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Case Report

An extra-articular surgical approach to subchondral bone cysts in the humeral head and talus in two horses

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Declarations

Authorship: P. Ravanetti conceived and executed the surgeries, drafted and critically revised the manuscript. C. Kühnle participated in case n.2 surgery session and contributed to case material. A. Lechartier participated in case n.1 surgery session and performed the morphometric analyses. E. Zucca drafted and revised the manuscript. All authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Ethical animal research: This is a report of client-owned horses and a owners' informed consent was obtained.

Highlights

- Subchondral cystic lesions (SCL) are rarely described in the humerus and talus
- An extraarticular approach was used to insert an absorbable implant in both locations
- This surgery may broaden prognosis of horses with SCL in humeral head and talus
- The horses were sound following surgery and returned to their previous level of athletic activity

Summary

To date, only a few reports describe the treatment. The present report describes an extraarticular surgical approach, with the insertion of an absorbable implant, to treat a SCLs in the humeral head 3year old racing Thoroughbred & in the talus of a 11year old Arabian horse. SCLs were radiographically visible and associated with severe lameness. Scintigraphy showed focal intense radiopharmaceutical uptake in both cases, and CT scan revealed signs of osteoarthrosis associated with SCL in the talus. The use of a biocompatible, osteoinductive and osteoconductive implant allowed a reduction of the SCL radiographic appearance of at least 70% in both cases and horses returned to their previous athletic activity. The results of the present study might provide substantial information about a new surgical option to treat SCLs in the scapulohumeral and tarsocrural joints and may broaden prognosis and prolong future athletic ability of

affected horses.

Keywords: horse; subchondral cyst; humerus ; hock; absorbable implant; extraarticular access

Introduction

Subchondral cystic lesion (SCL) can appear like lucent circular areas in subchondral bone often surrounded by a sclerotic margin. The most common site of SCL is the medial femoral condyle, followed by phalanges, carpal bones, metacarpal and metatarsal bones, tibia, radius, sesamoid bones, humerus, patella and tarsal bones [1]. It is recognized that when they are in proximity to the joint or when they communicate with articular space they are often responsible for lameness [2]. Many pathogenesis have been postulated including osteochondrosis, inflammation or trauma [2–4], with the latest having gained more weight in the last few years; however, in most cases the underlying cause remain unknown. To date, a few case reports describe the treatment of SCLs located at the bicipital bursa or glenoid cavity [5–8], however there are no studies documenting the treatment of SCLs in the humeral head; while a variable outcome has been reported following treatment an SCL involving the talus [9–12]. The purpose of this report was to describe the clinical signs, radiography, nuclear scintigraphy, computed tomography (CT) findings and surgical treatment an SCL located in uncommon joints in two mature horses. The surgical approach was extra-articular to avoid damage to the cartilage and to allow insertion of an absorbable device composed of nano-hydroxyapatite (μ-HA) calcium phosphate, and Poly-L-lactic acid (PLLA). In humans this device assures biocompatibility and degrades progressively as new bone tissue regenerates [13]

Case n.1

History

A 3 years old male racing Thoroughbred was referred because of right forelimb lameness that appeared suddenly three months earlier. A period of 10 weeks of complete box rest was performed as conservative treatment, and then the horse was referred due to persistent lameness.

Clinical exam

The horse (470 kg) showed a right forelimb lameness of grade 3/5 (AAEP Score). There were no palpable abnormalities and no resistance was elicited to passive range of motion of any joint. No detectable abnormalities were observed or painful response was elicited after manipulation of tendons and ligaments, and hoof tester examination was negative. Radiographic examinations of phalanges, fetlock, metacarpus, carpus, and elbow as well as ultrasound evaluation of tendons and ligaments of the metacarpal region were performed. Since no abnormalities were observed in the distal limb, it was assumed that the injury might originate from the proximal limb and a gamma scintigraphy was recommended. The exam was performed in an academic diagnostic imaging centre.

Gamma Scintigraphy exam

Technetium (^{99m}Tc) 3,3-diphosphono-1,2-propanedicarboxylic acid (5,8 GBq) was injected intravenously, scanning started 3 hours later to highlight the bone phase. The exam (Siemens Gamma sonics, Siemens AG, Medical Solutions, Erlangen, Germany) identified focal intense increase of radiopharmaceutical uptake in the proximal region of the right humerus (Figure 1a-b).

Radiography

Radiography of the right scapulohumeral joint was performed in the standing sedated patient (detomidine 0.01mg/kg bwt and morphine 0.1mg/kg bwt i.v.). A routine medio-lateral view was obtained [14]. A focal zone of radiolucency surrounded by sclerosis compatible with a SCL on the junction between the central and caudal third of the humeral head (Figure 2), associated with an articular cloaca, was identified. The SCL was 14 mm deep and 16 mm wide.

Ultrasound exam

Ultrasonography of the right scapulohumeral joint, was performed using a 13 MHz linear-array transducer, wich was unremarkable.

Diagnostic analgesia

According to the radiographic findings, intraarticular anaesthesia of the scapulohumeral joint was performed using 15 ml of mepivacaine HCl 2%. The horse showed a complete resolution of the lameness 10 minutes after injection.

Diagnosis

A subchondral cystic lesion in the caudo-medial aspect of the right humeral head, communicating with the scapulohumeral joint, was diagnosed as the cause of lameness.

Treatment

Considering no improvement of the lameness after conservative treatment, a surgical procedure was proposed. All the treatment options described in the literature were discussed with the owner and trainer. Eventually, the surgical insertion of an absorbable implant , according to the technique described by Ravanetti and colleagues [15] was chosen, and the informed owner consent form was signed.

General anaesthesia procedure

Premedication with procaine penicillin G (22,000 U/kg bwt i.m. q12 h), gentamicin (6.6 mg/kg bwt, i.v. q24 h), and phenylbutazone (4.4 mg/kg bwt, i.v. q12 h) was made. Then the horse was sedated with xylazine (1.1 mg/kg bwt i.v.), and induced with ketamine (2.2 mg/kg bwt i.v.) and diazepam (0.1 mg/kg bwt i.v.) and maintained on isofluorane inhalation anesthesia.

Surgical procedure

The horse was positioned in dorsal recumbency, and the right forelimb was attached to a hoist, positioned in full extension and pulled forward as much as possible. Subsequently, the area was

clipped, prepped, and draped in aseptic fashion. Since it was impossible to perform a caudo-dorsal view of the scapulohumeral joint, two orthogonal radiographic views cannot be obtained. Therefore, the lesion was pinpointed on a medio-lateral view and a caudal 65˚medial-craniolateral oblique view; the latter was obtained pushing the generator as near as possible to the thorax and the radiographic shot was performed at the end of the expiratory phase. Using these two projections the lesion was located and a 18G needle (length 70 mm) was used as a marker. The surgical approach was similar to that used to repair humeral epiphyseal fractures. A skin incision of 3 cm was made, at 15 cm distal to the distal end of the scapula spine parallel to the cranial edge of deltoid muscle. Sharp dissection of the deltoid and brachiocephalic muscles, allowed was needed to reach the lateral surface of the proximal diaphysis of the humerus. Under radiographic control a 7.0 mm drill bit was used in a lateral to medial to perform a bone tunnel with a lateral to medial direction in the humeral head (Figure 3a-b) and angled to intersect the SCL. A loss of resistance, confirmed that the cavity was debrided using a 4 mm Cobb curette and flushed with saline. A tap was then used to prepare the bone tunnel (Figure 3c) and a 9 mm interference screw (Osteotrans-OT, Takiron CO, M.I.T distributors, Piacenza, Italy) was inserted in the cavity. The muscles and subcutis were sutured with absorbable monofilament suture (poliglecaprone-25 n.0), and the skin incision was closed with non-absorbable monofilament suture (nylon n.0). An adhesive bandage was placed over surgery portal for recovery from general anaesthesia. The surgery was performed in about 45 minutes, the complete procedure needed 80 minutes.

Post-operative clinical follow-up

The horse was not lame at a walk in the subsequent days, antimicrobial and anti-inflammatory therapy used at the same dosage post-operatively was stopped 3 days after surgery, and the horse was discharged from hospital 72 hours after surgery. The skin sutures were removed 12 days post-surgery, and a 3 weeks period of stall-rest after surgery was recommended. The referring veterinarian recorded the presence of fever, lameness and swelling at the surgical site for the first two weeks after surgery.

Post-operative rehabilitation

After the 3 weeks of stall-rest, a post-operative rehabilitation program was introduced and included 8 weeks of exercise in the pool. The rehabilitation program started with 3 minutes of swim for the first week, which was then increased by one minute each week until reaching six minutes in the fourth week. During the subsequent four weeks the protocol included two sessions of six minutes swimming with three minutes of pause in between. Eight weeks after surgery the horse restarted his previous traditional training on the track.

Radiographic, clinical, and long-term follow up

Radiographs were taken at 90 and 210 days after surgery. Reduction of lesion size was evaluated using morphometric analysis (ImageJ, U.S. National Institutes of Health, Bethesda, Maryland, **USA)**. The comparison of pre-surgery and 210 days post-surgery radiographs showed 72% reduction of the cavity (Figure 4 a-b-c). The horse was judged sound during the rehabilitation and training periods; he started racing 170 days after surgery and raced successfully 17 times in the following 14 months. To date the horse is in training and no recurrence of lameness was reported. No subsequent anti-inflammatory medication or joint treatments were required to maintain soundness.

Case n.2

History

An 11 years old female Arabian endurance horse was presented for a second opinion of a severe intermittent left hind lameness between grade 4/5 and 5/5 (AAEP Score). The intermittent phases of non-weight bearing were reduced grade 3/5 (AAEP Score) after a full dose of meloxicam (0.6 mg/kg bwt p.o. q24h), however an obvious lameness at a walk persisted. The severe lameness appeared six months earlier, no signs of sepsis were reported, and due to the poor response to NSAID treatment euthanasia was suggested. However, the horse was presented with a previously performed scintigraphy, computed tomography (CT) and radiographic exams of the affected limb.

Clinical exam

Palpation of the limb showed a moderate distended tarsocrural joint (TCJ).

Scintigraphy findings

A marked focal increase of radiopharmaceutical uptake at the palmar proximal aspect of the talus was observed (Figure 5a-b).

Computed Tomography findings

The CT revealed a SCL communicating with the tarsocrural joint (TCJ). Additional finding included: mild to moderate talocalcaneal osteoarthrosis (Figure 5c-d) and signs of degenerative joint disease, such enthesophyte formation on the dorsal and medial aspect of the distal tibia.

Radiography

Radiographic latero-medial, dorso-plantar and 35˚medio-lateral oblique projections of the left hock, confirmed the presence of a well circumscribed radiolucency defect in the axial proximal aspect of the the lateral trochlear ridge of the talus (Figure 5e-f), with marked sclerosis around the radiolucent area. The SCL was 15.6 mm deep and 11.4 mm wide.

Diagnosis

Lameness was attributed to the presence of a subchondral bone cyst joint involving the lateral trochlear ridge of the talus.

Treatment

Considering the limited improvement of the lameness after anti-inflammatory treatment and the poor prognosis suggested previously, a surgical insertion of an absorbable implant was proposed [15].

General anaesthesia procedure

The general anaesthesia procedure was the same as case n.1.

Surgical procedure

Since the technique involved a lateral extraarticular approach, the horse was positioned in right lateral

recumbency with the affected limb uppermost. The limb was clipped and aseptically prepared for surgery. The surgical field and the horse were draped with sterile medical drapes. Radiographic latero-medial and dorso-plantar views were performed to localize the lesion and a 18G needle was used as a skin marker. A 1 cm skin incision was performed in the lateral surface of the talus caudal to the lateral extensor digital tendon and dorsal to the long plantar ligament. Further radiographs were performed to establish that the drill was angled appropriately to prevent the tarsocrural joint from being reached. A 5.5 mm drill bit was placed trough the incision to reach the lesion in a lateral to axial direction, after that the tunnel was over-drilled with an 8.5 mm drill bit. As described above (case1) a loss of resistance confirmed the entry into the cavity. Subsequently, debridement and flushing with sterile saline solution were performed. The bone tunnel was tapped and a 9 mm interference screw was inserted in the cavity (Figure 6 a-b). The subcutis was sutured with absorbable monofilament suture (poliglecaprone-25 n.0) and the skin incision was closed with absorbable monofilament suture (glycomer 631 n.0). The time of surgery was about 30 minutes, the complete procedure needed 50 minutes.

Post-operative clinical follow-up

A bandage was put on and changed 3 days after surgery and then every 4 days thereafter. Treatment with penicillin G (22,000 U/kg bwt i.m. q12 h), gentamicin (6.6 mg/kg bwt, i.v. q24 h), and phenylbutazone (2.2mg/kg bwt i.v. p12h) was continued for 3 days after surgery. The sutures were removed 12 days post-surgery.

Post-operative rehabilitation

The horse was discharged from the hospital 6 days after surgery and stall rest was continued at home for a total of 4 weeks. The lameness at a walk further improved over the following days and episodes of non-weight bearing were no longer observed. After this period, 10 minutes of walking machine for the first 2 weeks and 30 minutes during the following 4 weeks were scheduled.

Radiographic, clinical, and long-term follow up

Follow up radiographs were taken 3 months after surgery. The cyst was still noticeable on every projection with the device in place and well embedded. The morphometric analysis[3] showed a 74% reduction of the radiolucency. The horse had an uneventful rehabilitation with only a short period of mild swelling and heat around the lateral aspect of the hock two months after surgery, that resolved without treatment. No subsequent anti-inflammatory medication or joint treatments were required and no periods of non-weight bearing were recorded. When trotted on hard surface the horse appeared sound 4 months after surgery; six months after surgery the horse restarted her previous endurance athletic activity.

Discussion

The present report describes a surgical approach for lesions located into the humeral head and talus. Several surgical approaches, including drilling, bone grafting, mosaic arthroplasty, transcondylar metallic screw, and intra/extraarticular debridement, have been proposed to treat SCLs [16]. Although conservative management remains the initial treatment of choice, surgical procedures may become necessary when lesions do not heal. The authors prefer to use an extraarticular drilling technique that allowed the insertion of an absorbable implant, an adequate access to the cavity for debridement and flushing, and at the same time to preserving the articular cartilage. The device inserted provided a useful contact with the surrounding bone, ensuring osteoinductivity, osteoconductivity and stimulated the filling of the bone defect [13]. The cases described had some similarities, both were associated with severe lameness, despite differences in the affected limb and joint. The lack of historical and radiographic evidence of possible fractures, sepsis or osteochondrosis, that suggested a development of SCL due to subchondral bone trauma.

Case1: Although, a few case reports described the treatment of SCLs at the level of bicipital bursa or glenoid cavity [5–8], to the authors' knowledge there are no reports describing an extraarticular

surgical approach to treat lesions in the humeral head. However, lesions in different locations of the humerus have different prognosis and treatment, making extrapolation to the case described here difficult. Clinical results and the improvement on radiographic images demonstrated that SCL of the humeral head can be treated with the insertion of an absorbable implant, and that the combination of medio-lateral and cranial 65˚medial-caudolateral oblique radiographic views allowed correct placement of the implant to intersect the lesion. These findings may extend treatment options and improve prognosis in horses with SCL in the humeral head.

Case 2: The proximal lateral trochlear ridge may be visualized arthroscopically through the medial plantar pouch, and this would have provided surgical access to the lesion. However, surgical debridement of the SCL of the talus, particularly of larger lesions, has shown a variable outcome in the literature [11,12,17]. Garcia-Lopez and Kirker-Head [17] described the treatment of four SCLs in the trochlear groove of the talus; two of them were successfully treated by arthroscopy, while in the others conservative treatment failed to solve lameness. Conversely to our case, most of the SCLs described were small and not detectable on radiographs [17]. Moreover, a better prognosis was described after surgical debridement in young horses. Four cases of osteochondrosis and SCLs of the talus were treated by triamcinolone acetonide injection and arthroscopic debridement [11]. The outcome was positive in three 1 year old patients, although the required intraarticular injections of sodium hyaluronate and methylprednisolone acetate to decrease inflammation and effusion after surgery. The older patient (7 years old) was subjected to euthanasia due to lameness recurrence [11]. In addition, Fleck and Dyson [12] described a large SCL in the proximal aspect of the talus distal to the intermediate ridge of the tibia, quite similar to that reported here, which was considered surgically inaccessible. Based on the limited comparable cases mentioned above, we can infer that large SCLs in mature horses have poor prognosis, while small lesions affecting young horses may have a better prognosis. In the case described, a mature horse affected by a large SCL of the lateral trochlear ridge of the talus, was treated

with the insertion of absorbable device through a surgical access not described previously. The treatment allowed the horse to resume previous athletic activity and ensured a breeding career.

Limitations: It is important to recognize the current limitations of radiographic evaluation of the scapulohumeral joint to localize the SCL on two orthogonal radiographic planes during intraoperative set-up. Secondary, it would always be desirable to use advanced diagnostic imaging techniques during the long-term follow-up to monitor lesion healing, unfortunately this is not a practical goal among sport-horses and racehorses. Finally, radiographic controls were performed at the training stable in both cases, and slight variations in technique and position may have occurred.

Conclusions

Different treatment options have been described in the literature to treat SCLs and bioabsorbable implants are relatively new in equine orthopedic surgery. The surgical access allowed the insertion of an absorbable implant that seems to have a diverse use in many SCL locations, due to its iadvantages, compared to other options suggested. A possible transition from metallic screw to absorbable implant should be considered. Despite only two cases described, the results of the present study might provide substantial information to veterinarians, owners, and horseman; as it may improve prognosis provide additional treatment option and prolong future sport ability of horses affected by SCL in the scapulohumeral and tarsocrural joints.

Legend to figures

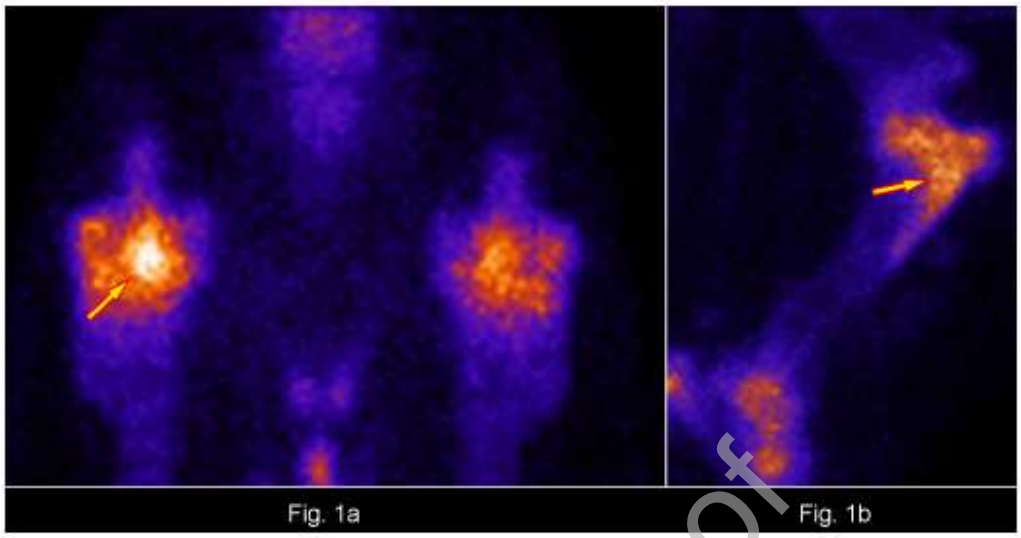

Figure1: Dorsal (a) and lateral (b) bone-phase scintigraphy of the scapulohumeral region show a focal intense increasing of the radiopharmaceutical uptake (yellow arrow) of the right proximal humerus.

Figure 2: Radiographic medio-lateral projection of the proximal humerus, a subchondral bone cyst is visible in the caudo-medial portion of humeral head (yellow arrow).

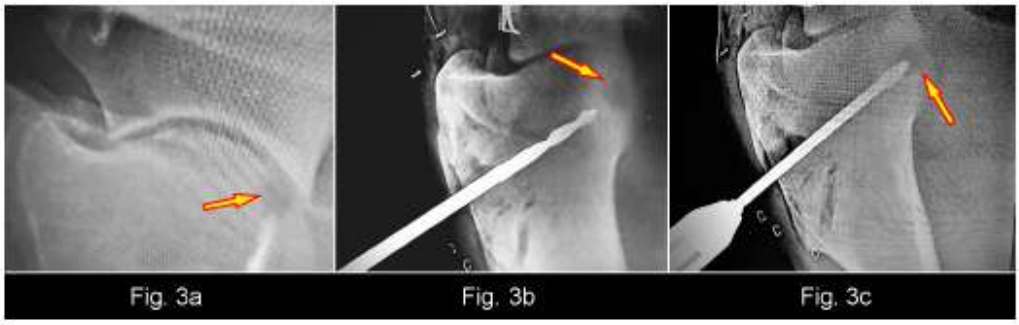

Figure 3: Intra-operative radiographs of the proximal humerus. Medio-lateral (a) and cranial 65˚medial-caudolateral oblique (b) views show the 7 mm drill bit directed towards the lesion (yellow arrow). Cranial 65˚medial-caudolateral oblique view (c) shows the tap used to prepare the bone tunnel (yellow arrow).

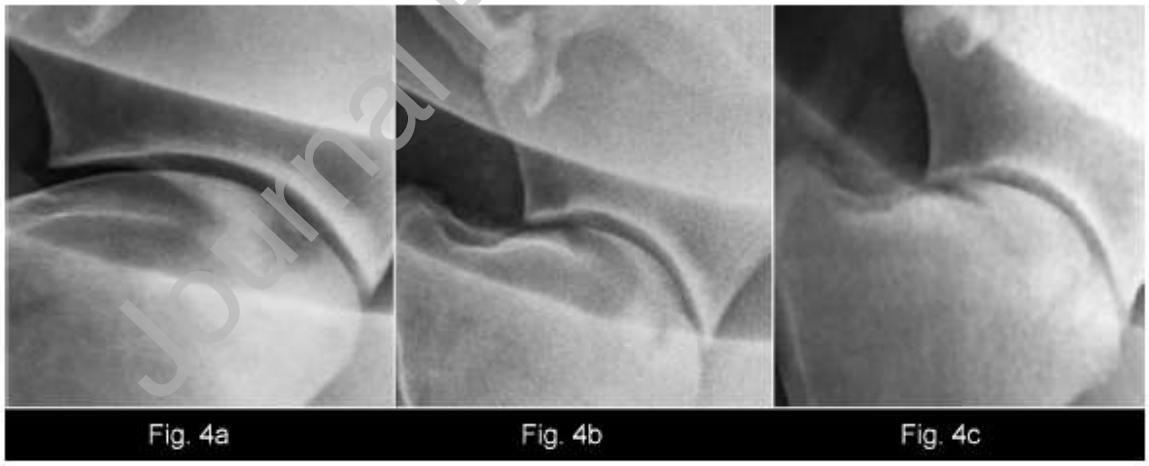

Figure 4: Radiographs of subchondral bone cyst of the humeral head treated with 9 mm interference screw. Radiographic medio-lateral views, side by side comparison pre-operatively (a), 90 days post-operatively (b), 210 days post-operatively (c).

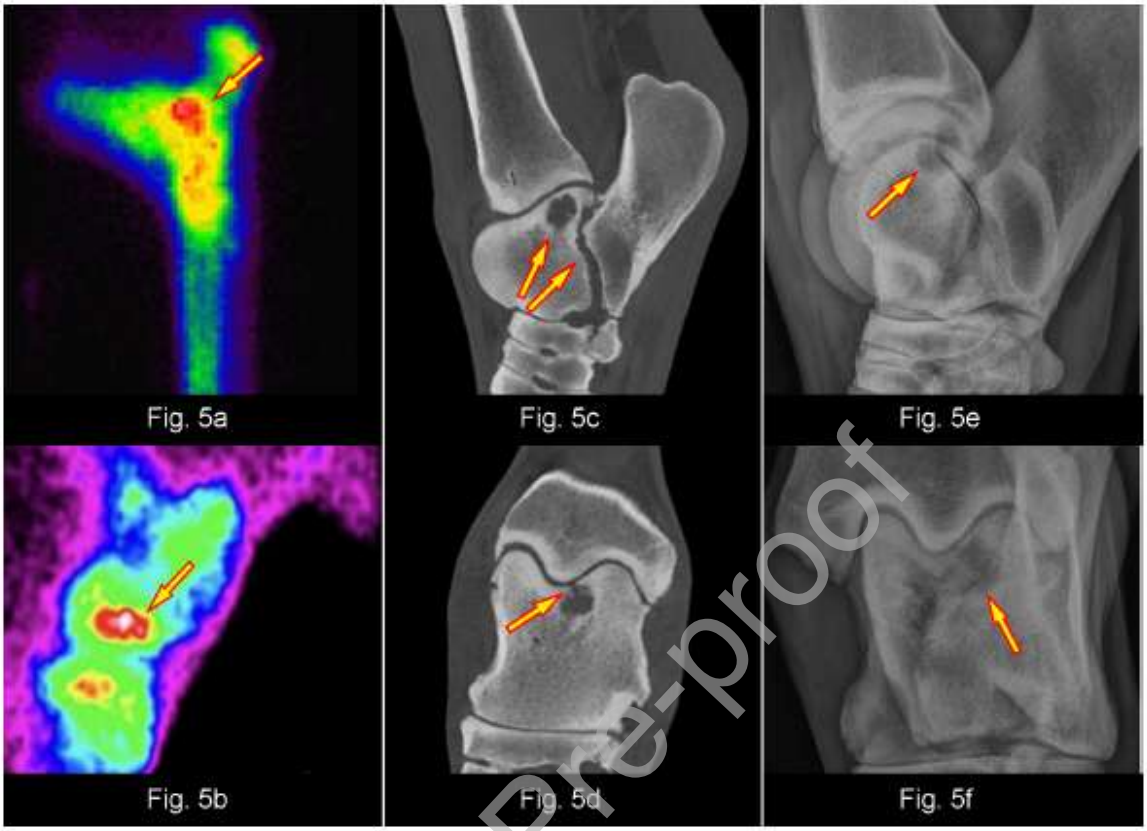

Figure 5: Lateral (a) and dorsal (b) scintigram of the left hock show localized increased uptake of radionuclide (yellow arrow). Computed tomography exam, frontal plane (c) of the talocrural joint shows a subchondral cystic lesion (yellow arrow). Sagittal plane (d) shows a cystic lesion communicating with joint surface and talocalcaneal osteoarthrosis (yellow arrows).

Radiographic latero-medial (e) and dorso-medial plantaro-lateral oblique (f) views show a lucent area of the lateral trochlear ridge of the talus ((yellow arrow).

Figure 6: Intra-operative dorso-plantar (a) and latero-medial (b) views of the left hock. The 5.5 mm drill bit is inserted into the lesion.

Figure 7: Radiographs of subchondral bone cyst of the talus treated with 9 mm interference screw. Radiographic dorso-palmar views, side by side comparison pre-operatively (a), 120 days post-operatively (b).

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