Title

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Case Report Rapport de cas

Medial malleolus fragmentation following talocalcaneal arthrodesis by a dorsomedial approach in a horse

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Abstract — A 16-year-old, Quarter Horse mare was presented for a 3/5 right hind lameness associated with osteoarthritis of the talocalcaneal joint (TCLJ). Positron emission tomography (PET) and computed tomography (CT) demonstrated marked increased uptake of 18F-sodium fluoride and bone remodeling at the medial facet of the TCLJ, respectively. Under general anesthesia 2 cortical screws (4.5 and 5.5 mm) were placed in neutral fashion *via* an arthrotomy from dorsomedial to plantaromedial through the medial facet of the TCLJ followed by copious lavage of the tarsocrural joint. Eight weeks after surgery, observable effusion of the tarsocrural joint was present and lameness had worsened. Radiographic examination revealed a fragmented medial malleolus of the tibia, likely secondary to repetitive trauma of the screw heads during tarsal flexion. Repeated CT showed partial fusion of the TCLJ. Both screws were removed and the tarsocrural joint was thoroughly lavaged arthroscopically. At a 20-month recheck the lameness had not improved, and ultrasound examination revealed severe thickening of the TCLJ capsule. Recheck examination 48 mo after surgery showed complete fusion of the TCLJ and resolution of the lameness.

Key clinical message:
Diagnosis of osteoarthritis of the TCLJ is challenging. Management by arthrodesis using a dorsomedial approach can result in fragmentation of the medial malleolus, with secondary synovitis and capsulitis of the tarsocrural joint.

Résumé — Fragmentation de la malléole médiale suite à une arthrodèse talo-calcanéenne par voie dorso-médiale chez un cheval. Une jument Quarter Horse âgée de 16 ans a été présentée pour une boiterie postérieure droite de 3/5 associée à une arthrose de l'articulation talo-calcanéenne (TCLJ). La tomographie par émission de positrons (TEP) et la tomodensitométrie (CT) ont démontré une augmentation marquée de l'absorption du fluorure de sodium-18F et un remodelage osseux significatif au niveau de la facette médiale du TCLJ, respectivement. Sous anesthésie générale, deux vis corticales (4,5 et 5,5 mm) ont été placées de façon neutre *via* une arthrotomie dorso-médiale à plantaro-médiale à travers la face médiale du TCLJ suivie d'un lavage abondant de l'articulation tarso-crurale. Huit semaines après la chirurgie, un épanchement significatif de l'articulation tarso-crurale était présent et la boiterie s'était aggravée. L'examen radiographique a révélé une malléole médiale du tibia fragmentée, probablement secondaire à un traumatisme répétitif des têtes de vis lors de la flexion du tarse. La tomodensitométrie répétée a montré une fusion partielle du TCLJ. Les deux vis ont été retirées et l'articulation tarso-crurale a été soigneusement lavée par arthroscopie. Lors d'un nouveau contrôle après 20 mois, la boiterie ne s'était pas améliorée, et l'échographie a révélé un épaississement sévère de la capsule TCLJ. Un nouvel examen 48 mois après la chirurgie a montré une fusion complète du TCLJ et une résolution de la boiterie.

Message clinique clé :
Le diagnostic de l'arthrose du TCLJ est difficile. La prise en charge par arthrodèse par voie dorso-médiale peut entraîner une fragmentation de la malléole médiale, avec synovite secondaire et capsulite de l'articulation tarso-crurale.

(Traduit par Dr Serge Messier)

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The talocalcaneal joint (TCLJ) is composed of 4 articular facets (1,2). The medial and lateral facets of the talus located proximally are the largest and both articulate with the calcaneus (1,2). The strong interosseous ligament occupies a central tarsal sinus holding both bones together (1,2). Motion of the TCLJ is limited and the forces applied between both bones by adjacent tendons and ligaments are complex (1). Contraction of the gastrocnemius muscle allows tarsal extension by pulling proximally on the tuber calcani (1,3).

Only 3 reports regarding TCLJ osteoarthritis management in horses are available in the literature (2–4) and surgical arthrodesis has only been reported in 8 cases (6 by plantarolateral approach, 1 by dorsomedial approach and 1 by combination of plantarolateral and dorsomedial approaches) (2,4). The reported outcome in these cases has been generally good (8/8 had improved lameness score) (2,4).

The aim of this report is to describe lameness evaluation and advanced diagnostic imaging findings in a horse affected by osteoarthritis (OA) of the TCLJ and to report a major postoperative complication not previously described after arthrodesis by a dorsomedial approach.

Case description

A 16-year-old Quarter Horse mare used for trail riding was admitted for evaluation of right hind lameness of 4 mo duration. Prior to referral, the tarsometatarsal (TMT) and distal intertarsal (DIT) joints were radiographed, showing bilateral moderate osteoarthritis of the TMT and DIT joints. These joints were previously medicated (14 and 6 mo before admission) with intra-articular corticosteroids by the referring veterinarian. Due to the lack of a satisfactory response with the injections, the case was referred for surgical arthrodesis of the TMT joint.

Clinical findings

At presentation, mild to moderate osseous proliferation at the medial aspect of the TMT and DIT joints was palpable bilaterally. Palpation of the tarsocrural joint (TCJ) indicated that it was normal. Lameness examination revealed a 3/5 right hind lameness (5). Proximal limb flexion of the right hind exacerbated the lameness. No change in lameness was noted after an abaxial sesamoidean nerve block and subsequent low 6 point nerve block of the right hind limb with lidocaine hydrochloride 2% (APP, Zurich, Illinois, USA) (2 mL per side). A high 4-point nerve block was performed (4 mL of lidocaine 2% per site) and resulted in a 50% reduction in lameness. Finally, a tibial nerve block (15 mL lidocaine 2%) completely abolished the right hind lameness 10 min after the injection. Intra-articular anesthesia of the TMT and DIT with lidocaine 2% was later attempted but the osseous proliferation and resulting reduced joint space made intra-articular administration impossible.

Diagnostic imaging

Repeat tarsal radiographs (Figure 1) confirmed the presence of moderate OA at the level of the TMT and DIT joints. Ultrasound examination of the proximal plantar metatarsal region revealed mild thickening of the suspensory ligament at its origin. A positron emission tomography (PET)/computed tomography (CT) scan was performed under general anesthesia to further characterize the tarsal joints changes for surgical planning. The PET images were acquired with a compact scanner (PiPET; Brain Biosciences, Rockville, Maryland, USA) 90 min after intravenous injection of 20 mCi of ^{18}F-sodium fluoride (^{18}F-NaF). Computed tomography was performed immediately after the PET scan under the same anesthetic episode using a 16-slice GE Lightspeed scanner (GE Healthcare, Princeton, New Jersey, USA). The PET images were co-registered with the CT images using 3D visualization and analysis software (Amira, FEI; ThermoFisher Scientific, Waltham, Massachusetts, USA) and fused using a DICOM viewer (Horos; Nimble, Annapolis, Maryland, USA).

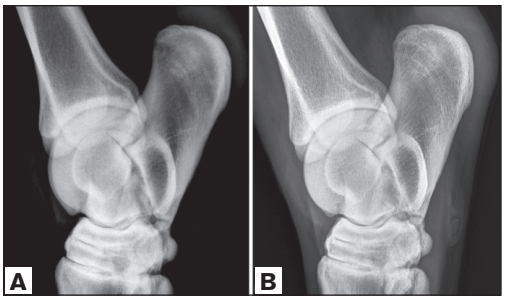

Figure 1. Lateral to medial radiographs of the right tarsus taken 6 mo before presentation (A) and at the time of presentation (B). Between A and B there is progression of the arthritic changes specially at the most distal portion of the talocalcaneal joint immediately proximal to its articulation with the tarsal bones 1 and 2.

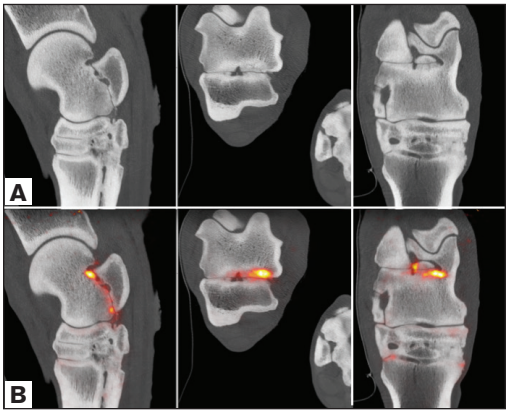

Figure 2. Multiplanar reformat computed tomography (CT) (top row, A) and fused positron emission tomography (PET)/CT (bottom row, B) images (sagittal, transverse, and dorsal from left to right) of the right tarsus are shown. Lateral is to the left. There is partial fusion of the tarsometatarsal and distal intertarsal joints without ^{18}F-NaF uptake. Marked ^{18}F-NaF uptake, is however, present at the medial aspect of the talocalcaneal joint.

Focal ^{18}F-NaF uptake was seen at the dorsolateral aspect of the TMT joint and at the proximomedial aspect of the third metatarsal bone consistent with the sites of osseous remodeling observed with CT. The PET/CT demonstrated fusion of the plantar and medial aspect of the DIT joint without concurrent increased ^{18}F-NaF uptake. Marked ^{18}F-NaF uptake was present at the medial aspect of the TCLJ (Figure 2) with osseous remodeling visible at the distal aspect of this joint. On CT, marked

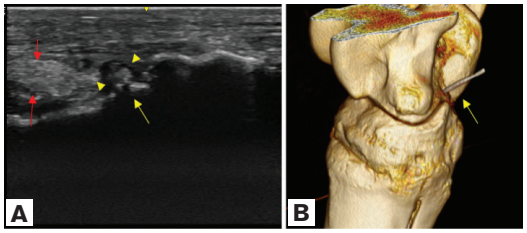

Figure 3. A – Ultrasound image of the medial side of the talocalcaneal joint. Irregular joint margins (yellow arrow) and effusion (arrowheads) are visible. The deep fibers of the medial collateral ligament are visible (red arrows). B – 3D-volume rendering CT image after needle placement confirming proper intra-articular positioning.

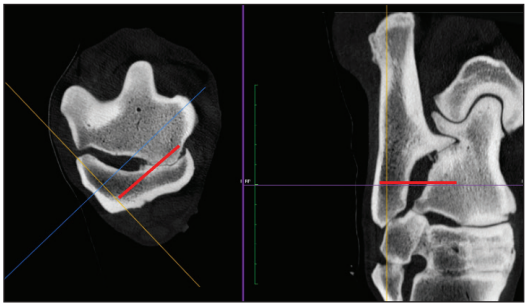

Figure 4. Multiplanar reformat computed tomography (CT) on transverse (left image) and dorsal plane (right image) illustrating the angulation required to reach the medial facet of the talocalcaneal joint using the plantarolateral approach.

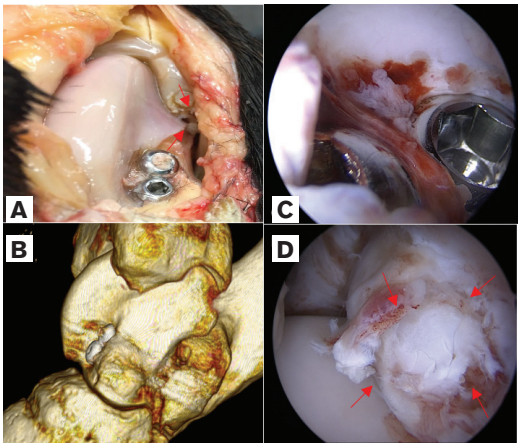

Figure 5. A – Opened tarsocrural joint of cadaveric specimen after placement of two 4.5-mm cortical screws and maximal flexion of the tarsus. Proximal is to the top and medial is to the right. There is clear impingement of the screw head of the proximal screw in the medial malleolus (red arrowheads). B – Three-dimensional CT reconstruction of the CT performed immediately before screw removal. The distal screw head appears to protrude more dorsally compared to the proximal one. C – Intra-operative arthroscopic from second surgery showing both screw heads. Proximal is the right. In this image, the distal screw head also appears to slightly protrude more compared to the proximal one. D – Intra-operative arthroscopic image of the medial malleolus. Impression marks from the distal screw head are obvious (red arrowheads).

osseous remodeling of the distal aspect of the TCLJ was visible without notable increase in ^{18}F-NaF uptake visible on PET scan. These findings suggested that active osteoarthritis of the TCLJ was likely the main cause of the lameness as the DIT changes appeared inactive and the TMT abnormalities were mild.

Ultrasound revealed effusion of the medial aspect of the TCLJ (Figure 3). An ultrasound-guided injection of 80 mg of methylprednisolone (Zoetis, Kalamazoo, Michigan, USA) into the TCLJ was performed in a sterile fashion using a linear 5–10 MHz transducer (LOGIQ e Ultrasound; GE Healthcare) and a 21-gauge 1.5 inch needle. The position of the needle was confirmed with CT (Figure 3). The horse had an uneventful assisted recovery from general anesthesia.

Surgery

Two weeks after injection, notable, gradual improvement of lameness was reported by the owner. Eight weeks later, the lameness had worsened and was similar to the degree of lameness at initial presentation. Surgical arthrodesis of the medial facet of the TCLJ was then elected. A dorsomedial approach was chosen over a plantarolateral approach in order to better target the distal portion of the TCLJ medial facet that was severely affected in this case. A plantarolateral approach would imply that the medial facet is entered at a very acute angle as illustrated in Figure 4. For the most proximal portion of the medial facet, the plantarolateral approach would have risked penetration of the tarsal sheath and disruption of the plantar concave cortex of the sustentaculum tali.

Prior to surgery, 6 cadaveric limbs were used to test the optimal point for drilling and angle for screw placement targeting the medial facet of the TCLJ from a dorsomedial approach with the starting point dorsal to the distal tubercle of the talus. After screw placement, maximal flexion of the tarsus revealed impingement between the screw heads and the medial malleolus (Figure 5) in the first 3 specimens. In the remaining limbs, a more aggressive countersink was performed before screw insertion and the impingement with the medial malleolus was avoided. The horse was premedicated with procaine penicillin G (VetOne, Boise, Idaho, USA), 22 000 IU/kg body weight (BW), IM, gentamicin (Phoenix TM, St. Joseph, Missouri, USA), 6.6 mg/kg BW, IV, and phenylbutazone (Phoenix TM), 4.4 mg/kg BW, IV. After sedation with xylazine hydrochloride (Sigma Aldrich, St. Louis, Missouri, USA), 1.1 mg/kg BW, IV, anesthesia was induced using a combination of midazolam (Cerilliant, Round Rock, Texas, USA), 0.2 mg/kg BW, IV, and ketamine (Cerilliant), 2.2 mg/kg BW, IV, and maintained on isofluorane (Zoetis) with a closed circuit system. The horse was positioned in dorsal recumbency with the affected hind limb extended. A 4-cm incision was made axial to the saphenous vein. The proximal part of the cunean tendon was transected to facilitate access to the distal talus. The joint capsule of the TCJ was incised. Lateral radiographs were taken to ensure proper positioning of a 3.2-mm drill bit in the dorsal aspect of the talus and proper angulation in a distoproximal direction (Figure 6). Plantaroproximal-plantarodistal oblique (calcaneal skyline) views were taken to ensure correct lateral to medial angulation of the drill bit with respect to the medial facet of the TCLJ

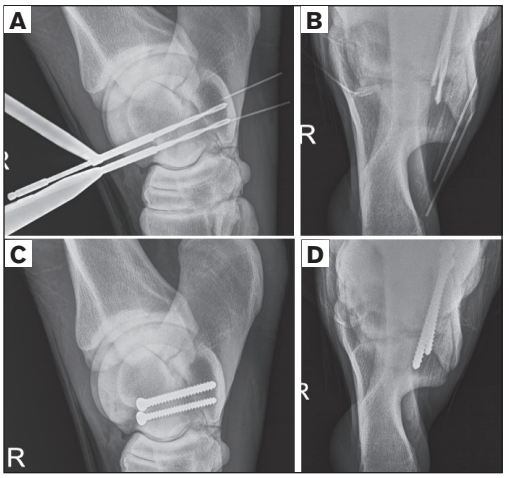

Figure 6. Latero-medial (A) and calcaneal skyline (B) intra-operative radiographs showing drill bits orientation targeting the medial facet of the talocalcaneal joint. Subcutaneous needles were placed in the plantar aspect of the tarsus in order to facilitate orientation. Lateral to medial (C) and calcaneal skyline (D) intra-operative views after screw placement. Intra-operative dorso-plantar view after screw placement (E).

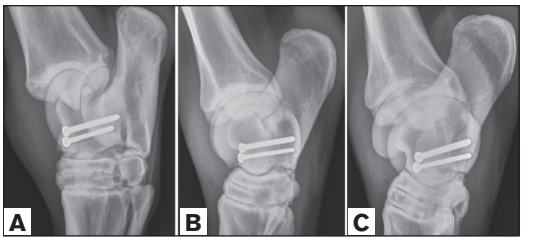

Figure 7. Dorsolateral-plantaromedial oblique (A), latero-medial (B), and dorsomedial-plantarolateral oblique (C) projections taken at the 8-week postoperative recheck examination. There is moderate to severe soft tissue swelling on the dorsomedial aspect of the tarsus and bony debris originating from fragmentation of the medial malleolus. Both screws appeared to be in the same position when compared to the intra-operative radiographs.

(Figure 6). The 3.2-mm drill bit was left in place and a second 3.2-mm drill bit was placed more proximally using the first drill bit and the same radiographic projections (lateral to medial and calcaneal skyline) to assist with targeting of the medial facet of the TCLJ. After satisfactory positioning of the bits was achieved, the second more proximal 3.2-mm drill bit was replaced with a 4.0-mm drill bit. Both drill bits were advanced into the calcaneus without penetrating the far cortex of the sustantaculum tali. Both holes were deeply countersunk, measured, and tapped. For the distal hole, a 46-mm 4.5-mm cortical screw was placed in neutral fashion. Proximally a 50-mm 5.5-mm cortical screw was placed, also in neutral fashion. Intra-operative radiographs confirmed correct angulation and slight divergence of the screws (Figure 6). The TCJ was then needle lavaged.

The TCJ capsule and subcutaneous space were closed and the limb was bandaged in a sterile fashion. Assisted recovery from general anesthesia using head and tail ropes was uneventful. Phenylbutazone was administered (1.1 mg/kg BW, PO) twice daily for 3 d and once daily for another 7 d. After surgery, the horse was kept under strict stall rest for 2 wk, followed by 5 min hand walks for 6 wk.

Outcome

Eight weeks after surgery, the owner reported that the mare appeared more painful when standing. A postoperative recheck examination revealed moderate to severe TCJ effusion. Radiographs showed a fragmented medial malleolus of the right tibia (Figure 7). Minimal fusion of the TCLJ was noted to have occurred with the joint margins stillvisible, although slightly less well-defined. Rehabilitation maneuvers (passive flexion exercises twice daily) were recommended and a 3-week course of firocoxib (Merial, Duluth, Georgia, USA), 0.1 mg/kg BW, PO, q24h, was started. Ten weeks after surgery, the effusion and pain were still apparent. The degree of lameness seen at the trot had worsened when compared to the examination performed before surgery. Radiographs showed fragmentation of the medial malleolus and incomplete fusion of the TCLJ. A CT was performed to assess the degree of fusion of the TCLJ. Computed tomography showed several small osseous fragments adjacent to the medial malleolus. There was progressive sclerosis and osteophytosis along the length of the talocalcaneal joint and along the medial aspect of the calcaneus; however, fusion of the joint remained incomplete. Considering the fragmentation of the medial malleolus associated with impingement of the screw heads as noted during the pre-operative cadaveric trial, removal of both screws under arthroscopic guidance under the same anesthetic episode as the CT was performed. Arthroscopic exploration revealed severe synovitis and multiple adhesions dorsally. Mild cartilage fibrillation was present at the distal portion of the medial trochlear ridge; no wear lines were visualized. The proximal screw head appeared well-buried and the distal screw head seemed to protrude very slightly from the hole (Figure 5C). A defect on the medial malleolus from the screw head was evident (Figure 5D). During flexion of the tarsus under arthroscopic guidance, the defect aligned with the distal screw head. Instrumental portal location was guided by inserting a percutaneous needle into the dorsomedial pouch of the TCJ. A motorized synovial resector (Karl Storz, Goleta, California, USA) connected to a suction pump was used to debride proliferative synovium. Osseous debris was removed from the space between the distal tubercle of the talus and the medial malleolus using a Ferris Smith rongeur (Sontec Instruments, Centennial, Colorado, USA). Larger bony fragments were also removed with the rongeurs. The medial malleolus was curetted until subchondral bone was exposed. A third incision was made dorsomedially by the screw heads. A notable amount of metallic debris resulted from the impact of the screwdriver with the screwheads. After removal of both screws the joint was copiously lavaged. The horse was discharged 2 d later with recommendations for 2 wk of strict stall rest followed by short periods of hand walking. Three doses of autologous conditioned serum (IRAP; Orthokine, Dechra Veterinary Products, Leawood, Kansas, USA) were injected into the TCJ at 2-week intervals starting at the time of suture removal. Eight weeks later, the horse was admitted for recheck evaluation. The lameness grade was static (3/5), the TCJ was still

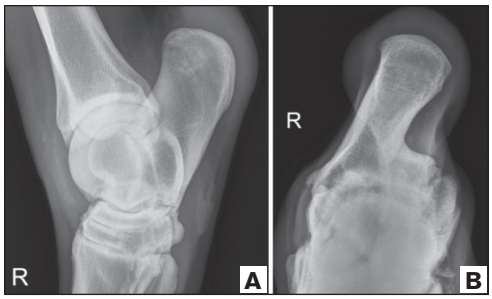

Figure 8. Radiographs taken 48 months after surgery. A – Lateral to medial projection and calcaneal skyline (B) views of the right tarsus showing complete fusion of the TCLJ and progressive loss of visualization of the distal intertarsal joint space with bridging new bone.

effusive, and tarsal flexion elucidated an obvious pain response. Radiographs taken at this time showed almost complete fusion of the medial facet of the TCLJ. The horse had been turned out in a small paddock when at home. Twenty months after the initial surgery the horse was still lame at the trot (3/5) and it was retired from any future athletic activity. Ultrasonographic examination showed severe capsulitis and synovitis of the TCJ. Radiographic examination showed progression of the arthritic changes at the level of the DIT joint and improved but still incomplete fusion of the TCLJ. Intra-articular block of the TCJ with 15 mL lidocaine hydrochloride 2% (VetOne, Boise, Idaho, USA) induced a marked improvement of the lameness (approximatively 75% reduction of lameness).

A recheck examination 48 mo after the initial surgery showed absence of lameness and negative flexion test. Radiographs revealed complete fusion of the TCLJ visible on both lateral to medial and the calcaneal skyline view (Figure 8). Progressive loss of visualization of the distal intertarsal joint space with bridging new bone was also visible. The intracapsular soft tissue swelling had improved and the horse was used for pleasure riding.

Discussion

This is the first report of severe TCLJ osteoarthritis treated with surgical arthrodesis that included the use of PET/CT to assess complex tarsal lesions in horses. A rare complication not previously described is also reported.

Advanced imaging was indicated in this case for further characterization of the tarsal lesions and to better determine appropriate surgical options. Computed tomography is commonly used for this purpose as it provides cross-sectional data and allows for excellent assessment of osseous structures. The addition of ^{18}F-NaF PET imaging provided functional information, which is complementary to the structural information from the CT. ^{18}F-NaF incorporates at sites of exposed hydroxyapatite matrix, thus highlighting active bone turnover (6). In humans, ^{18}F-NaF PET has been used to detect, and precisely localize sites of active bone modelling in patients with foot pain of undetermined origin (7,8). This case is an excellent illustration of the use of 2 synergistic imaging modalities. The most severe changes observed on CT related to the disease and subsequent fusion of the DIT. These changes, however, were not associated with uptake on the PET scan, suggesting the lesions were not active and likely not clinically relevant at this stage. The PET demonstrated that the most active lesions in the tarsus were in the talocalcaneal joint. Nuclear scintigraphy has been previously used to identify osteoarthritis of the TCLJ (2,4). It is likely that in the current case, scintigraphy would also have shown increased radiopharmaceutical uptake in the TCLJ region, but PET was chosen over scintigraphy for its 3-dimensional properties that allow for direct pairing with the excellent anatomical resolution provided by the CT. Due to the cross-sectional nature, the higher spatial resolution and the higher affinity of the ^{18}F-NaF for areas of bone remodeling, PET compares favorably to scintigraphy as was recently demonstrated in the racehorse fetlock (9). Positron emission tomography is not only more sensitive than scintigraphy, but it also greatly improves the localization of active osseous lesions. Whereas scintigraphy would indicate uptake in the region of the talus and calcaneus, PET can specify which part of which articular surface is involved, which is important for surgical planning.

In retrospect, arthritic changes of the TCLJ were present on the radiographs of the case reported here. The advanced arthritic changes and remodeling at the TMT and DIT joints present at that time had likely distracted examiners attention away from the TCLJ. This report shows that careful assessment of the TCLJ should always be performed when lameness is localized to the tarsal region.

Intra-operative imaging was essential to better target the medial facet. More specifically, a vertical calcaneal skyline view helped to precisely target the affected medial facet. To our knowledge, this intra-operative view for this procedure has not been reported. In the current case, slight divergence between the 2 drill bits was achieved in the lateral to medial plane by leaving 1 drill bit in place, placing subcutaneous needles on the plantar aspect of the tarsus, and by using the vertical calcaneal skyline view. A repeat PET scan before the second surgery in order to assess the changes in bone activity subsequent to the initial examination could have yielded valuable information; however, as surgical removal of the screws was planned under the same anesthetic episode, PET was not possible due to radiation safety concerns. Therefore, only a CT scan was performed. Ultrasound of the TCLJ, although primarily used for needle guidance, was able to identify changes including joint effusion and irregular joint margins with periarticular osteophytosis.

Pauwels et al (2) reported the use of 3 screws inserted at the distal tubercle of the talus in a pony. The aim of the surgical arthrodesis was to provide stability to the medial facet of the TCLJ. In the current report, the cortical screws were placed in neutral over lag fashion to avoid modifying the biomechanical relationship of the talus and the calcaneus to one another (4). A dorsomedial approach was chosen in this case. However, relatively successful outcomes were reported by Smith et al (4) using the plantarolateral approach. Future studies evaluating the effect of screw angulation are necessary to better determine the optimal screw position.

The cadaveric specimens used for preparation showed the potential complication of impingement of the screw heads with the medial malleolus and the dorsomedial approach. Awareness

of this complication meant that both screw holes were deeply countersunk during surgery. Computed tomographic examination showed that the distal screw head was protruding slightly more than the proximal one. We suspect that this complication could have been avoided with even more aggressive countersinking, using another approach (plantaromedial or plantarolateral), applying headless compression screws (10), or by using arthroscopy during the initial surgery in order to directly assess the depth of the screw head within the countersunk hole. Alternatively, a more medial location of the screws may have minimized the risk of screw impingement. The fragmentation of the medial malleolus seen on this case lead to severe synovitis and capsulitis of the TCJ and secondary chronic pain and lameness at this location.

The current article reports a major postoperative complication after surgical arthrodesis of the TCLJ that equine orthopedic surgeons should be aware of. This report also highlights the complexity of tarsal osteoarthritis in horses and demonstrate the value of ^{18}F-NaF PET for specific assessment of activity and localization of osseous lesions.

Acknowledgments

We thank the referring veterinarian and owner Dr. Jill Higgins without whom this case report would not have been possible.

CVJ

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Erratum

CVJ 2019:60:1060

Error in the Abstract:

Original:
…however, dogs premedicated with methadone and alfaxalone appeared significantly less sedated than dogs premedicated with midazolam at 15, 20, and 25 minutes post-injection ($P = 0.04$). Dogs receiving methadone and alfaxalone were almost 5 times more likely to show excitement than those receiving midazolam ($P = 0.03$). We concluded that adding midazolam to an intramuscular combination of methadone and alfaxalone cannot be recommended in healthy dogs.

Correction:
…"however, dogs premedicated with midazolam, methadone, and alfaxalone appeared significantly less sedated than dogs premedicated without midazolam at 15, 20, and 25 minutes post-injection ($P = 0.04$). Dogs receiving midazolam, methadone, and alfaxalone were almost 5 times more likely to show excitement than those not receiving midazolam ($P = 0.03$). We concluded that adding midazolam to an intramuscular combination of methadone and alfaxalone cannot be recommended in healthy dogs."