The equine tarsus is an anatomically complex region with many joints, ligaments, and tendons. It is often involved in hind limb lameness in performance horses. A satisfactory diagnosis of most orthopedic problems in horses can usually be achieved with the combination of a standardized lameness examination and a judicious choice of radiography and ultrasonography. The equine tarsal joint has been thoroughly examined with cross-sectional anatomy and computed tomography of the tarsus in horses.

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Objective—To compare computed tomography (CT) images of equine tarsi with cross-sectional anatomic slices and evaluate the potential of CT for imaging pathological tarsal changes in horses.

Sample—6 anatomically normal equine cadaveric hind limbs and 4 tarsi with pathological changes.

Procedures—Precontrast CT was performed on 3 equine tarsi; sagittal and dorsal reconstructions were made. In all limbs, postcontrast CT was performed after intra-articular contrast medium injection of the tarsocrural, centrodistal, and tarsometatarsal joints. Images were matched with corresponding anatomic slices. Four tarsi with pathological changes underwent CT examination.

Results—The tibia, talus, calcaneus, and central, fused first and second, third, and fourth tarsal bones were clearly visualized as well as the long digital extensor, superficial digital flexor, lateral digital flexor (with tarsal flexor retinaculum), gastrocnemius, peroneus tertius, and tibialis cranialis tendons and the long plantar ligament. The lateral digital extensor, medial digital flexor, split peroneus tertius, and tibialis cranialis tendons and collateral ligaments could be located but not always clearly identified. Some small tarsal ligaments were identifiable, including plantar, medial, interosseus, and lateral talocalcaneal ligaments; interosseus talocentral, centrodistal, and tarsometatarsal ligaments; proximal and distal plantar ligaments; and talometatarsal ligament. Parts of the articular cartilage could be assessed on postcontrast images. Lesions were detected in the 4 tarsi with pathological changes.

Conclusions and Clinical Relevance—CT of the tarsus is recommended when radiography and ultrasonography are inconclusive and during preoperative planning for treatment of complex fractures. Images from this study can serve as a CT reference, and CT of pathological changes was useful. (Am J Vet Res 2011;72:1209–1221)

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Abbreviations

CT  Computed tomography
EDLo  Long digital extensor tendon
HU  Hounsfield unit
LCL  Lateral collateral ligament
LDFT  Lateral digital flexor tendon
MCL  Medial collateral ligament
MRI  Magnetic resonance imaging
PT  Peroneus tertius tendon
SDFT  Superficial digital flexor tendon
SFOV  Scan field of view
TC  Tibialis cranialis tendon

Radiography and ultrasonography, however, radiography provides little information on soft tissue structures and ultrasonography is limited to the bone surface and a small field of view. Therefore, additional modalities such as CT, MRI, and scintigraphy are sometimes required to arrive at a conclusive diagnosis.

Computed tomography has become an established clinical diagnostic tool in equine medicine as scanners have become more available and affordable, and CT equipment has improved dramatically: image resolution...
Materials and Methods

Anatomic sections—To produce anatomic reference images, 3 hind limbs of 3 horses that had been euthanatized for reasons unrelated to the musculoskeletal system were used to make anatomic sections. To ensure that they were not abnormal, the hind limbs were inspected, palpated, and radiographed (lateral-medial, dorsoplantar, dorsolateral-plantaromedial oblique, and dorso-medial-plantarolateral oblique views of the tarsal region were obtained) and no abnormalities were identified prior to sectioning. Before anatomic sections were made, the tarsocrural joint was punctured with a 16-gauge needle and the synovial fluid was aspirated when present. The tarsocrural joint was then filled with a yellow dye. The limbs were frozen in extension for at least 48 hours at −18°C, and each limb was sectioned in a different plane (sagittal, dorsal, and transverse), in slices approximately 5 to 10 mm thick, with an electric bandsaw. All anatomic sections were photographed.

CT examinations—The tarsal joints of 3 other adult horses euthanatized for reasons unrelated to the musculoskeletal system were studied. One hind limb of each horse was severed at the level of the hip joint, including the entire femur. Like the limbs used for anatomic sectioning, the hind limbs had a normal appearance and no abnormal findings via palpation and radiography. The CT examination of the tarsal joints was performed immediately after euthanasia. The CT scans were performed with a 4-detector row helical CT scanner: the limbs were placed on their lateral aspects, with the foot first to obtain transverse slices, with the metatarsus parallel to the CT table to mimic lateral recumbency, and with the hind limb extended caudally. Acquisition variables were as follows: 120 kV, 352 mA, slice thickness of 1.3 mm, slice increment of 0.6 mm, rotation time of 1 second, pitch of 0.63, SFOV of 20 cm, and matrix size of 512 × 512.

To obtain postcontrast images, a positive-contrast arthrogram of the same tarsal joints was performed. By use of an 18-gauge needle, 60 mL of iodinated contrast medium diluted 1:10 (30 mg of iodine/mL) in saline (0.9% NaCl) solution was injected into the tarsocrural joint (in one of the hind limbs, 120 mL was used); 3 mL was injected into the centrodistal joint, and 3 mL was injected into the tarsometatarsal joint. After each injection of the contrast medium, the limb was flexed and extended several times to distribute the medium optimally: A postcontrast image (120 kV, 244 mAs, slice increment of 0.3 mm, rotation time of 1 second, pitch of 0.88, SFOV of 15 cm, and matrix size of 512 × 512) was obtained by use of a smaller slice thickness (0.6 mm) for better evaluation of the cartilage. All pre- and postcontrast data were stored, and dorsal and sagittal reconstructions were made. Transverse, sagittal, and dorsal images from all hind limbs were reviewed by the use of a bone setting.
and a soft tissue setting (window width, 200 HUs; window level, 60 HUs). The HU values were measured on the precontrast images for the gastrocnemius tendon, SDFT, and LDFT.

Comparison of CT images and anatomy—For each anatomic slice, a corresponding CT image was chosen on the basis of similar appearance. Bony and soft tissue structures were identified on the anatomic sections and were subsequently located on the corresponding CT images. In addition, a published anatomy atlas was consulted.

Pathological lesions—Additionally, 4 adult horses with joint lameness located in the tarsus were submitted to a CT examination for diagnosis, delineation of the extension, and exact location of the lesions. The positioning of the limb and acquisition variables (120 kV, 352 mAs, slice thickness of 1.3 mm, slice increment of 0.6 mm, rotation time of 1 second, pitch of 0.63, SFOV of 20 cm, and matrix (window width, 3,200 HUs; window level, 800 HUs) and a soft tissue setting (window width, 200 HUs; window level, 60 HUs). The HU values were measured on the precontrast images for the gastrocnemius tendon, SDFT, and LDFT.

Figure 2—Photographic views of transverse anatomic sections (left) and transverse CT scans (middle, soft tissue window; right, bone window) of an anatomically normal tarsal joint in a horse sequentially displayed from proximal to distal (planes A, B, D, F, G, and H as indicated in Figure 1). Each image is oriented with the lateral aspect to the left and the dorsal aspect to the top. The tarsocrural joint is indicated by yellow dye. 1 = Long digital extensor tendon. 2a = Lateral lobe of the PT. 2b = Medial lobe of the PT. 2c = Lateral superficial branch of the PT. 2d = Dorsal branch of the PT. 2e = Lateral deep branch of the PT. 2f = Medial branch of the PT. 3a = Tibialis cranialis tendon. 3b = Tibialis cranialis muscle. 3c = Tibialis cranialis cunean branch. 3d = Tibialis cranialis lateral branch. 4 = A/V tibialis cranialis. 5 = Ramus cranialis of the medial vena saphena. 6a = Superficial part of the MCL. 6b = Deep part of the MCL. 6c = Pars tibiocalcaean of the MCL. 6d = Pars tibiotali of the MCL. 7 = Medial digital flexor tendon. 8 = Lateral digital flexor tendon. 9 = Gastrocnemius tendon. 10 = Superficial digital flexor tendon. 10a = Medial retinaculum of the SDFT. 10b = Lateral retinaculum of the SDFT. 11 = Vena malleolaris caudalis lateralis. 12a = Superficial part of the LCL. 12b = Deep part of the LCL. 12c = Pars tibiotali of the LCL. 12d = Pars tibiocalcaean of the LCL. 13 = Lateral digital extensor tendon. 14 = Proximal plantar ligament. 15 = Plantar vessels and nerves. 17 = Talometatarsal-ligament. 18 = Interosseus talocalcaneal ligament. 19 = Long plantar ligament. 19a = Long plantar ligament lateral part. 19b = Long plantar ligament medial part. 22 = Talus. 23 = Tarsal sinus. 25 = Interosseus tarsometatarsal ligament. 26 = Tarsal canal with tarsea perforans artery and vein. 27 = Short digital extensor muscle. 28 = Distal plantar ligament. 29 = Suspensory ligament. 30 = Interosseus metatarsal ligament. 31 = Chestnut. 33 = Calcaneoquartal ligament. 34 = Tarsal sinus. 35 = Lateral part of the talocalcaneal joint. 39 = Medial part of the talocalcaneal joint. 40 = Ligamentum accessorium. Ca = Calcaneus. Cast = Sustentaculum tali of the calcaneus. Catub = Calcaneal tuberosity. DL = Dorsolateral recess of the tarsocrural joint. DM = Dorsomedial recess of the tarsocrural joint. MTII = Second metatarsal bone. MTIII = Third metatarsal bone. MTIV = Fourth metatarsal bone. PL = Planarolateral recess of the tarsocrural joint. PM = Plantaromedial recess of the tarsocrural joint. Ta = Talus. Tal = Lateral trochlear ridge of the talus. Tam = Medial trochlear ridge of the talus. Tc = Central tarsal bone. Ti = Tibia. Tica = Caudal aspect of the intermediate ridge of the cochlea tibiae. Ticr = Cranial aspect of the intermediate ridge of the cochlea tibiae. TI+II = Fused first and second tarsal bones. TIII = Third tarsal bone. TIV = Fourth tarsal bone.
size of 512 × 512) were identical to the precontrast CT examination in the anatomic study.

Results

Computed tomographic images from 12 sections in 3 planes were selected (Figure 1) and compared with the corresponding anatomic slices: 8 in the transverse plane, 1 in the dorsal plane and 3 in the sagittal plane (Figures 2–5). By use of the bone window settings, excellent differentiation between cortical, subchondral, and cancellous bone could be made. The trabecular pattern of the cancellous bone was well depicted. The HU values measured for the SDFT, LDFT, and gastrocnemius tendons were tabulated (Table 1).

On the transverse slice at the level of the distal portion of the tibia (Figure 2), the cortical and medullary

Table 1—Mean HUs of the gastrocnemius tendon, SDFT, and LDFT measured at various sites on precontrast CT images of 3 horses.

<table>
<thead>
<tr>
<th>Site</th>
<th>Gastrocnemius tendon</th>
<th>SDFT</th>
<th>LDFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TubCal</td>
<td>—</td>
<td>66 ± 3</td>
<td>—</td>
</tr>
<tr>
<td>PROX ST</td>
<td>—</td>
<td>70 ± 5</td>
<td>118 ± 13</td>
</tr>
<tr>
<td>TC-CQ</td>
<td>—</td>
<td>102 ± 4</td>
<td>96 ± 6</td>
</tr>
<tr>
<td>CD</td>
<td>—</td>
<td>102 ± 4</td>
<td>96 ± 6</td>
</tr>
<tr>
<td>TMT</td>
<td>—</td>
<td>108 ± 4</td>
<td>114 ± 4</td>
</tr>
</tbody>
</table>

— = Not applicable. CD = Level of the centrodistal joint. PROX ST = Most proximal to the tuber calcanei. TC-CQ = Level of the talocalcaneal-centroquartal joint. TMT = Level of the tarsometatarsal joint.

bone of the tibia and tuber calcanei were clearly depicted on the bone window. On the soft tissue window, 3 hyperattenuating tendinous structures were recognized dorsal to the distal aspect of the tibia: a linear structure lateral to the sagittal plane (EDLo), a bilobated structure medial to the latter (PT), and, deep to the PT, a linear structure (TC) surrounded by its muscle belly. Anatomically, the collateral ligaments of the tarsus consist of a long superficial part (ie, superficial MCL and superficial LCL) and a short deep part (ie, deep MCL and deep LCL). The most proximal aspect of the superficial MCL was recognized at the medial aspect of the distal portion of the tibia; just caudal to this structure, a well-defined ovoid hyperattenuating structure was present (the medial digital flexor tendon). Between the tuber calcanei and distal portion of the tibia, a heterogeneous ovoid structure (the LDFT with mixed tendinous and muscle tissue) was evident. At the level of the tuber calcanei, the distal aspect of the gastrocnemius tendon was seen as a heterogeneous structure surrounded by the SDFT with its lateral and medial retinaculum. At the lateral aspect of the distal portion of the tibia, the lateral digital extensor tendon, surrounded by a hypointesing ring, its tendon sheath, was seen as a well-defined ovoid structure in a groove of the bone. Just caudal to this tendon, the most proximal attachment of the superficial LCL was evident.

On the transverse slice at the level of the tarsocural joint (Figure 2), the contours of the trochlear ridges of the talus, the intermediate ridge of the cochlea tibiae, and calcaneus were recognized on the bone window. By use of soft tissue window settings, the EDLo was recognized as a well-defined linear structure located dorsolateral to the tibia. Just medial to the latter, 2 tendons

![Figure 3](https://example.com/figure3.jpg)

Figure 3—Photographic views of the dorsal anatomic section (left) and dorsal CT scans (middle, soft tissue window; right, bone window) of an anatomically normal tarsal joint in a horse (plane I as indicated in Figure 1). 36 = Lateral digital flexor muscle. Capc = Coracoid process of the calcaneus. See Figure 2 for remainder of key.
of the PT and 2 tendons of the TC were clearly visible. At the medial aspect of the tibia, the medial digital flexor tendon was recognized as a well-defined, ovoid structure plantar to the MCL. The deep MCL is subdivided into 3 parts: pars accessorius, pars tibiotalis, and pars tibiocalcanea. The subdivisions of the deep MCL

Figure 4—Photographic views of sagittal anatomic sections (left) and sagittal CT scans (middle, soft tissue window; right, bone window) of a normal tarsal joint in a horse sequentially displayed from lateral to medial (J through L as indicated in Figure 1). Each image is oriented with the dorsal aspect to the left and the proximal aspect to the top. 2 = Peroneus tertius tendon, 23 = Interosseus talocalcaneal ligament, 32 = Loose connective tissue, 38 = Tarsea perforans artery and vein. See Figures 2 and 3 for remainder of key.
Figure 5—Photographic views of transverse anatomic sections (left) and transverse CT scans (right, soft tissue window) of a clinically normal tarsal joint displayed from proximal to distal (planes C and E as indicated in Figure 1). 16 = Dorsalis pedis artery and vein. 20 = Tarsal flexor retinaculum. 21 = Lateral talocalcaneal ligament. 37 = Plantar talocalcaneal ligament. Tatm = Medial tubercle of the talus. See Figure 2 for remainder of key.
were difficult to distinguish at this level. At the plantar aspect of the tarsus, the LDFT was recognized as a homogeneous, well-defined ovoid structure just medial to the calcaneus and plantar to the proximal plantar ligament, which was hypoattenuating, compared with the LDFT. Plantar to the calcaneus, the SDFT was evident as a well-defined linear structure just under the skin. At the lateral aspect of the tibia, the lateral digital extensor tendon could be seen but not clearly delineated between the deep and superficial LCL. The proximal attachment of the deep LCL was difficult to delineate but could be located; the proximal aspect of the superficial LCL was clearly recognized at the plantar aspect of the lateral malleolus of the tibia.

On the transverse slice at the level of the talocaneal joint (Figure 2), the outline of this joint was clearly evident on the bone window; it consisted of a lateral and medial portion with the tarsal sinus in between. The contours of the trochlear ridges of the talus and sustentaculum tali were clearly depicted. On the soft tissue window, 2 tendons of the PT and 2 tendons of the TC were clearly detected dorsal to the talus and just medial to the well-defined, linear-shaped EDLo. The superficial MCL was recognized as a well-defined ovoid structure; just deep to the latter, 3 parts of the deep MCL could be distinguished (from superficial to deep, the pars tibiocalcanea, pars tibiotali, and pars accessoria) that could be recognized as linear structures directed toward their distal insertion. Just plantar to the MCL, the medial digital flexor tendon was recognized as a well-defined ovoid structure. The LDFT was detected at the sustentaculum tali of the calcaneus. More lateral, the long plantar ligament was clearly visualized. A thin band was present between the medial aspect of the long plantar ligament and sustentaculum tali, representing the tarsal flexor retinaculum. Plantar to the long plantar ligament, the SDFT was recognized as a well-defined ovoid structure with rounded edges. At the lateral aspect, the superficial LCL was detected as an ovoid structure. The deep LCL consists of 2 subdivisions: the pars tibiocalcanea and pars tibiotali. Both parts of the deep LCL were recognized as linear structures running toward their distal insertion sites. Just dorsal to the superficial LCL, the lateral digital extensor tendon was visible but less defined at this level.

On the transverse slices at the level of the talocaneal-centroquartal, centrodistal, and tarsometatarsal joints (Figure 2), the proximal and distal row tarsal bones and metatarsal bones were recognized on the bone window. By use of soft tissue window settings, the EDLo was clearly recognized at the dorsolateral aspect of the tarsus; at the level of the talocaneal-centroquartal joint, this tendon was surrounded by the tarsal extensor retinaculum. Medial to the EDLo, the split tendons of the peroneus tertius and tibialis cranialis were recognized at the level of the talocaneal-centroquartal joint; more distal, these tendons were more difficult to delineate. At the dorsomedial aspect of the tarsal bones, the talometatarsal ligament was recognized; it was hyperattenuating, compared with the overlying soft tissues. At the plantar aspect (from lateral to medial), the SDFT, LDFT, and medial digital flexor tendon were detected as 3 well-defined ovoid structures, with the LDFT being the largest. Dorsal to the SDFT, the long plantar ligament was present, although differentiation between the lateral and the medial part was difficult. At the lateral aspect, the lateral digital extensor tendon was clearly recognized at the level of the centrodistal and tarsometatarsal joints and, less well-defined, at the level of the talocaneal-centroquartal joint. At the lateral and medial aspect, the superficial LCL and MCL were difficult to delineate but could be located. At the level of the centrodistal joint, the plantar margin of the

Figure 6—Postcontrast sagittal CT view of the tarsocrural and talocalcaneal-centroquartal joints in a horse. Each image is oriented with the dorsal aspect to the left and the proximal aspect to the top. A—Scan obtained at the level of the intermediate ridge of the tibia and trochlear groove of the talus. A part of the articular cartilage is recognized as a black line overlying the weight-bearing surfaces of the trochlear groove of the talus and distal tibia (white arrowhead). The articular cartilage is recognized as a black line overlying the weight-bearing surfaces of the tibia and distal tibia (black arrowheads). B—Scan obtained at the level of the lateral trochlear ridge of the talus. The articular cartilage at the weight-bearing surfaces of the lateral trochlear ridge and distal tibia is difficult to recognize (white arrowhead). See Figure 2 for remainder of key.
superficial LCL and dorsal margin of the long plantar ligament were difficult to distinguish.

On the dorsal slice (Figure 3), the distal tibia, contours of the cochlea tibiae, talar trochlear ridges, tarsal canal, joint spaces, and associated interosseus foramina of the talocalcaneal-centroquartal, centrodistal, and tarsometatarsal joints were clearly depicted by use of the bone window settings. By use of soft tissue window settings, the proximal attachment of the superficial parts of the collateral ligaments on the malleoli of the tibia was clearly visualized. Because the superficial collateral ligaments run slightly obliquely in a dorsoproximal-plantarodistal direction, the dorsal plane should be angled likewise to view their distal insertion at the same time. The deep collateral ligaments were only partially visible as they ran in a nearly horizontal (dorsoproximal-plantarodistal) direction. The interosseous centrodistal ligament and interosseus tar-sometatarsal ligament were recognized at the level of the associated joint spaces.

On the sagittal slices (Figure 4), the joint spaces of the talocalcaneal-centroquartal, centrodistal, tarso-metatarsal (with their associated interosseus foramina), and talocalcaneal joints were well depicted in the bone window. The contours of the trochlear ridges of the talus, cochlea tibiae, and the sustentaculum tali were also clearly detected in the bone window. The 3 sagittal slices in the bone window revealed that the subchondral bone in the dorsal aspect of the small tarsal bones and distal talus and proximal third metatarsal bone was thicker, compared with their plantar aspects. In the soft tissue window, the SDFT was clearly recognized along the entire plantar aspect of the tarsus. The long plantar ligament with its insertion on the lateral splint bone could be evaluated on the lateral parasagittal slice and its transition into the suspensory ligament on the sagittal slice. The interosseus talocalcaneal ligament in the tarsal sinus and the distal insertion of the gastrocnemius tendon on the tuber calcanei could be evaluated on the sagittal slice. Detectable on the medial parasagittal slice were the proximal plantar ligament and the distal plantar ligament with its transition into the distal accessory (check) ligament, the LDFT running over the sustentaculum tali, and the talometatarsal ligament, which was hyperattenuating, compared with the overlying soft tissues.

Several small tarsal ligaments were recognized on the CT images. Additionally, the plantar and lateral (Figure 5) talocalcaneal ligaments were recognized. The plantar talocalcaneal ligament was detected as a mildly heterogeneous structure between the plantar aspect of the talus and adjacent calcaneus; a part of this ligament, called the medial talocalcaneal ligament, attaches on the medial aspect of the sustentaculum tali, just proximal to the distal attachment of the pars tibiocalcanea of the deep MCL. The lateral talocalcaneal ligament was recognized just distal to the distal attachment of the deep parts of the LCL and connected the talus and calcaneus at their lateral aspects.

Two postcontrast CT images were selected in the sagittal plane (Figure 6). The articular cartilage at the level of the non-weight-bearing surfaces of the talus and distal tibia was clearly depicted in all planes. The articular cartilage of the weight-bearing surface of the distal tibia and proximal talus at the level of the intermediate ridge of the distal tibia and the intertrocchlear groove of the talus could be partially depicted. Nevertheless, the articular cartilage of the weight-bearing surface of the distal tibia and proximal talus was difficult to evaluate at the grooves of the...
The articular cartilage at the level of the talocalcaneal, talocalcaneal-centroquartal, centrodistal, and tarsometatarsal joints was not detected.

Compared with the precontrast CT, the CT arthrogram defined some ligaments better but was not needed to identify them. The distal aspect of the dorsomedial pouch of the tarsocrural joint defined the dorsal delineation of the talo-metatarsal ligament. The plantarolateral and plantaromedial pouches of the tarsocrural joint delineated the most proximal attachment of superficial LCL and superficial MCL, respectively. The plantarolateral pouch of the tarsocrural joint surrounded the proximal aspect of the superficial LCL. The plantaromedial pouch of the tarsocrural joint surrounded the distal attachment of the pars tibiocalcanea of the deep MCL. These findings were most evident in the transverse slices.

The 4 horses with tarsal joint lameness all had lesions on CT images. In 1 horse, mineralization was present in the collateral ligaments and distal insertion of the gastrocnemius tendon on the calcaneus. Two horses had degenerative joint disease. In one of those horses, the medial part of the talocalcaneal joint was affected. In the other horse, the centrodistal and tarsometatarsal joints were affected; additionally, subchondral sclerosis and cystic lesions in the third tarsal bone were detected. In the fourth horse, a cartilage lesion was detected in the cochlea tibiae on the postcontrast CT (Figures 7–10).

Discussion

This study provides a detailed reference of CT anatomy of the equine tarsus in various planes. Results indicated that CT can provide valuable information on bone and soft tissue structures at the same time. With window settings adjusted for bone, subchondral and cortical bone and the trabecular pattern of the cancellous bone were well depicted. The dorsal and sagittal planes were most appropriate for evaluation of the multiple joint spaces and bone contours. In all horses, the subchondral bone at the dorsal aspects of the distal talus, small tarsal bones, and proximal third metatarsal bone was thicker than at the plantar aspect. This subchondral bone pattern reflects the higher loading in this area.19 The subchondral bone plate pattern can be influenced by the type or level of exercise and tarsal pain.20,21

Computed tomographic images with a soft tissue window allowed identification of most of the clinically important soft tissue structures. Large soft tissue structures such as the SDFT, LDFT, gastrocnemius tendon, EDLo, long plantar ligament, and PT and TC proximal to their splitting were easily recognized. Smaller structures, including the bifurcated PT and TC, lateral digital extensor tendon, medial digital flexor tendon, and collateral, talometatarsal, and distal plantar ligaments, were more difficult to recognize or were visible only to identify them.
over a short distance. The transverse slices distal to the talus and calcaneus were most valuable for evaluation of the plantar soft tissue structures. At the dorsal, lateral, and medial aspects, the soft tissues were more difficult to differentiate because they are in close connection with each other and the surrounding fascia and are similar in density. Difficulty in differentiating the dorsal tendon of the TC and PT, the medial tendon of the PT and talometatarsal ligament, and the LCL and long plantar ligament can be explained by the fusion of these structures distally. The interosseous talocalcaneal, centrodistal, tarsometatarsal, and talocalcaneal ligaments are small soft tissue structures but were clearly recognized because their location between adjacent bones resulted in high contrast.

Although most soft tissue structures surrounding the tarsus can be visualized with ultrasonography, this technique cannot detect the small tarsal interosseus ligaments because it cannot penetrate the bone surface. The anatomy of the collateral ligaments of the tarsus is described in detail in the veterinary literature. In the present study, 2 subdivisions of the deep collateral ligament were visible on the LCL and 3 on the MCL. In a previous CT study of the tarsus, the divisions of the deep collateral ligaments were not visible. The transverse plane was the best plane for visualizing the subdivisions of the deep collateral ligaments. In previous CT studies of the carpal and metacarpophalangeal (fetlock) joints, differentiation between the superficial and deep parts of the collateral ligaments was impossible. With ultrasonography, differentiating the subdivisions of the deep collateral ligaments is challenging, but their separate attachment sites on the talus and calcaneus can be detected. With low-field MRI, the differentiation between deep and superficial collateral ligaments seems equally difficult. Subdivisions of the deep collateral ligaments are sometimes visible with high-field MRI.

At present, abnormalities of the small tarsal ligaments are described only with MRI. However, several small tarsal ligaments were well recognized in the present study. This is in contrast to the small carpal ligaments, which could not be visualized by use of CT in a previous study. In a previous CT study of the equine tarsus, only the transverse plane was used, although previous MRI studies of the equine tarsus found that the sagittal and transverse planes provided the most complete visualization of clinically important anatomic structures. This is in agreement with results of the present study. However, the dorsal reconstructions were useful in evaluation of the proximal attachment of the superficial parts of the collateral ligaments and small tarsal joints. Presently, with the use of multislice CT scanners, the loss of image quality after reconstruction in the orthogonal planes is substantially reduced.

Computed tomographic arthrography of the tarsocrural joint revealed that only the articular cartilage at the level of the non–weight-bearing surfaces of the distal portion of the tibia and proximal portion of the talus could be clearly detected in all planes. At the level of the weight-bearing surfaces of the distal tibia and proximal talus, it was difficult to differentiate the 2 opposing articular surfaces. Increasing the amount of contrast to 120 mL and rigorously flexing and extending the limb did not increase the visibility of the contrast medium at the cochlea tibiae. Also, the articular cartilage could not be evaluated at the level of the talocalcaneal, talocalcaneal-centroquartal, centrodistal, and tarsometatarsal joints. At these sites, the joint spaces are narrow. To the authors' knowledge, no data on the thickness of the cartilage at the weight-bearing surface of the talar ridges in horses are available. At the non–weight-bearing surfaces, a thickness of 0.57 mm for the lateral trochlear ridge and 0.58 mm for the medial trochlear ridge has been estimated. In a study that measured the overlying articular cartilage thickness in the distal tarsal joints in horses with various exercise levels, the thickness of the cartilage was from 0.489 to 1.004 mm. When the slice thickness is close to the object size, spatial resolution is considerably increased because the partial volume effect is decreased. Therefore, the slice thickness was decreased to 0.6 mm, but unfortunately, this did not result in visualization of the cartilage. Nevertheless, CT arthrography can provide more information on the articular cartilage, compared with ultrasonography, because ultrasonography is strictly limited to the non–weight-bearing surfaces of the joints. Computed tomographic studies in the fetlock joint reveal that CT can also provide indirect information regarding the articular cartilage via detection of changes in subchondral bone density. Also, with low-field MRI, only the articular cartilage of the non–weight-bearing surfaces of the trochlear ridges of the talus and distal tibia can be detected. Even with high-field MRI, it is not possible to distinguish the opposing articular cartilage layers at the cochlea tibiae.

In human medicine, CT arthrography of the tarsus is considered to be a good technique for assessing osteochondral lesions and cartilage defects, but soft tissue abnormalities, such as ligament or tendon tears, are best assessed with MRI. In the equine stifle joint, CT arthrography revealed ligament structures that were not detected with precontrast CT in an anatomic study and has been helpful in detecting ligamentous lesions in clinical cases. In the tarsus, additional ligaments were not identified on the CT arthrogram, compared with precontrast CT. The value of CT arthrography of the tarsus in ligamentous lesions has not been described.

Results of the CT examinations of the horses with a diagnosis of pathological changes in the tarsal joint indicated that CT is a good modality to detect pathological changes involving that joint. Use of CT enabled detection of bone injury as well as soft tissue injury. It allows definition of the extent and exact location of the lesions, both essential factors for prognosis.

Computed tomography and MRI should be regarded as complementary techniques. However, in veterinary medicine, only 1 cross-sectional technique can typically be used because of financial and practical reasons. The tissue type is an important determining factor: MRI is superior to CT for soft tissue imaging, whereas CT provides the best images of bone. Disadvantages of MRI are the long scanning times and high cost of purchase and maintenance of the scanning.
system. Use of standing MRI is increasing in equine orthopedics because it is more affordable and general anesthesia is not necessary. However, standing MRI is limited to low-field magnets, resulting in poorer image resolution, compared with high-field MRI.33,34 A limitation of the present study was that the limbs used for CT examination and the anatomical images were not from the same horses. Filling the joints with contrast medium for the CT examination and holding the limbs as fresh specimens precluded use of the same anatomical specimens for injection with colored dye and then freezing them. In this study, the HU values were measured only for the SDFT, LDFT, and gastrocnemius tendon. Contrary to the other soft tissue structures of the joint, repeatable measurements could be performed at different levels in these structures because of their size and shape. The HU values of these structures were compared with those of 3 living horses with no abnormalities in these tendons. Because there was no significant difference between the HU values of both groups and because the cadaver limbs were scanned immediately after euthanasia, the HU values are considered to be useful for in vivo studies.

Few reports on CT evaluation of the equine tarsus have been published in the veterinary literature. Results of 2 studies36,37 indicate the value of CT for assessment of subchondral cyst-like lesions and changes in bone density in the tarsus. Early or small subchondral lesions are difficult to recognize or are not recognized at all with radiography.36–38 Subchondral osseous cyst-like lesions in the tarsus are rare and are described at the level of the cochlea tibiae, the trochlear groove, and trochlear ridges of the talus, calcaneus, third and central tarsal bones, and lateral and medial malleoli.36–40 These lesions are recognized as a hypodense focus surrounded with a sclerotic rim. In the evaluation of subchondral osseous lesions, the transverse plane was used.36,37 Fractures at the level of the tarsus are rare in horses.41 Computed tomography can be used to define the fracture planes in simple and comminuted fractures of the central and third tarsal bones.42 Radiography can fail to reveal nondisplaced tarsal fractures, but CT can be useful in such cases.43

References