Successful treatment of a proximal displacement of horny tissue with an uniaxial traction device and shoeing

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Abstract

A wound in the distal part of the horse’s limb with involvement of the foot can lead to large impacts in life prognosis and, depending on the severity of the lesion, may render successful recovery of the horse difficult or even questionable. Due to that fact and the high frequency of complications associated with wounds in the foot, the approach and management is not always straightforward, nor easy. In this case report a 9-year-old mare is presented with a chronic wound in the inner surface of foot of the right hind limb. The wound involves the medial coronary band with its proximal displacement and an inadequate push of horny tissue. For treatment, a surgical approach was chosen with application of a uniaxial traction device between the coronary band and the hoofwall in order to direct and adapt as much as possible the growth direction of coronary papillae after resection of the scar tissue. The aim of this approach was to reduce, firstly the defect in the proximal hoof wall, and secondly, the deviated growth of the hoof wall. 15 days after surgery and a resin casting, an orthopaedic shoe (three-quarter bar shoe) was placed to stabilize the hoof and eliminate weight bearing on that portion of the hoof wall This additional management changed the deviation from a 135° to a completely parallel growth, with complete healing of the tissue. This case example demonstrates the importance of working together between the farrier and the veterinarian to improve the aspect and functionality of the hoof.

Keywords: horse, wound, coronary band, shoeing, three-quarter bar shoe, foot

Summary:

A wound in the distal part of the horse’s limb with involvement of the foot can lead to large impacts in life prognosis and, depending on the severity of the lesion, may render successful recovery of the horse difficult or even questionable. Due to that fact and the high frequency of complications associated with wounds in the foot, the approach and management is not always straightforward, nor easy. In this case report a 9-year-old mare is presented with a chronic wound in the inner surface of foot of the right hind limb. The wound involves the medial coronary band with its proximal displacement and an inadequate push of horny tissue. For treatment, a surgical approach was chosen with application of a uniaxial traction device between the coronary band and the hoofwall in order to direct and adapt as much as possible the growth direction of coronary papillae after resection of the scar tissue. The aim of this approach was to reduce, firstly the defect in the proximal hoof wall, and secondly, the deviated growth of the hoof wall. 15 days after surgery and a resin casting, an orthopaedic shoe (three-quarter bar shoe) was placed to stabilize the hoof and eliminate weight bearing on that portion of the hoof wall This additional management changed the deviation from a
135° to a completely parallel growth, with complete healing of the tissue. This case example demonstrates the importance of working together between the farrier and the veterinarian to improve the aspect and functionality of the hoof.

Introduction

Distal limb wounds most commonly involve the foot (Adam & Southwood, 2006). Animals can present varying degrees of lameness depending on the location, depth, and duration of penetration. The specific anatomy and biomechanical function of the equine foot, renders the reconstruction of the structures of utmost importance; With involvement of the coronary band, several complications can occur, for example excessive scarring of the coronary band and as a consequence a hoof with development of protuberant horny tissue (Ketzner et al., 2009). This can have a serious effect on the hoof and its ability to move. Therefore, financial implications for loss of function of the horse or the need of strenuous remedial therapies are a concern.

The coronary band is a special area for healing, as there is limited capacity for wound contraction. Healing relies on epithelialization and corium reformation. Several factors can impact the healing process, first, the relative rigidity of the tissues, and the constant loading and unloading of the hoof, results in considerable movement at the healing site; Secondly, the proximity of the injury to the ground considerably increases the risk of wound contamination and infection. Furthermore, blood supply to the area is often compromised by the initial trauma. All of this may require radical surgery and prolonged treatment with extensive and prolonged farriery. Appropriate management of the initial injury by thorough debridement followed by appropriate wound apposition, immobilisation and surgical shoeing will maximise the chances of successful early resolution and rapid return to normal function. (Markel et al., 1987; Riggs et al., 1995).

In human medicine, mechanotherapy for surgical incisions is the most effective treatment for preventing hypertrophic and keloid pathological scars. (Huang et al., 2013) A system of uniaxial traction has been described in human and equine medicine to control tension and direct the edges of a wound (Simon, 2005 and Lepage et al., 2022).

This case report describes the successful management of a wound in the medial aspect of the right hind foot that involves the coronary band with a proximal displacement and an inadequate growth of horny tissue. The treatment was inspired by a uniaxial traction mechanotherapy system installed in a surgical approach and the use of an orthopaedic horseshoe.

Case history

A 9-year-old warmblood mare was admitted for assessment and treatment of a chronic wound. The wound was first noticed 1 month prior to the admission and treated at home. At the arrival to the clinic, the horse was in a good general condition and the clinical examination was within normal limits.

Clinical findings

A wound was located on the medial aspect of the right hind limb, between the coronary band and the hoof wall. The wound involved a 6 cm damage on the coronary band, additionally there was a proximal displacement and inadequate development of cornified tissue. The angle of displacement was 135° from the horn wall. The coronary band was sectioned on the plantar part of the wound and an abundance of granulation tissue was observed beneath the hoof wall (Figure 1a and 2a). The horse had no signs of pain on palpation, but lameness was present when the mare trotted in a straight line on asphalt.

Medical imaging

In order to investigate the possibility of a primary wound that hadn’t closed, radiological and ultrasound examination were carried out. No signs of a foreign body, deep damage or deep infection were diagnosed.

Surgical treatment
The horse was starved 12 hours before surgery. The mare received preoperative medication with phenylbutazone (2.2 mg/kg IV) and penicillin (22,000 IU/kg IM). For anesthesia the mare was pre-medicated with acepromazine (0.04 mg/kg IM) 30 minutes before induction that was conducted with medetomidine (0.007 mg/kg IV) and morphine (0.1 mg/kg, IV). The mare was then anaesthetized with ketamine (2.2 mg/kg IV) and diazepam (0.5 mg/kg IV). General anesthesia was maintained with sevoflurane, medetomidine (at 0.00035 mg/kg/h) and Ringer’s lactate (at 5-10 ml/kg/h). The horse was placed in right lateral recumbency. A Esmark torniquet was applied to minimize bleeding and to provide adequate visualization during surgery. A mid-digital nerve block was performed bilaterally (lateral and medial) with 100 mg mepivacaine.

The foot was clipped and aseptically prepared, the wound was scrubbed with chlorhexidine. After draping, the exuberant granulation tissue from the hoof’s wall was resected from the coronary band. Due to the nature of the wound, the lack of horn means that the hoof as a whole (stratum internum, stratum medium, stratum externum) was 1 cm width. Below this, the hoof wall was just flattened with a bur down to the stratum externum at a distance of 1.5 cm. In the distal part of this fenestration, the hoof wall was drilled in four points with a 2 mm drill bit at an angle of 45° to create channelling holes for tension suture placement. A polyamide UPS 2 was used to place two interrupted horizontal mattress patterns placed as a tension suture with stents in the skin to reduce focal pressure and knots in the hoof wall. To do the suture, the coronary band was fully crossed, the suture entered distally closest to the corium coronae and ended 1.5 cm proximal to the coronary band; in the skin. These sutures formed an uniaxial traction device with disto-sagittal traction between the coronary band and the hoof. Three interrupted points of polyamide UPS 0 were done on the section of the coronary band (in the plantar part of the wound) (Figure 1b).

The foot was immobilised in a cast. Before casting, the wound surface was covered with a non-adherent dressing (Aniplaste Surgi®, Genia, France) and secured with a sterile soft wrap (Softban® Synthetic, BSN medical, France). A small pack of compresses was placed on the coronary band just before the dressing was applied. A 12.5 cm polyester casting tape (Delta-cast®, BSN medical, France) was applied evenly over the distal limb from the mid-pastern to the sole in a spiral pattern with 50% overlap. The total surgical time was 92 minutes and the total anesthesia time was 120 minutes.

After recovery, systemic antibiotic therapy was continued with sodium penicillin 22,000 IU/kg BID for 2 days, followed by TMPS (trimethoprim sulfonamide) 25 mg/kg PO BID for 6 days. Post-operative pain management was achieved with phenylbutazone at 2.2 mg/kg BID IV for 24 hours, PO BID for 4 days, then continued SID for a further 1 day.

Immediately after recovery, a facial paralysis was observed, which disappeared after three weeks. Additionally, after one week, a pressure sore was observed on the plantar surface of the pastern, for which a reinforced bandage was applied. The cast was removed after 2 weeks; the mare’s comfort was good throughout the hospitalization. Fourteen days after the operation, the cast and the device were removed. At the site of the stents, the skin was compressed, but there was no necrosis and no permanent sequelae were observed for the remainder of the healing process after their removal (Figure 2b). A hoof dressing was applied to the wound and changed every 3 to 5 days. During the first 2 weeks, a slight movement of the coronary band was always observed. Continuous light to moderate pressure was applied with the help of a dental resin which was molded and placed on the coronary band, immediately after the application of the soft wrap.

Shoeing Treatment

Fifteen days after surgery, the feet were trimmed. The first 0.5 cm of new hoof wall growth was observed and the angle between the old and new hoof wall was 8°. The horse was shod with a three-quarter shoe and a single dorsal clip (Figure 3a). A final simple bandage was performed 19 days after the operation, after which, the horse was discharged.

Outcome

Forty height days after the surgery, the mare was seen for a follow up examination. She was in a good general condition and the clinical examination was normal. No signs of pain on palpation and no lameness
were present when trotting in a straight line on asphalt. Two point four centimeters of new horn had grown and the distal and the new proximal hoof wall was totally parallel (Figure 1c and 2c). The wound was completely keratinized to this day; only a slight outward deviation was visible between the growth of the new horn and the distal hoof wall (Figure 2c). All 4 feet were trimmed and the orthopedic shoe was put back on. After a good cleaning, a resin (Adhesive Resine®, black, Top Gum) was applied to fill the gap in the horn (Figure 3b). It was advised that a gradual return to riding was necessary, with a change to a full bar shoe when the defect in the hoof capsule came into contact with the asphalt.

Discussion

In wounds with impairment of the coronary band, it is imperative to maintain the alignment and apposition of the coronary band in order to minimize hoof wall defects or abnormal hoof growth (Burba, 2013). It has been recommended that vertical mattress pattern should be used for coronary band sutures (Burba, 2013; Schumacher and Stashak, 2016). Interrupted horizontal mattress distributes tension over a larger area, but is weaker under tension comparing to interrupted vertical mattress which also has less interference with vascular supply (Kümmérle, and Fogle, 2018). However, the vertical mattress pattern has the same direction as the perimeter and layer. In practice, this method introduces more material into the wound and therefore can cause slippage between the lamina that make up the coronary band and the hoof wall, this is particularly seen where there is poor tissue resistance in chronic wounds. To form the uniaxial traction device with disto-sagittal traction, an interrupted horizontal mattress was use in this case with some modifications.

A stent made of soft rubber tubing was placed under the sutures to prevent the sutures from cutting through the skin and to prevent impaired vascular circulation (Kümmérle and Fogle, 2018). As we can see in this case, when the sutures are removed, the defect is still present and can cause deformation of the tissue; other studies have described the same conclusion with another mechanotherapy device (Lepage et al., 2022). For these reasons, the stent was placed over the coronary band. Suture placement was of particular importance: for the anchorage point in the hoof wall, to avoid extending the dissection too far to the distal side avoiding a bad angle and insufficient pressure of the coronary band on the foot. Conversely, an anchor point that is too high will not allow the coronary band to be properly traversed.

Another essential factor is the application of a foot cast which restricts the movement of the distal limb while it also protects the wound bed from ongoing trauma and contamination. However, some studies found that the outcome following management with a foot cast was not always significantly different than management with a bandage alone (Janicek et al., 2005; Sloan et al., 2022). A foot cast may minimize excessive granulation tissue formation and facilitate healing by second intention (Burba, 2013). Some authors mention that a period of 2 at 3 weeks of foot cast bandage might be beneficial for complete wound healing (Ketzner et al., 2009; Burba, 2013; Schumacher and Stashak, 2016). In this case report, the choice of using a foot cast is explained by the intention of implementing adequate immobilization and compression on the coronary band for improved wound healing.

A key point to improve the outcome after any hoof injury is the need for the farrier and the vet to work collectively and jointly together (Chanda, 2021). The main goal is to stabilize the hoof wall, because this will be the most important part of a good healing process; the best way to do this is with the bar shoe and four clips. This has been reported for treatment in cases where the horse has a coffin bone fracture. (Honnas et al., 1988). The bar shoe is also recommended when a large portion of the hoof capsule has been lost. In this case, the region of the hoof wall distal to the defect should be removed (rasped away) to eliminate weight bearing on that portion of the hoof wall (Schumacher and Stashak, 2016). Weight bearing on the affected area maybe beneficil to eliminate pain and to promote growth of the affected horn (Chanda, 2021). However, in this case, the removed part would have been very extensive and would have caused instability to the whole foot. To combine all of these objectives, a bar shoe was opened in the mammal and quarter hoof wall. Finally, hoof resin was used to fill the cornified deficit in the hoof wall. This can be applied within approximately 4 weeks, when the granulation tissue in the defect hoof wall becomes cornified. (Schumacher and Stashak, 2016).
The successful treatment of this case was achieved through the development of the appropriate surgical technique orientated to the particular presentation and nature of the wound. Which, in conjunction with specific remedial farriery, resulted in a good cosmetic and functional outcome.

**Author’s declaration of interest**

No conflicts of interest to declare.

**Ethical animal research**

Not applicable.

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**Authorship**

All authors contributed to the preparation of the manuscript and gave their approval of the final version.

**References:**

Figure - Successful treatment 1.0.docx available at https://authorea.com/users/623749/articles/646335-successful-treatment-of-a-proximal-displacement-of-horny-tissue-with-an-uniaxial-traction-device-and-shoeing