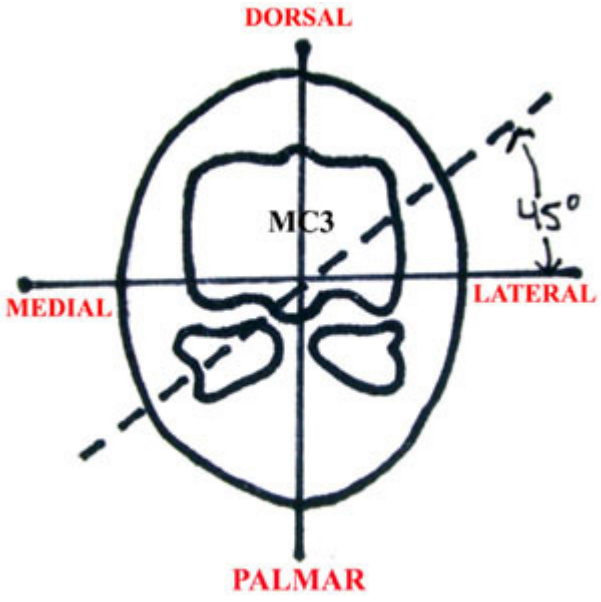
OBLIQUE RADIOGRAPHIC PROJECTIONS

The skeletal structures of horses are large and complex. In order to evaluate as many surfaces of the bones as possible multiple views are required. Understanding how and why these views are obtained is important.

Routine radiographic series of the joints of the lower limbs include latero-medial and dorso-palmar (plantar) views. These views highlight the dorsal and palmar and lateral and medial margins of the limbs respectively.

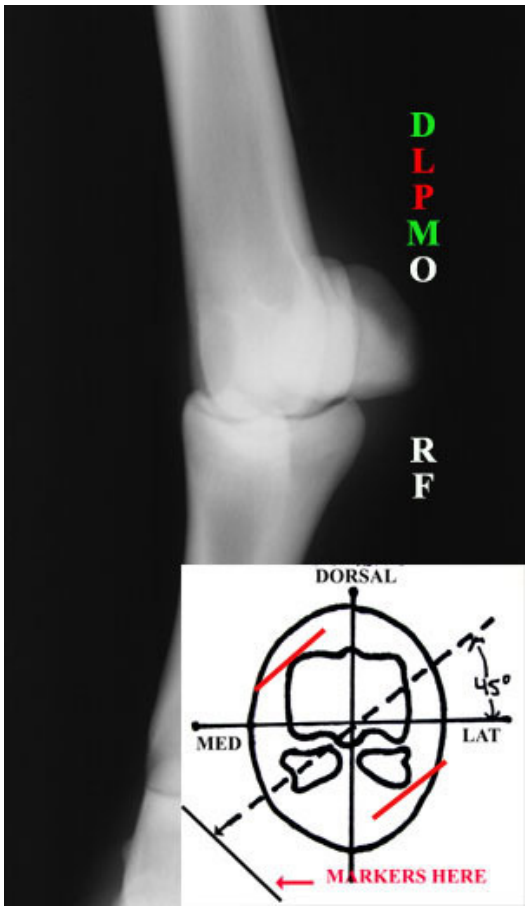


Considering the size of equine skeletal structures these views allow evaluation of only about 50% of the surfaces of the bone structures. In order to evaluate 100% of the bone surfaces additional views are needed. These views are known as oblique views and are generally obtained with the radiographic beam at 45 degrees to the dorsal aspect of the limb (halfway between dorsal and lateral or dorsal and medial).



The oblique radiographic projections are named for the direction of beam travel. In the case illustrated above the radiograph would be a dorsolateral - palmaromedial oblique or DLPMO.

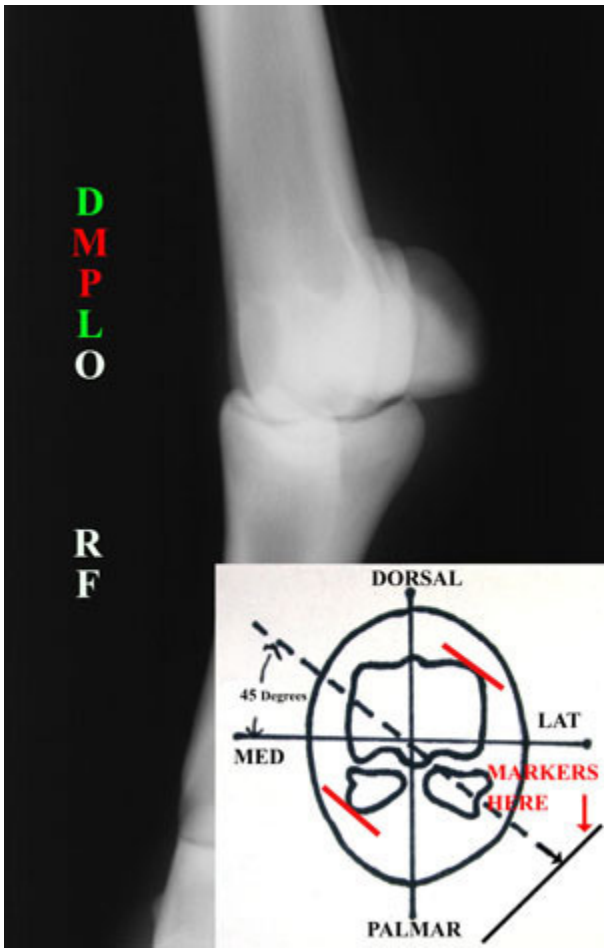
DORSOLATERAL - PALMAROMEDIAL OBLIQUE (DLPMO)



This view is obtained with the x-ray camera along the dorsolateral aspect of the limb and the film cassette on the palmaromedial aspect of the limb. The x-ray beam travels from dorsolateral to palmaromedial. By convention the film marker is placed along the lateral aspect of the cassette - this creates the appearance of the marker being along the palmar aspect of the limb in the radiograph. This oblique projection highlights the dorsomedial and palmarolateral surfaces of the limb (red lines). Note that these are the opposite surfaces to the name of the view. Another method to remember which surfaces are highlighted is to look at the abbreviation for the view -DLPMO - disregarding the O the highlighted surfaces will be the middle 2 letters (LP) and the outer 2 letters (DM).

DORSOMEDIAL - PALMAROLATERAL OBLIQUE

This view is obtained with the x-ray camera along the dorsomedial aspect of the limb and the film cassette on the palmarolateral aspect of the limb. The x-ray beam travels from dorsomedial to palmarolateral. By convention the film marker is placed along the lateral aspect of the cassette - this creates the appearance of the marker being along the dorsal aspect of the limb in the radiograph.



The same principle can be illustrated using an anatomic specimen of the tarsus and a film cassette. Note the position of the markers in the views. The surfaces of the bones that are clearly seen are the ones that are projected onto the film and therefore highlighted in the final radiographs - dorsomedial and plantarolateral in the DLPMO and dorsolateral and plantaromedial in the DMPLO.

ADDITIONAL OBLIQUE VIEWS

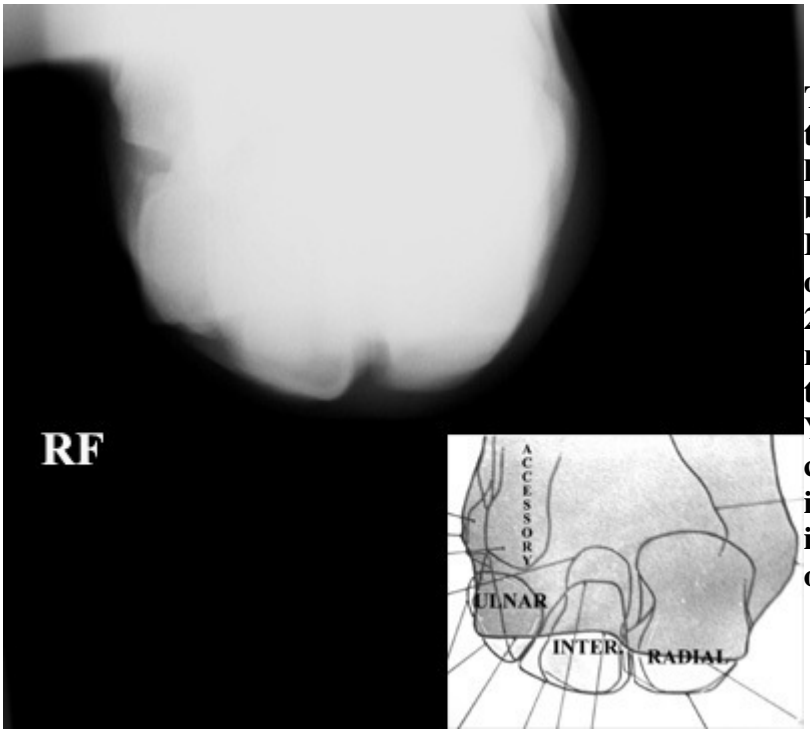
The DLPMO and DMPLO views are the most commonly used oblique views - they are included in the routine radiographic evaluation of most joints. However, there are many additional oblique radiographic projections that are used to highlight particular bones or portions of bones under evaluation. In this section we'll consider some of the more common of these.

THE CARPUS

Dorsoproximal-dorsodistal oblique (DPr-DDiO)projections of the carpal bones are some of the most commonly used projections. These are commonly referred to as "skyline" views and allow evaluation of the dorsal surface of the distal radius and each row of carpal bones.

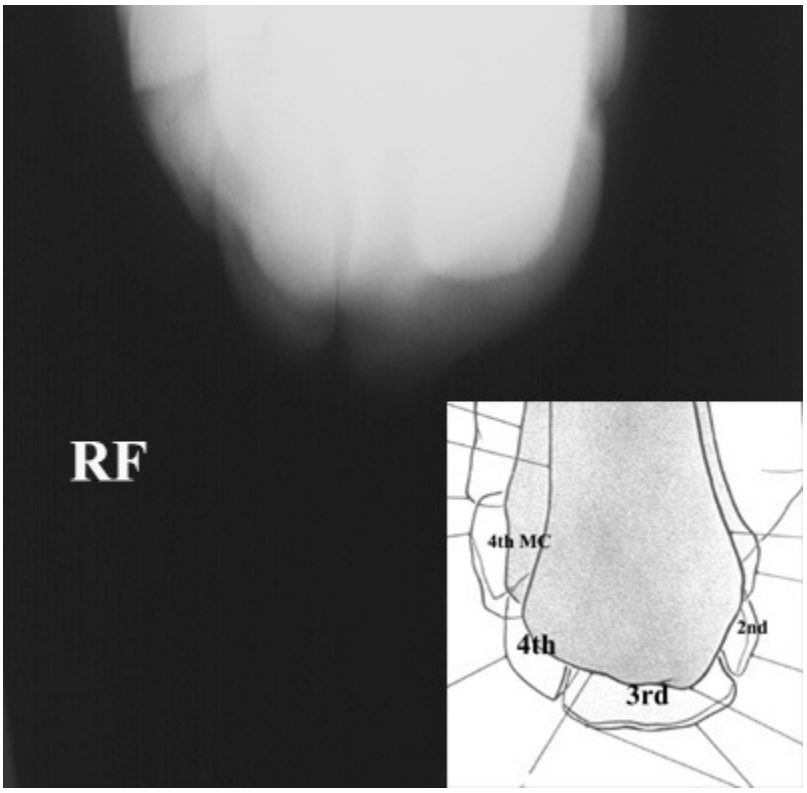
The general principle of a dorsoproximal-dorsodistal oblique is illustrated below. The carpus is flexed and pushed cranially to isolate the margins of the joint. The cassette is held below the carpus, parallel to the ground. The x-ray beam is directed along the dorsal aspect of the joint in a proximal to distal direction.

The portion of the carpus that is highlighted in the dorsoproximal-dorsodistal oblique views is determined by the position of the carpus and the angle of the x-ray beam.



This radiograph is a DPr-DPiO view of the right carpus. This DPR-DDiO view highlights the proximal row of carpal bones. The marker is placed laterally. However, a trick that can allow you to orient yourself is to remember that the 2 carpal bones of similar size are the radial and intermediate carpal bones; the ulnar carpal bone is much smaller. You know (I hope!) that the radial carpal bone is medial so with this information you should be able to identify the lateral and medial aspects of the limb.

This radiograph is a DPr-DDiO view of the distal row of carpal bones in the right carpus. By convention the marker is lateral. The 3rd carpal bone is by far the largest bone in this row. The 4th carpal bone is approximately 1/2 the width of the 3rd. The 2nd carpal bone is quite small and in the radiograph is less visible than in the diagram due to positioning.

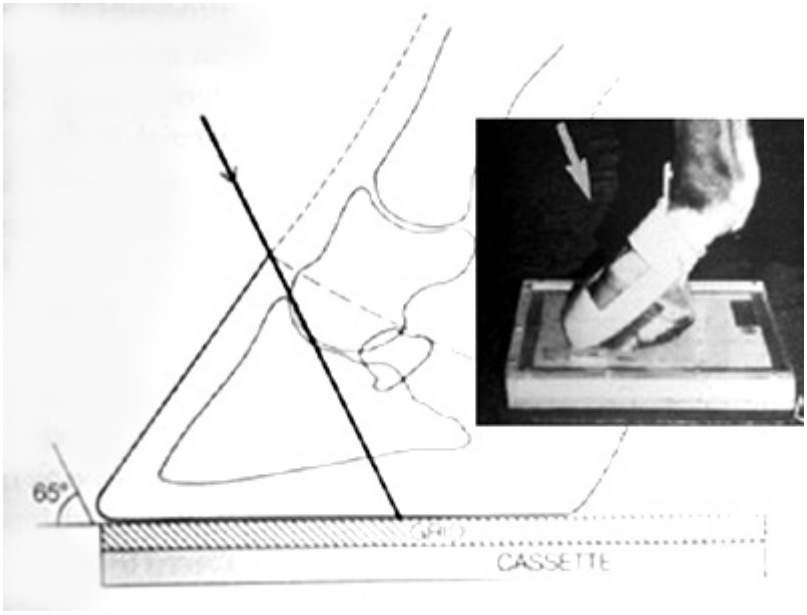


THE NAVICULAR BONE

Oblique radiographic projections are routinely included in the evaluation of the navicular bone. These views allow the margins of the navicular bone to be evaluated.

Dorsal 65-degree Proximal-Palmarodistal Oblique (D65Pr-PaDiO)

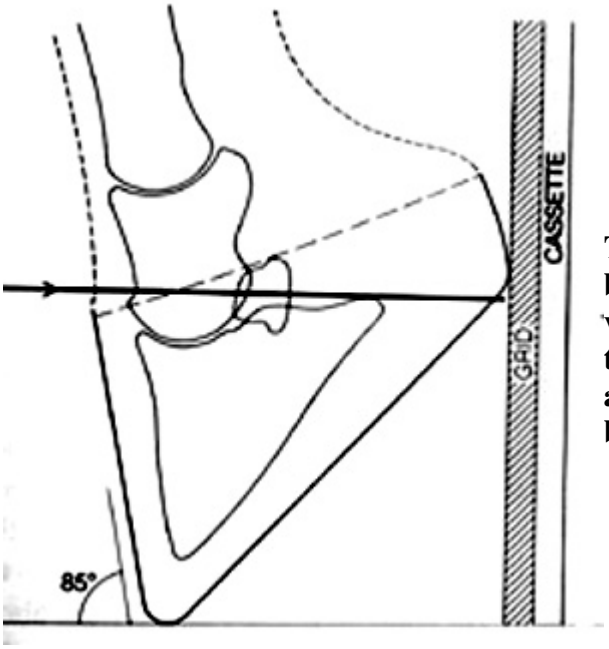
This view is used to evaluate the distal margin of the navicular bone. As with other oblique views the name of the view describes the direction of the x-ray beam. The beam is aimed from dorsoproximal to palmarodistal at a 65 degree angle to the sole of the foot.



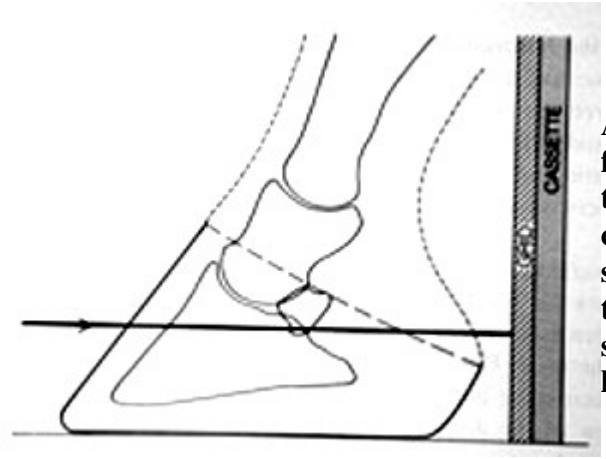
This view may be obtained with the horse standing on the cassette as in this illustration. The x-ray beam is centered at the coronary band.

Notice in the photo that the cassette is actually placed within a protective holder - this is commonly called a "tunnel." This protects the cassette from the weight of the horse.

In the photo the square object overlying the coronary band is a lead shield. The lead shield helps limit scatter radiation.

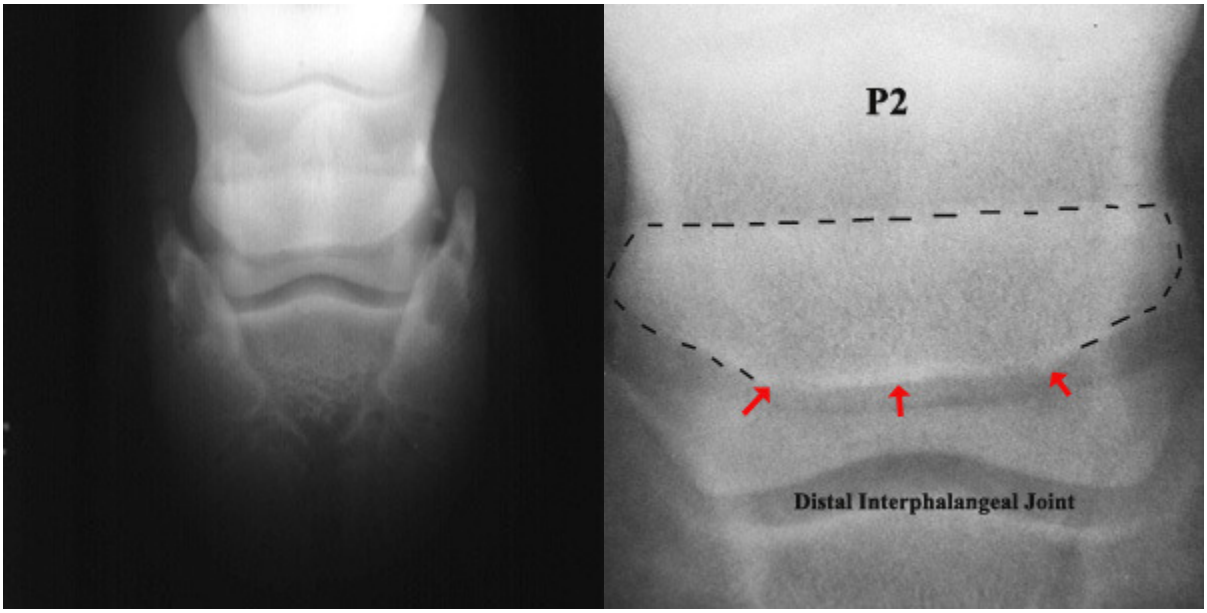


This view may also be obtained with the cassette behind the foot. In the dorsoproximal-palmarodistal view the horse stands with the toe on the ground and the dorsal aspect of the hoof wall is at an angle of approximately 85 degrees to the ground. The x-ray beam is centered at the coronary band.



Another way to position with the cassette behind the foot is the "standing" dorso-palmar view. In this view the horse is standing flat and the x-ray beam is centered halfway between the coronary band and the solar surface of the foot. This generally requires that the horse be standing on a block - this raises the foot so that the x-ray beam can be centered at the correct level. This method is not very commonly used.

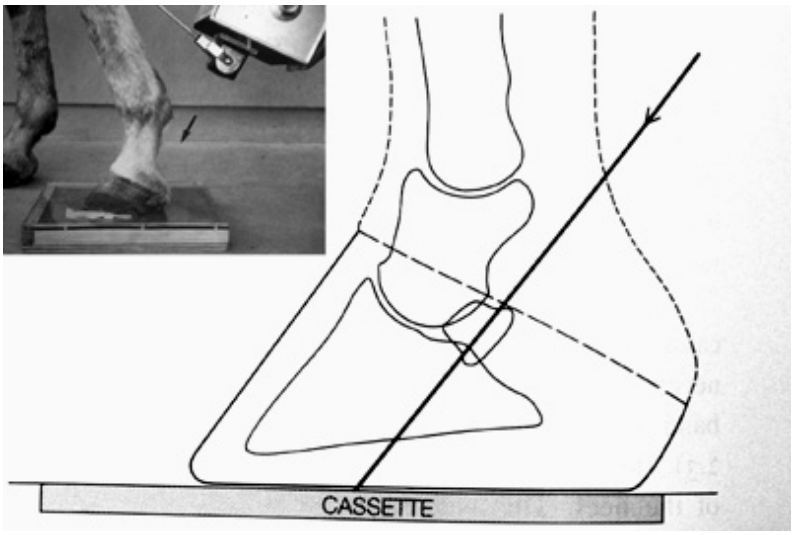
The angle of the x-ray beam causes the distal margin of the navicular bone to be superimposed with the overlying 2nd phalanx. This allows clearer visualization of the distal border than when it is superimposed with the distal interphalangeal joint.



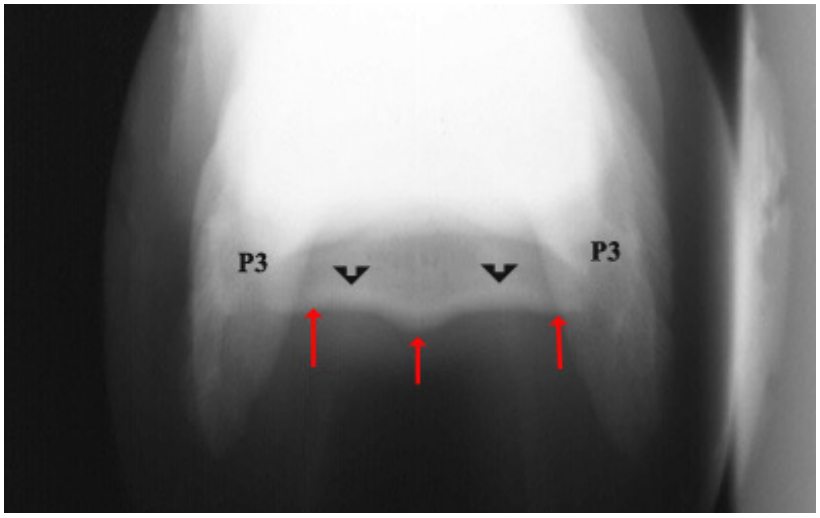
Palmaroproximal-Palmarodistal Oblique (PaPR-PaDiO)

This is another very important oblique view used in the evaluation of the navicular bone. The x-ray beam is directed from proximal to distal along the palmar margin of the foot. This will highlight the flexor surface of the navicular bone and allow the distinction between the cortex and medulla to be visualized.

In the image below the positioning for the view is demonstrated - the inset shows where the x-ray beam is centered. Note that the foot must be positioned caudally and the heel rotated outward to obtain this view. Most, but not all horses, will allow this positioning.



In the radiograph the navicular bone is visible between the palmar processes of P3. The arrows indicate the outer surface of the cortex of the navicular bone; the arrowheads indicate the inner surface. This cortex, which is in contact with the deep digital flexor tendon as it travels to the insertion on the third phalanx, is called the flexor cortex.



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