Title: Extraction of rudimentary bones in horses.

Estudent:
Teresa Szlosek Sosa

Tutor:
María Luisa Díaz-Bertrana Sánchez

Co-tutor:
Lidia del Pilar Pitti Ríos

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ABSTRACT

The rudimentary bones are identified as small bony and partly vestigial structures that contribute to the stability and support of the equine limb. Adjacent are the ligamentum propria (interosseous ligaments), suspensory ligament and proximal joints.

Ruderal fractures are relatively common in practice due to the discipline of these horses or anatomical position of their limbs. They can occur at any age and condition and are mostly seen as a result of kicks caused by another horse.

Their severity will depend on the location of the fracture in the rudimentary bone, the simplest being those of the distal third and the most complicated those of the proximal third, due to the risk of comminution, osteomyelitis, development of bone sequestrations, instability of the joint or involvement of important adjacent structures such as the suspensory ligament of the fetlock.

The removal of rudimentary bones in the horse is a surgical technique performed by osteotomy aimed at improving the horse's performance and reducing the risk of subsequent complications occurring in the underlying structures, if not properly treated. It can be performed under both field and hospital conditions. Total surgical excision of the rudimentary bone is controversial and contraindicated as it may cause joint instability in the tarsus and carpus.

These fractures usually have a good prognosis. It all depends on the type of fracture and the damage to the underlying tissues, which will also directly influence the recovery period. Other techniques such as laser can be used to speed up this recovery and to maintain good rest with light activity.

INTRODUCTION

Surgical removal of the rudimentary bones in the horse, also known as 'accessory bone osteotomy', is the indicated treatment (MC veterinary, 2023). It is a surgical procedure performed with the aim of relieving pain and improving the function of the horse's limbs.

Anatomical introduction

The rudimentary bones are also referred to as vestigial bones or second/fourth metacarpal/metatarsal bones. They are structures that contribute to limb support and stabilization in the horse (Andrades, 2011). They are located in both the fore and hind limbs of the animal.

They serve as an insertion point for ligaments and have a ligament of their own which is also called the interosseous or suspensory ligament of the fetlock (MC Veterinary, 2023) which is located palmar to the third metacarpal and is followed by the accessory ligament of the deep digital flexor tendon (check ligament), the deep digital flexor tendon and the superficial digital flexor tendon. The suspensory is destined to help support and prevent hyperextension of the metacarpophalangeal and metatarsophalangeal joints (UNNE, 2016).

Figure 1. Left forelimb. Caudal view. Superficial structures. Figure 2. Right forelimb. Caudal view. Superficial structures. Figure 3. Left forelimb. Caudal view. Bone structures (Ashdown & Done, 2012).

Figure 4. Left forelimb. Lateral view. Superficial structures. Figure 5. Right forelimb. Medial view. Superficial structures. Figure 6. Left forelimb. Bone structures (Ashdown & Done, 2012)

Figure 7. Left forelimb. Medial view. Superficial structures. Figure 8. Right forelimb. Lateral view. Superficial structures. Figure 9. Left forelimb. Bone structures (Ashdown & Done, 2012).

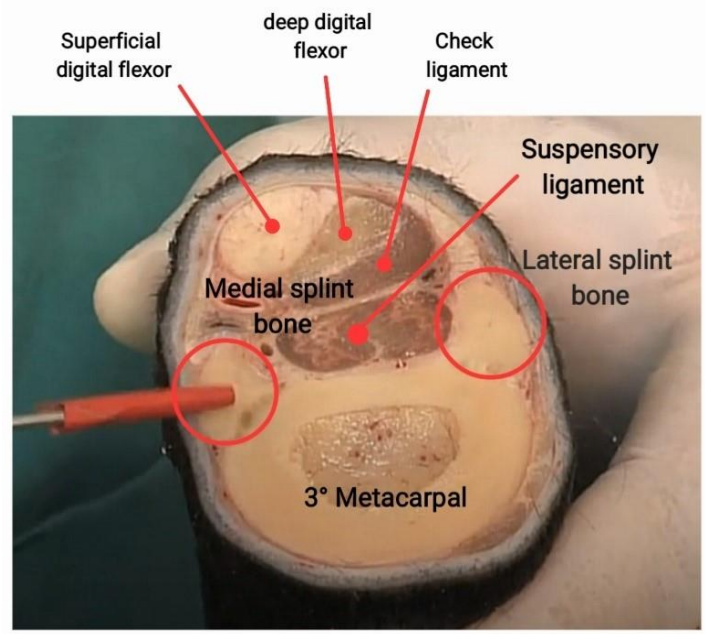

Figura 10. Cross-sectional view of the proximal section of the third metacarpal (University of Murcia, 2012).

The anatomical relationships of these bones can be important in assessing an injury as well as in establishing appropriate treatment. Their articular surfaces will support the carpus and tarsus. The metacarpals have larger articular surfaces than the metatarsals (Jenson *et al.*, 2003).

Rudimentary bones are predisposed to injury due to their anatomical location, the nature of the horse in question and equine management practices. Fractures of these bones can occur at any level throughout the bones and at all ages (Jackson, 2019). In addition, they have little soft tissue protection (Andrades, 2011). They are most prominent at the distal third due to kicks from another horse, although they also occur spontaneously (Ashdown & Done, 2012). Impact at the time of exercise is a common factor in disciplines such as polo and racing. In addition, those in the distal third are simpler compared to those in the middle or proximal third (MC Veterinary, 2023). Injuries to the rudimentary bone of the medial side of the forelimb are more common than those of the lateral side. In the case of external trauma, it involves interference with the opposite limb, but in the case of internal trauma it is usually

due to deep fascial traction or may also be due to suspensory desmitis (Hickman, 1988). The latter has a very close relationship with this type of fracture, being more frequent in racehorses, because of fatigue because the ligament is enlarged, therefore, what it does is to push distally abaxially when the fetlock is flexed (Bowman and Fackelman, 1982; Verschooten *et al*., 1984) (Andrades, 2011).

Ruderal fractures are classified as open or closed and simple or comminuted and are located along the entire length of the ruderal (Jackson, 2019). It is typical in ruderal fractures to see extensive new bone development or excessive callus, differentiating it from periostitis (Hickman, 1988).

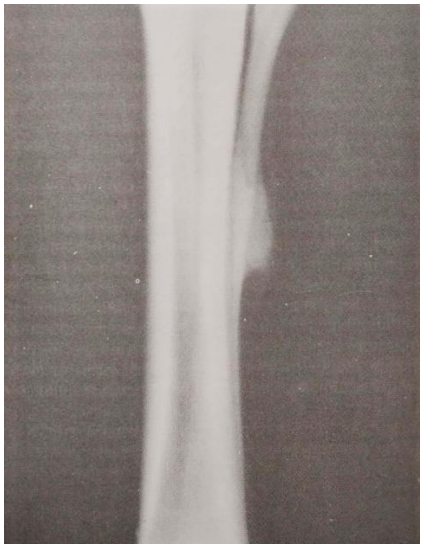

Figure 11. It has been formed the bone callus in the fracture area (Hickman, 1988).

- **Simple transverse fracture:** They are usually seen in the distal third. They often resolve on their own by the formation of a fibrous junction that becomes asymptomatic when the inflammatory reaction subsides. Friction with the suspensory ligament or flexor tendons may also be seen in certain cases (Hickman, 1988).

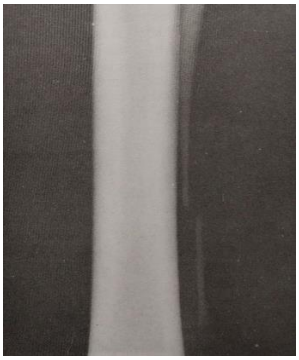

Figure 12. Simple transversal fracture of the distal third (Hickman, 1988).

- **Comminuted fractures:** It is possible that they may also become infected. They are usually due to injuries by other horses and consequently, osteomyelitis and sequestration formation is produced, which is usually evidenced by the consequent formation of a fistula (Hickman, 1988).

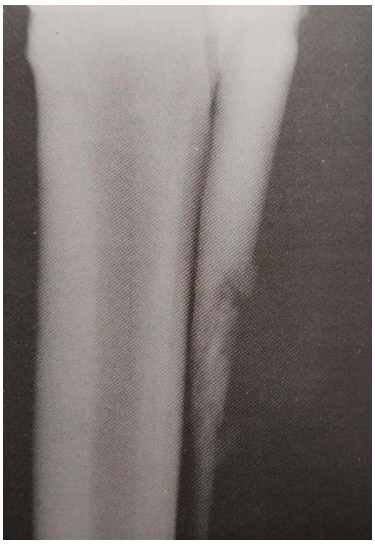

Figure 13. Comminute fracture of the splint bone (Hickman, 1988).

- **Location in the proximal third.**

In this type of fractures, we will see that horses will present more marked lameness. As we said before, they are usually produced by the traumatic action of other horses, so they are usually open fractures (Jackson, 2019). These are classified as comminuted, oblique articular, associated with osteomyelitis or chronic fractures in which there is no union of the fragments. Osteotomy of more than two-thirds of the rudimentary bone may subsequently generate excessive movements in the remaining segment, leading to displacement instability (Sağlam, 2022).

- **Location in the distal third.**

If the fracture is in the distal third, a mild lameness may be present or the lameness may be exposed only at rapid gait. These are most common in horses between four and seven years of age. It may be due to the interosseous ligament (check ligament) becoming less

malleable with age. It is characteristic of the discipline of the animal being for example racehorses during intense exercise, not only in competition but at the time of training (Kidd, 2015). /In those chronic fractures may manifest as a less marked problem, being seen only when the horse is moving at high speed or as a swelling that is adjacent to the suspensory (Munroe & Weese, 2011). Therefore, diagnosis is made by a combination of clinical methods and imaging tests. Among them:

CLINICAL SIGNS

We will be able to observe and/or palpate the inflammation, heat and pain in the affected area due to damage to the suspensory ligament. It is observed that the animal limps and the degree will depend on the location of the injury and the type of fracture (MC veterinary, 2023). In the case of a chronic injury, in which the bony callus or fibrous tissue has been produced, it will be visible and/or palpable. Chronic fractures can be the result of desmitis and a disease that produces carpometacarpal and tarsometatarsal joint degeneration. If it is a severe suspensory ligament injury, in addition to the resulting pain and swelling, it will be accompanied by a drop in the fetlock joint. It is possible that they may develop a subperiosteal exostosis seeking resolution that, on the suspensory may limit the recovery to its athletic state and its removal will become necessary (Kidd, 2015; Sağlam, 2022). Therefore, among the clinical signs we can observe:

- Lameness: the horse may limp or show a clear difficulty in bearing weight on the affected limb.

- Swelling: at the fracture site, which is usually visible and palpable.

- Pain: the horse may show signs of discomfort or pain when touching the affected area or claudication.

- Warmth: touch due to swelling and the body's response to the injury.

- Behavioral changes: the horse may be restless, anxious, aggressive, listless, irritable or depressed due to pain.

- Changes in gait: the horse may avoid supporting the affected limb, so that stiff and staggering movements are seen.

- Changes in posture: the horse may adopt an abnormal posture or shift its weight to other limbs to relieve pressure on the fractured limb.

DIAGNOSTIC

These fractures will be associated mainly with focal pain, swelling and heat or septic fistulation, accompanied by lameness that may be intermittent or persistent. To establish the definitive diagnosis, radiography should be performed (Du Preez, 1994). A nerve block is rarely necessary to confirm that the lameness that is occurring is a consequence of the fracture of the rudimentary, after having observed the radiographs.

Clínical history

Within the diagnosis is the most important. This will allow us to obtain information on age, breed, discipline and years of exercise, duration of exercise, severity of the process, if the lameness changes at the time of activity, if it occurs cold or hot, ... For this we cannot do without the testimony of the owner or rider (Bajón, 2021). In addition, other information of interest is whether the animal had pre-existing injuries, whether it suffered an accident, recent changes in activity or behavior that occurred before the onset of symptoms and the specific time of onset of clinical signs.

Dinamic test

Before approaching the animal, we will examine it visually. The movement will be carried out on a smooth and flat surface, hard (asphalt) or soft (sand). The horse will advance at a walk and trot in a straight line or by winding it up so that the horse moves in circles, in the latter case changing hands to observe the other half of the animal. We stand in front of the animal's gait both going and coming back. We will consider that when the gait is in circles, mild lameness will be manifested and will indicate that the lesion is in the limb located inside the circle (Bajón, 2021).

Static exam

The veterinarian will begin with a complete clinical examination of the horse, paying attention to lameness, swelling, tenderness, warmth in the affected area and behavioral changes in the horse. In addition, he will observe the posture, any deformity in the affected limb and skin changes. We will perform palpation of the affected area. It is important to have a pattern of action to not forget any step. As an example, one way to proceed would be to start with the forelimbs. We will take as a reference the other limbs in a comparative way, but taking into account that both limbs can present alterations. The forceps will be used to explore the hoof, exerting pressure on different structures (Bajón, 2021).

In this part the mobility of the limb is also evaluated by means of flexion tests that consist, as the word says, in flexing a joint for one minute and once it is finished arranging the horse to trot in a way that reveals the lameness and locate it in the affected limb. A prognosis of the injury can then be obtained, which will help determine the appropriate treatment approach.

In the forelimbs we proceed as follows: distal interphalangeal flexion, flexion of the fetlock (metacarpophalangeal joint), flexion of the carpus, flexion/extension of the shoulder and elbow (Bajón, 2021). This is done from palmar/plantar to dorsal because in this way we can establish a differential point for the lameness to be evidenced. If we do it from top to bottom, all the structures are compromised and we will not be able to differentiate if the animal limps because it has pain at the moment of flexion or if, on the contrary, it hurts because it has manipulated a superior joint.

Perineurals blocks

With this method of innervation, if the affected area is anesthetized, we will see that there will be a considerable improvement in the lameness of the horse. It is important in the diagnosis of chronic fractures of both the proximal and distal sector. The response is positive in all cases of rudimentary fractures except those involving the articular surface in which intra-articular carpometacarpal or tarsometatarsal block is used (Hinchcliff *et al.*, 2007).

Image diagnosis test

To confirm the fracture and determine its location and severity, imaging tests are performed. The most common are:

- **Radiography**: is crucial to diagnose these fractures. Images are taken of the affected extremity, the 4 basic projections are dorsopalmar (DP), Lateromedial (LM), dorsolateral palmaromedial oblique (DLPMO) and dorsomedial palmarolateral oblique (DMPLO) (A. de Llano, 2011); to evaluate the injury as it can reveal details about the location, type and severity of the fracture. We will also take complete radiographs of the tarsus and carpus in those fractures of the proximal third (Hinchcliff *et al.*, 2007). Radiographs should have a good projection in order to clearly see the lesion and/or if there are other findings.

- **Ecography:** should be done in those cases in which the suspensory is affected by concurrent desmitis (Hinchcliff *et al.*, 2007).

Complementary tests

In some cases, blood tests or other complementary tests may be performed to evaluate the overall health of the horse and to rule out other underlying conditions.

TREATMENT

The treatment can be conservative or surgical and can be performed either in field conditions or in a veterinary hospital. One treatment or the other will depend on the level of the fracture along the bone and whether it is open, closed, simple or comminuted. Bone sequestration does not have a significant incidence in cases of closed fractures even when comminuted (Sağlam, 2022).

Procedure

- **Initial handling.** Initial management with bandages, anti-inflammatory drugs, rest and immobilization with tensoplast and/or glass splint is important.
- **Conservative.**

It is usually performed for economic reasons (Jackson, 2019). It is applied in all cases of ruderal fractures. Including bandages and anti-inflammatories, apart from keeping the horse at rest in the box limiting its movement. In case of an open fracture, the superficial wound will be

healed, and antibiotics will be administered when required (Hinchcliff *et al.*, 2007). Also in these cases, drains will be used for about 3-4 days. Once they are removed, the wound heals by first intention (Jackson, 2019).

In the cases in which it is a fracture of the distal third this type of techniques are effective, but they are going to have a slow recovery. In addition, non-union is common with the consequent formation of callus that can affect the interosseous tendon or that the suspensory ligament of the fetlock is affected, in this way intermittent lameness can occur, in which surgery is finally advised. In the case of a simple or comminuted proximal third fracture, four to six weeks of rest may be recommended, even requiring casting of the entire limb or the use of bandages (Du Preez, 1994).

Figura 14. Evolution with conservative treatment in a conminute fracture of the splint bone (Jackson, 2019).

- **Surgical.**

It is directly indicated in those cases in which the owner of the animal does not respect the sufficient rest time that the animal needs, in those cases in which there is a painful pseudoarthrosis or that the rudimentary is thickened in size (Verschooten, 1984). It can be performed with local anesthesia while the animal is in station, under deep sedation and nerve desensitization in the middle or distal third; or general anesthesia by positioning the animal in

lateral decubitus with the affected limb above. A tourniquet is applied discreetly and the limb to be manipulated is prepared in an aseptic manner (Peterson *et al.,* 1987; MC veterinary, 2023).

Among the techniques that are conducted:

Segmentary osteotomy.

In case conservative treatment has failed or the veterinarian considers, depending on the type of fracture or conditions, that the procedure to correct the injury is by surgery:

- Fracture of the **proximal third**: many authors are inclined to the idea of surgical fixation in the case of open proximal fractures with the intention of reducing complications and residual lameness following recovery (Jackson, 2019). An osteotomy with fixation should be performed for stabilization of the remaining proximal third attempting to prevent the development of chronic posterior claudication.
- Fractures of the **medial third**: consists of a partial osteotomy. In this case, due to the movement in this area, it takes time to heal, and a callus or exostosis usually forms (Hinchcliff *et al.,* 2007). They will require removal of the distal fragment, removal of the callus if it has formed and removal of about one centimeter of the distal edge of the remaining fragment with an oscillating saw and obliquely, since with the use of an osteotome we can cause microcracks (Jackson, 2019).
- Fracture of the **distal third**: in the case of acute distals, this is the best method. The remaining fragment is not associated with the interosseous ligament, so excision is not a complicated procedure, using scissors and moving upwards from distal to proximal. Therefore, the distal fragment, the callus and the fragment of the proximal portion that is affected by the callus will be removed, in addition to the periosteum (Hinchcliff *et al.*, 2007).

Completal extraction of the splint bone.

This is a controversial procedure due to its subsequent complications. There is a possibility of tarsal/carpal joint instability.

Fixation.

It is performed by means of screws and plates. It is implanted in those where there is a high possibility of dislocation or subluxation of the proximal third of the rudimentary bone. Therefore, in those cases where there is instability of the joint (Jackson, 2019).

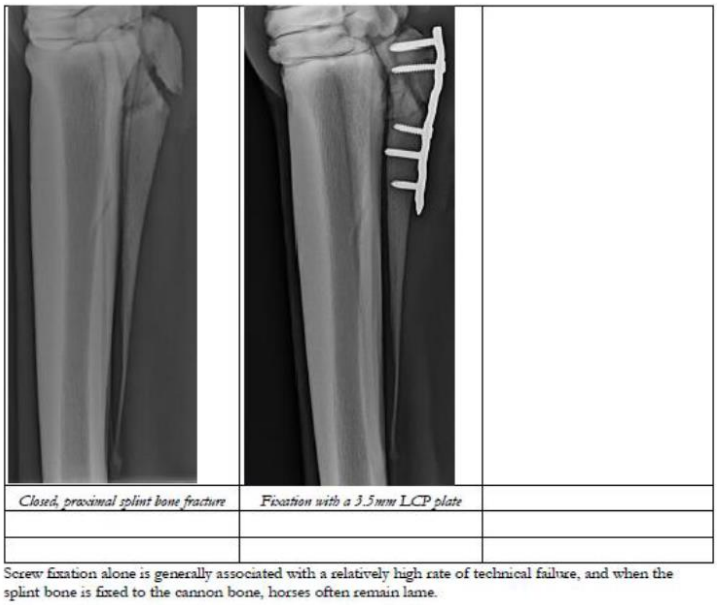

Figura 15. Fixation of the proximal portion of the splint bone (A. Jackson, 2019).

Neurectomy.

This surgical technique involves the elimination of nerve sensation in the affected area. A palmar or plantar digital neurectomy can be performed, which consists of sectioning the digital nerves. This helps relieve pain and inflammation caused by interrupting transmission to more distal areas, thus acting as a palliative for lameness. Before it is performed at a particular site, it should be based on the result of perineural anesthesia. An important point is that any animal that undergoes this operation is forbidden to participate in competitions (XI international congress on equine medicine and surgery, 2010).

POST-SURGICAL MANAGEMENT

After surgery, the horse will need a period of recovery and rehabilitation to allow the wound to heal and normal function to be restored. The veterinarian will prescribe physiotherapy, analgesics, anti-inflammatories, and antibiotics, as well as bandage changes every 48 hours.

Pressure bandages are applied and well-padded after surgery (Richardson, 1990) during the first week to reduce the likelihood of seroma formation. In addition, antimicrobial

therapy will be maintained for 3-5 days (Nixon & Fortier, 2019). The animal is going to be kept in a box for 2-4 weeks, taking the animal out for daily walks. After this period, they will spend 2-4 weeks performing low intensity exercise. They will be bandaged for 2-3 weeks and sutured for 10-14 days after surgery. In cases where a plate has been implanted as a fixation, these will be removed after 4 months. From this point on, the patient will gradually resume activity for 2 months (Du Preez, 1994; J. Hinchcliff *et al.*, 2007).

COMPLICATIONS

As with any operation, the removal of rudimentary bones is a surgery that carries certain risks and complications. Chronic lameness caused by suspensory desmitis, infected seroma or iatrogenic damage to the metacarpal/metatarsal III cortex produced during the osteotomy (MC veterinary, 2023).

Intraoperative

- Iatrogenic damage: over the metacarpal III, metatarsal, metacarpal or to the palmar/plantar metacarpal and metatarsal vessels and nerves during rudimentary surgery.
- Instability of the proximal fragment. Because it has a lot of range of motion after disruption of distal fixations.

Earlier postoperative

- Complete metacarpal/tarsus fractures III
- Local infection, osteomyelitis, bone sequestration or sepsis in the joint

Late postoperative

- Excessive callus formation associated with a fracture of the distal third of the rudimentary or its amputation.
- Non-union. Failure of bone healing
    - Desmitis of the suspensory. Inflammation of the suspensory by fracture of a rudimentary or associated with it (Lescun, 2021).

FORECAST

It is usually good. It will depend on the type of fracture involved and the damage to the tissues (MC veterinary, 2023).

Starting with fractures of the distal third, the prognosis is good if the suspensory ligament is not affected by desmitis. It is this last factor that will directly influence the severity of the animal. In cases of fractures of the middle third, after a partial osteotomy, the prognosis is also good. Problems arise when the horse does not have sufficient rest (Hinchcliff *et al*., 2007). This will be directly influenced by the temperament of the horse, with the calmest horses having the best prognosis (Mudge & Bramlage, 2007).

OBJECTIVES

- Evaluation of the osteotomy technique to obtain remission of symptomatology in different disciplines of affected horses.
- Show the benefits of the osteotomy surgical technique over others in terms of symptomatology and complications.
- Follow-up of the evolution of the animal to verify that they have recovered their performance.

MATERIAL AND METHODS

Surgical material used:

- Scalpel
- Surgical chisel
- Surgical hammer
- Osteotome
- Penrose drainage
- Kocher hemostatic forceps
- Sterile gauze
- Fixation plate and screws
- Periosteal elevator

The cases chosen were surgeries of the rudimentary bones conducted in the Veterinary Clinical Hospital of the University of las Palmas de Gran Canaria in order to demonstrate with practical cases the benefits of the osteotomy surgical technique over others in terms of symptomatology and complications.

Both horses are affected by fracture of the IV metacarpal in the distal third and in the right forelimb. In this case, no plates or fixation screws will be used.

CASE 1: CARAMELO

Animal profile

Especie	Equino
Raza	Lusitana
Género	Caramelo
Género	Macho
Número de microchip	10010000724170000217031
Fecha de nacimiento	24/09/2011
Edad	12 años y 2 meses
Capa	Tordo

Figure 16. Caramelo´s profile table.

Clinical history

A crossbred neutered male, whose activity is walking, has been hit in his stable producing a slight inflammation in the right forelimb, with a previous record of recurrence of inflammation as a result of other conditions in the hoof.

An anti-inflammatory treatment is prescribed to see if the inflammation subsides and subsequent review after 8 days. It is treated with NSAIDs (Phenylbutazone, 15 cc). Thereafter, 1 sachet (EQ-Zona, oral granulated 1 g) is prescribed every 12 hours for 48 hours and the following 48 hours, one sachet per day. In addition to the application of rest bandages 20 hours a day and applying cold after removing the bandages. No results were obtained, so further tests were performed.

Clinical findings

There is swelling in the lateral aspect of the right forelimb and left forelimb fetlock, edema in the medial aspect of the flexor area, swelling in the distal lateral region of the metacarpal due to the fracture of the IV metacarpal and due to the desmitis present in the lateral branch of the suspensor. There is palpable warmth in the area, pain on palpation in the IV rudimentary.

In the dynamic examination, he does not limp when walking, but he does when trotting.

He is long in pincers and the horseshoe is irregular worn.

Diagnostic tests

Several complementary diagnostic tests were performed to obtain more information, including:

- **Radiological study:**

Dorsopalmar projection right forelimb

Figure 17. Dorsopalmar projection of the metacarpal IV in the right forelimb (Caramelo´s radiograph HCV ULPGC, 2020).

In this projection we clearly see that the right forelimb presents a distal fracture of the

IV metacarpal, it is a simple fracture, but it is slightly deviated, there is great swelling of the adjacent soft tissues. In the lateral sesamoid of this extremity there is a circular area with less density.

Dorsopalmar projection left forelimb

Figure 18. Dorsopalmar projection of the metacarpal IV in the left forelimb (Caramelo´s radiograph HCV ULPGC, 2020).

The left forelimb shows a microfracture of the head of the fourth metacarpal, well aligned and without inflammation of the surrounding tissues.

The study of these radiographs allows us to conclude that it is a fracture of the IV metacarpal of both forelimbs.

- **Ecography:**

It revealed in the distal area of the fractured metacarpal, desmitis of the lateral branch of the suspensor at 1.6 mm, just where the fracture occurs, without fiber rupture. Proximal and distal to this, the measurement is normal 1.2 mm. In addition, the fracture of the IV metacarpal is also observed.

Diagnostic

It was determined by radiological study that the male had a fracture of the IV metacarpal in the right forelimb and left forelimb, and for this reason the distal fragments were surgically removed.

Treatment and surgical protocol

- Surgical mention: Only the right forelimb intervention was performed since in the left forelimb the microfracture affected only the head of the IV rudimentary and was well aligned.

Due to the diagnosis, until the time of surgery, laser sessions were given in the affected area. This was conducted up to a total of 5 sessions in which the edema and inflammation decreased allowing to reduce the horse's discomfort, in addition to the pain at the moment of palpation.

The surgical technique of osteotomy was performed. The horse was stationed under sedation. Two ampoules of Lidocaine were locally administered with green palometa, as local anesthetic, in several points in the area to be intervened and at 09:30, 0.5 cc Iv of detomidine was administered.

With the horse in station, the area is shaved and aseptically prepared. We proceed to make an incision from distal palpating the head of the fractured rudimentary, towards proximal at the level of the fracture line. By means of a resection in the skin in which it is deepened by layers until locating the fragment. This is exposed and dissected from the dorsal side, since the suspensor branch is palmar. A little leverage is made and it is extracted. It is closed by layers, subcutaneous and skin, giving continuous stitches except the three most distal stitches that are going to be sutured with simple stitches in case it is necessary to drain in case of infection.

We must be very careful with the metacarpal/metatarsal artery that extends dorsal to the edge of the rudimentary and that is finally introduced between the metacarpal III and the rudimentary.

We can use a surgical chisel and hammer if we have any complications to extract it.

It is important that we extract all the fragments that could have been fractured because they can cause later complications as a consequence of a continuous damage in the adjacent structures, that the animal continues limping and that it does not recover correctly.

After the extraction, control radiographs are taken to determine if the entire fragment has been extracted.

Figure 19. Dorsolateral palmaromedial oblique projection of Caramelo after the extraction of the distal end of metacarpal IV
(Caramelo´s radiograph HCV ULPGC, 2020)

Post-operative care and outcomes

After surgery, 10 cc of phenylbutazone is administered and he is prescribed this (EQ-Zone, oral granulated 1 g) in sachets every 12 hours for 3 days. He is also administered 25 cc of Penivex (250 ml bottle) every 12 hours for 5 days.

Bandages are applied with abundant gauze, two layers of cotton, a cohesive bandage and tensoplast at the ends.

In addition, rest is prescribed for 2 weeks. Do not leave the stable until the stitches are removed and maintain with bandages. These bandages are changed every 48 hours and are cured with saline or gauze with alcohol and covered again. These bandages are only removed to refresh the area and bandaged again. Stitches are removed 15 days after the operation.

CASE 2: URACO

Animal profile

Especie	Equino
Raza	CDE (caballo de deporte español)
Género	Uraco
Género	Macho
Número de microchip	981098100760060
Fecha de nacimiento	01/01/2007
Edad	16 años y 10 meses
Capa	Tordo

Figure 20. Uraco´s profile table.

Clinical history

Male gelding whose discipline is jumping. He came in for consultation, his general condition was good, as were his vitals.

According to the owner, the animal began to limp after a session of intense exercise and after this, the inflammation and lameness in the right forelimb became noticeable.

NSAIDs, rest and 5 laser sessions were prescribed to reduce the inflammation, with no results. The horse limped again (2/5) and the inflammation in the affected area was persistent.

Clinical findings

Inflammation of the lateral area of the metacarpal region of the right forelimb was observed and as a consequence, overloading of both hind limbs.

Diagnostic tests

- **Radiological study**

A radiological examination of the affected limb is performed to identify the cause of the inflammatory process.

Dorsopalmar projection in right forelimb

Figure 21. Dorsopalmar projection of the distal end of the metacarpal IV in the right forelimb (Uraco´s radiograph HCV ULPGC, 2021).

Dorsomedial palmarolateral oblique projection in right forelimb

Figure 22. Dorsomedial palmarolateral oblique projection of the distal end of the metacarpal IV in the right forelimb (Uraco´s radiograph HCV ULPGC, 2021)

Lateromedial projection in right forelimb

Figure 23. Lateromedial projection of the distal end of the metacarpal IV in the right forelimb (Uraco´s radiograph HCV ULPGC, 2021)

The study of these radiographs allows us to conclude that it is a fracture of the IV metacarpal in the right forelimb.

- **Ecography**

It revealed a mild desmitis of the lateral branch of the right forelimb suspensor. The fracture of the IV metacarpal is also easily visualized.

Diagnostic

Fracture of the IV metacarpal in the MAD with slight involvement of the suspensory ligament, for this reason the distal fragments were surgically removed by osteotomy.

Treatment and surgery protocol

The laser sessions, 5 in total, were helpful in reducing the inflammation along with resting the animal. This allowed the horse to be less uncomfortable from both the inflammation and the associated pain at the fracture site.

Uraco was also operated on in this case using the osteotomy technique.

With the animal in station under sedation, 10 cc of Lidocaine (lidor 20 mg/ml) distributed in several points in the area to be intervened was locally administered with orange palometa as local anesthetic.

Hora	09:18	09:55	10:10	10:50
Fármaco	Detomidina + Butorfanol	Detomidina	Detomidina	Detomidina
Dosificación	0,5 cc IV + 3 cc IV	0,3 cc IV	0,3 cc IV	0,2 cc IV

Table 1. Drug and dosage administered during the procedure to maintain sedation of Uraco.

The surgical technique of osteotomy is to be performed. The horse is prepared at the station to begin. The horse is brushed, shaved and the area is aseptically prepared. At 9:30 a tourniquet is placed. An incision is made parallel to the limb over the area of injury, through a resection of the skin that is deepened in layers. It is kept stable by taking the constants every 10 minutes. Great care must be taken with the metacarpal/metatarsal artery that extends dorsal to the edge of the rudimentary and that is finally introduced between the metacarpal III and the rudimentary. Once the area is exposed, the fractured metacarpal IV can be seen. A little leverage is made and it is extracted. We can help us of a chisel and surgical hammer if we have some complication to extract it. Once the fragment is extracted, the incision is closed in layers. The internal plane is performed with Monosyn 2/0 using simple stitches. We proceed to the closure of the skin by giving two suture planes with Monosyn 1.

We must be very careful with the metacarpal/metatarsal artery that extends dorsal to the edge of the rudimentary and that is finally introduced between the metacarpal III and the rudimentary.

We can use a surgical chisel and hammer if we have any complications to extract it.

It is important that we extract all the fragments that may have fractured because they can cause later complications as a result of continuous damage to adjacent structures, that the animal continues limping and that it does not recover correctly.

Figure 24. Extracted fragment of the distal fracture of the metacarpal IV in right forelimb (Uraco´s surgery HCV ULPGC, 2021).

Post-operative care and outcomes

After surgery, 20 cc of Phenylbutazone (Butasyl 4 ml/100 kg) is administered. Antibiotic therapy is continued with 20 cc of penicillin retard IM.

Rest is prescribed for 15 days during which laser sessions will continue to be used. Cleaning and changes of compressive bandages should be done every 3 days to avoid infections in the operated area and the removal of stitches is carried out 15 days after the intervention, coinciding with the time he has to rest. The rest bandages are kept on schedule and are removed to aerate the area and the bandage is re-bandaged.

RESULTS AND DISCUSION

There is no definitive solution for this type of fracture. It will depend on the type of fracture. The technique that has been used in clinical cases is that of osteotomy, dealing with fractures in the distal third, which are the most common in practice. This will allow us to eliminate the distal fragment, the possible callus formed and the periosteum (Hinchcliff *et al*., 2007), as well as possible subsequent complications such as bone neoformation with the possibility of causing desmitis, possible infection due to open fracture or residual lameness.

In the past, conservative treatment was chosen, but it entails a prolonged recovery and is not applicable to all the degrees in which this fracture occurs.

It is very common to see desmitis together with the fracture of the distal third of the rudimentary especially in racehorses. For this reason, knowing which is the primary pathology is a controversial point. It is considered that desmitis can be produced either as a primary or secondary cause. If it is the primary cause, that a fatigue fracture occurs as a result of suspensory desmitis, the traction exerted by the interosseous tendons and the hyperextension of the fetlock will be important, especially in distal fractures. In the case that it is the secondary cause, it arises from the friction of a bony callus with the suspensory (Verschooten, 1984).

One of the advantages of osteotomy is that it can be performed on station with the animal sedated, which avoids possible complications due to general anesthesia. Therefore, it is confirmed that this is the method of choice in these cases. In addition, in cases where the proximal third is involved, we will have to resort to plate and screw fixation in addition to osteotomy in order to recover structural stability (Hinchcliff *et al*., 2007).

CONCLUSION

The rudimentary bones form an important part in the stability of the carpal and tarsal joints. In addition, it is formed by a large amount of soft tissue at the proximal end of each rudimentary bone and an interosseous ligament that reaches to contact the first two thirds of the bone, keeping it attached to metacarpal III. It is also necessary to consider that there are movements between the rudimentary ones, of the rudimentary ones with the metacarpal III and of tension by the ligamentous fixations in the proximal end of the rudimentary one that are counteracted by the interosseous ligament, which is in charge of maintaining the orientation of these avoiding its rotation. At the same time, the ligamentous attachment implies a functional reduction so that it will have a greater tendency to dislocate and rotate (Nixon & Fortier, 2019).

The laser, as we have already seen, can be a very useful tool to reduce inflammation and edema, improving the condition and state of the animal. It is a form of electromagnetic radiation. It is carried out at low intensity or type IV, with waves ranging from 650 nm - 980 nm (rises in deeper wounds). Working with higher intensity may cause undesirable tissue effects. It is indicated in injured soft tissues, in cases of osteoarthritis and to relieve local pain. It acts by increasing cellular increase and collagen synthesis. It does not only imply that there

is a serious injury to use it, but it can also be employed as a fitness treatment and to prevent repeated injuries (Kaneps, 2016; Garau & Sirvent, 2017).

Shock waves have also been shown to be effective. It consists of fast pressure waves with a + phase followed by a - phase (Perea, 2016). Which are amplified with their transmission as they advance through the tissues. Its effect is analgesic. It is used on soft tissues and even on bone lesions as it acts by creating microtraumas in the tissue due to the pressure changes generated by these waves, thus promoting neovascularization and increased blood supply to the tissue, which implies a greater supply of nutrients and inflammatory cells (Garau & Sirvent, 2017).

Another method is monopolar radiofrequency at 448 kHz frequency. It consists of external radiation that activates the internal energy by attraction of charges in the form of ions present in the tissues to be treated. Cell stimulation, circulation, temperature and the triggering of natural mechanisms is achieved. This reduces recovery time and prevents injuries. Above all, it is seen in sport horses that carry out intense and constant training (Campos et al., 2019).

The choice of treatment will depend on the type of fracture. Good hemostasis, removal of dead space by diligent primary closure and the use of pressure dressings greatly improves a good cosmetic outcome. The prognosis is good for well-treated fractures (Du Preez, 1994).

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