Case Report

Computed tomographic (CT) arthrogram contributes to the diagnosis of an osteochondroma of the distal calcaneus in a horse

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Summary

Osteochondromas in the horse are most commonly found as a solitary lesion affecting the distal radial metaphysis. In this location, diagnosis is reliant on radiographic and ultrasonographic examination and confirmed with postoperative histopathology. This case report describes the additional benefit of performing a CT arthrogram to aid the diagnosis of an osteochondroma in an atypical location.

Case history and clinical findings

A 10-year-old Connemara cross gelding was presented for investigation of moderate tarsocrural effusion and lameness of the right hindlimb that had been localised to the tarsocrural joint with diagnostic anaesthesia. The tarsocrural joint effusion had been present for 5 months prior to referral. The tarsocrural joint was medicated with 10 mg triamcinolone, and the horse received 0.06 mg/kg bwt intravenous dexamethasone when the effusion initially developed. On lameness examination, the patient was 3/5 right hindlimb lame at a trot (AAEP lameness scale, Anon 1991), with an increase in the lameness on whole limb flexion. Palpation revealed a severe tarsocrural joint effusion with pain on palpation over the lateral aspect of the calcaneus.

Diagnosis

Radiographic examination

Six radiographic views were acquired of the right tarsus including weightbearing latero-medial, dorso-plantar, dorsal-45°lateral-plantaromedial oblique (DLPMO), dorsal-45°medial-plantarolateral oblique (DMPO), dorsal-15°lateral-plantaromedial oblique and flexed latero-medial views. Radiographic examination was performed using AGFA DX-G 1 under standing sedation. From these views, three separate mineral opacities dorsal and lateral to the calcaneus were evident (Fig 1a-d). The opacities were irregularly marginated and heterogeneous but with similar opacity to the neighbouring trabecular bone. There was no evidence of degenerative joint disease affecting any of the tarsal joints from the radiographic findings. Under standing sedation ultrasonographic examination of the plantarolateral aspect of the tarsocrural joint revealed an irregular hyperechogenicity with a thin hypoechoic layer overlaying it suggestive of a mineral structure with a thin layer of surface cartilage. Other findings included a severe joint effusion and moderate synovial proliferation. The plantarolateral pouch of the tarsocrural joint extended more proximally than normal. There was no sonographic evidence of compression or disruption of the associated tarsocrural joint soft tissue structures.

CT examination under general anaesthesia

The horse received a premedication of acepromazine 0.03 mg/kg bwt i.v., flunixin meglumine 1.1 mg/kg bwt i.v. (33), procaine benzylpenicillin 22,000 IU/kg b.i.d. i.m., and intravenous gentamycin 6.6 mg/kg bwt i.v. s.i.d. The horse was anaesthetised and placed into left lateral recumbency. A computed tomography (CT) scan was obtained using a 16-slice helical wide bore scanner (Toshiba LB 16 slice). The slice acquisition was collimated to 2 mm and reconstructed with a bone algorithm. The tube rotation time was 0.75 s with a kVp 135 kV and 225 mAs.

Within the dorsal and transverse multiplanar views, it was evident that four differing sized, rounded mineral-attenuating structures were present, compared to three being visible on the radiographic views. The largest most distal structure was adherent with the dorsolateral aspect of the calcaneus and isoattenuating to the neighbouring trabecular bone (Fig 2a-d). The internal architecture of the structures was heterogeneous and with an irregular trabecular pattern. In addition, there was osteophyte formation involving the plantar aspect of the lateral trochlear of the talus and caudal aspect of the tibia (Fig 2d).

The joint was aseptically prepared, and a positive contrast CT arthrogram was performed; 40 mL of iohexol contrast material (350 mg I/mL; Omnipaque®) diluted 50:50 with sterile saline and 80 mL of the solution was injected into the dorsolateral compartment of the tarsocrural joint. There was a delay of 5 min between administration and image acquisition to allow the contrast material to diffuse throughout the joint and to enable repositioning of the patient. The positive contrast outlined a thin rim of soft tissue attenuation encapsulating and dissecting between the four previously described mineral structures (Fig 3a-d). This suggested that instead of multiple structures the pathology within the joint was a single mass originating from the distal dorsal calcaneus and surrounded by a soft tissue capsule incorporating all the previously described mineral structures within the joint.

Treatment

Under the same anaesthetic, arthroscopic examination of the tarsocrural joint was performed. An arthroscopic portal was made into the plantaromedial pouch of the tarsocrural joint. The plantarolateral aspect of the joint was examined, and a firm, white, smooth structure was evident occupying...
a significant proportion of the plantarolateral pouch, extending dorsally from the plantar aspect of the joint and from the distal calcaneus, and significantly obliterating the normal view of the trochlear ridges. There was evidence of mild synovitis within the tarsocrural joint but the cartilage within the joint and the soft tissue structures examined were normal in appearance. The most distal aspect of the structure was not visible arthroscopically, and a 5 cm arthrotomy incision was made over the plantarolateral pouch, under arthroscopic guidance. The structure was grasped with Allis tissue forceps, and Ferris Smith bone rongeurs were used to remove the proximal portion of the structure, which came away readily. Most of the structure was resected, except for the most distal aspect, which was adherent to the distal calcaneus and left in situ. During surgery, a significant haemarthrosis occurred, and despite copious lavage this did limit the visualisation. The arthrotomy incision was closed with vertical mattress sutures using 4 metric Nylon (Ethilon) and skin staples. Five-hundred milligrams of amikacin sulphate (Amikacin 250 mg/mL) were instilled into the tarsocrural joint.

**Outcome**

The excised mass that had been removed was submitted for histopathology which revealed the structure to consist of a core of well-differentiated trabecular bone, with a thin surface layer of cartilage typical of an osteochondroma (Fig 4).

A repeat radiographic examination was performed 2 days post-operatively to obtain a flexed latero-medial and a dorso-plantar projection which highlighted that the majority of the osteochondroma had been removed however the most distal part was still adherent to the calcaneus (Fig 5). The horse was 2/5 right hindlimb lame (AAEP lameness scale, Anon 1991) for 3 days post-operatively which was thought to be due to the extensive and traumatic removal and so was maintained on phenylbutazone 2.2 mg/kg bwt per os s.i.d. The horse was discharged from the hospital sound at walk to

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**Fig 1:** a) Weightbearing latero-medial radiograph of the right tarsus. There are three differently sized rounded mineral opacities dorsal to, and partially superimposed on, the calcaneus and plantar to the distal tibia with an opacity similar to trabecular bone. The largest is found most distally and in this view is partially superimposed on the dorsal aspect of the distal calcaneus (largest arrow) and the caudal tibia. The two proximal opacities are mildly irregular margined and less distinct than the larger, more distal opacity on this view (two smaller arrows). b) Flexed latero-medial radiograph of the right tarsus. The flexed lateral view highlights the close association of the largest distal mineral opacity with the dorsal aspect of the calcaneus, extending to approximately two-thirds of the calcaneus length (arrow). c) Weightbearing dorso-plantar radiograph of the right tarsus. There is marked soft tissue opacity surrounding the medial tarsus associated with a tarsocrural joint effusion. The opacities as previously described are found lateral and partially superimposed on the calcaneus (small and large sized arrow). d) Weightbearing dorsal-15lateral-plantaromedial oblique radiograph of the right tarsus. This oblique view highlights the extent of the marked soft tissue swelling laterally and medially (arrow heads) as well as the location of the distinct mineral opacities lateral to and partially superimposed on the calcaneus (large arrow and small arrow).
continue on box rest and in-hand walking. Due to the incomplete removal of the osteochondroma and the degenerative joint disease in the tarsocrural joint, a guarded prognosis for returning to athletic function was given.

The horse developed a surgical site infection of the arthrotomy incision 2 weeks post-operatively that developed into septic arthritis. An arthroscopy of the tarsocrural joint under general anaesthesia was performed and revealed a significantly inflamed joint with fibrin in the dorsal and plantar pouches. The arthrotomy incision was resected, fibrin removed, and an extensive synovectomy was performed. The horse did not respond to surgical treatment, and bacteriology results taken from surgical samples confirmed growth of a multi-antimicrobial resistant non-haemolytic E. coli species. The horse was non-responsive to a change in antimicrobial therapy and was subjected to euthanasia on humane grounds, and therefore, no long-term follow-up is available.

Discussion

This case report describes how non-contrast and CT contrast arthrography aided the diagnosis of an osteochondroma in an atypical location within the tarsocrural joint on the distal calcaneus. Osteochondroma formation is an infrequent cause of hindlimb lameness in the adult horse. It most commonly presents at the caudal-distal radial metaphysis within the carpal sheath (Wright and Minshall 2012; Russell et al. 2017). Other locations are reported including the distal tibia within the tarsal sheath (Kenzora et al. 1995; Agass and Fraser 2018) and the calcaneus within the...
tarsal sheath (Welch et al. 1990). Extra-synovial locations are reported at the proximal phalanx (Seghrouchni et al. 2019), the skull (Adair et al. 1994) and the cervical spine (Dixon and Anderson 2019). Potential differential diagnoses would include osteochondral fragmentation or fracture; however, due to the radiographic and CT appearance in this case these are unlikely. There was no evidence of articular surface disruption and the location of the fragments would be atypical.

Solitary osteochondromas are cartilage capped benign tumour-like exostoses that arise from the surface of endochondral bone adjacent to the growth plate (Thompson 2007). In horses, these lesions are reported to be present from birth and develop from an abnormal island of growth plate in a metaphyseal location (Thompson 2007). They develop via endochondral ossification and slowly grow, normally stopping when the neighbouring growth plate closes. Osteochondromas are normally associated with mild to moderate lameness associated with either disruption of overlying soft tissues, or distension of an involved synovial structure. In this case, the presentation of the osteochondroma was not only in a unique location, but the age of presentation of lameness was also unusual. It is hypothesised that the osteochondroma had been present for a significantly longer period of time and was detected when lameness developed most likely due to the development of degenerative joint disease and significant tarsocrural joint synovitis. In humans, osteochondromas are a commonly diagnosed extra-synovial

Fig 3: a) All CT images are in a bone window after injection of contrast material. 3D MPR transverse positive contrast CT arthrogram image, positioned midway along the length of the calcaneus, showing the two more proximally situated, previously described mineral-attenuating structures (two white arrows) surrounded by a rim of soft tissue, which is delineated by the positive contrast material (black arrow). b) 3D MPR sagittal positive contrast CT arthrogram image, positioned towards the lateral aspect of the tarsocrural joint showing the larger of the four previously described mineral-attenuating structures adherent to the dorsal aspect of the calcaneus (black arrow) with positive contrast delineating a rim of soft tissue dorsal to this structure (white arrow). c) 3D MPR dorsal CT image, positioned towards the lateral aspect of the proximal tarsal region, showing the previously described mineral-attenuating structures within the soft tissues dorsal to the calcaneus. Two smaller structures (two smallest white arrows) are situated more proximally, just distal to the margin of the calcaneus. The larger, more distal structure (largest white arrow) is clearly adherent to the dorsal margin of the calcaneus and a thin rim of soft tissue attenuation encapsulates all these structures delineated by the positive contrast (black arrow). d) Surface rendered MPR CT image showing the previously described mineral-attenuating structures situated dorsal and lateral to the calcaneus with the larger, more distal structure adherent to the dorsal margin of the calcaneus distally. The fourth smallest, rounded mineral-attenuating structure is visible just proximal to the two more proximal structures (black arrow).
benign bone tumour normally presenting in children and young adults (Thompson and Pool 2001). The calcaneus is an infrequently reported location causing minimal clinical signs remaining dormant through adulthood (Yan et al. 2018). Rarely, pain and swelling can develop around dormant calcaneal osteochondromas and this is normally associated with malignant transformation (Yan et al. 2018). There are no reported cases of malignant transformation of solitary osteochondromas in horses, and the histopathologic findings in this case suggested a benign process.

Surgical removal via endoscopy is the current treatment of choice for appendicular lesions, with good outcomes presented in the literature in regards to return to athletic function and lack of recurrence (Welch et al. 1990; Kenzora et al. 1995; Secombe and Anderson 2000; Wright and Minshall 2012; Russell et al. 2017; Agass and Fraser 2018). For this case, a guarded prognosis for return to athletic function was suspected due to incomplete removal of the distal part of the osteochondroma and the degenerative joint disease present within the joint.

No long-term follow-up was available in this case due to a surgical site infection of the arthrotomy incision and septic arthritis that necessitated euthanasia. Surgical site infections and septic arthritis are recognised complications of arthroscopy and arthrotomy although risk factors have not been fully characterised. Intra-articular contrast administration is not a reported risk factor for either surgical site infections or intra-articular infection within human or veterinary diagnostic imaging and is not hypothesised to be a relevant factor in the outcome of this case. The degree of surgical trauma as well as previous intra-articular medication with corticosteroids has been associated with increased risk of infection and both of these risk factors were present (Brunsting et al. 2018).

Diagnostic imaging of osteochondroma routinely includes radiographic and ultrasonographic examination which normally identifies a solitary exostosis growing perpendicular to the bone of origin. These findings increase the index of suspicion of an osteochondroma; however, histopathology is necessary for a definitive diagnosis. There have been reports

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Fig 4: Subgross images of decalcified sections through the excised tissue samples. A core of well-differentiated trabecular bone is covered by a cartilage ‘cap’ (asterisk). c) Higher power image of the transition from cartilage to bone: small areas of retained endochondral ossification are discernible near the cartilage-bone interface and within the core of deeper trabeculae (arrows). H&E staining; (a & b): 20× magnification; scale bar = 2 mm; (c) 100× magnification, scale bar = 500 µm.

Fig 5: Flexed latero-medial radiograph of the right tarsus one day post-operatively showing the previously described more proximal mineral opacities are no longer present and the larger, most distal mineral opacity has reduced in size with a clearly margined, straight dorsal margin, consistent with surgical resection of a proportion of this mass.
of advanced imaging techniques such as scintigraphy, CT and MRI, being used to aid diagnosis of osteochondroma (Secombe and Anderson 2000; Dixon and Anderson 2019; Seghrouchni et al. 2019). Non-contrast CT and MRI were used to aid the diagnosis of an osteochondroma on the proximal phalanx (Seghrouchni et al. 2019). Seghrouchni et al. (2019) described how CT provided essential cross-sectional information about the cortical and medullary continuity of the osteochondroma with the underlying bone. Dixon and Anderson (2019) used CT myelography to aid diagnosis of an osteochondroma within the cervical spine causing compression and displacement of the spinal cord. These studies highlight that the initial imaging was unable to appreciate the true extent of soft tissue and bone pathology and that advanced imaging techniques can provide important prognostic information (Dixon and Anderson 2019; Seghrouchni et al. 2019). The present report is the first case of positive contrast CT use to aid diagnosis of an osteochondroma in the limb of a horse.

In this case, it appeared that three mineral opacities were present on the radiographs and due to the unusual appearance and location; further diagnostics were needed to narrow down the differential list. The non-contrast CT examination provided excellent bone information highlighting a fourth mineral structure within the joint as well as degenerative joint disease at the lateral trochlear of the talus and caudal aspect of the tibia. As well as this, it provided information on the region of interest without superimposition of neighbouring anatomy. The contrast CT provided more detail on the soft tissue pathology by delineating a soft tissue capsule surrounding all the mineral structures suggesting the pathology was one large mass growing perpendicular from the distal calcaneus. The imaging findings aided our diagnosis, narrowed our differential list and gave more prognostic information about the extent of the pathology.

In conclusion, contrast CT is a quick and safe technique that can be performed and should be employed more frequently prior to surgery to aid diagnosis for suspected osteochondromas in unique locations.

Authors’ declaration of interests
No conflicts of interest have been declared.

Ethical animal research
Not applicable to this case report.

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Authorship
T. de Souza, J. Suthers and B. Jones contributed to study conception and design. All authors contributed to acquisition of data, analysis and interpretation of data, drafting the article and revising the article for intellectual content. All authors gave their final approval of the manuscript.

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