EQUINE VETERINARY EDUCATION
Equine vet. Educ. (2008) **20** (8) 406-410
doi: 10.2746/095777308X332240

Case Report

A singular case of traumatic total hoof capsule avulsion

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Keywords: horse; hoof avulsion; exungulation; transcortical cast; Gore-Tex

Summary

Total, full thickness hoof wall avulsion is rare in horses. Sometimes complications such as fracture of the distal phalanx, osteomyelitis, septic arthritis and degenerative joint disease have been reported. Limiting motion at the affected site and hoof stabilisation are essential to obtain a good hoof regeneration.

This case report reviews the clinical features including diagnostic techniques (radiographic examination and venography) of a Quarter Horse filly presented with a complete and full-thickness traumatic hoof capsule avulsion complicated by an open fracture of the third phalanx. A transfixation casting technique was performed followed after one month by 2 short limb casts applied for 2 months each. Twenty-four months after trauma the foot had completely regrown. The dorsal aspect of the hoof wall appears to be remarkably shorter compared to the heels. From a radiographic viewpoint, the lateral aspect of the left hind foot shows diffuse bone remodelling and a deformed distal phalanx.

Introduction

Traumatic hoof wall avulsion is not uncommon but total, complete and full thickness hoof wall avulsion is a rare condition in horses. To our knowledge, only 2 similar cases over about 40 years have been reported (Jackson 1969; Stanek and Brkic 1980). Hoof avulsion can be secondary to acute injuries, as consequence of weakening of the lamellae (Parks 1999; Ross 2003) or achieved by surgical treatment (Redden 2002). Surgical resection of the wall takes 2 forms: one in which undermined or loose wall is removed (laminitis) and the other in which the wall is essentially torn away from the underlying dermis (Pollitt and Daradka 2004). Spontaneous avulsion may extend to involve proximally the coronary band and distally the sole. Hoof avulsion and hoof wounds in general may be classified as complete or incomplete, total or partial and full- or partial-thickness lesions. In "complete avulsions, the affected wall and attached structures are completely separated from the foot. Incomplete hoof wall avulsions remain attached to the foot along at least one margin, usually proximally" (Parks 1999). To our knowledge, the difference between total and partial hoof avulsion has not well been defined, but it appears that in total avulsion the anatomical portions of the foot affected by pathological mechanisms are the toe, quarters and heel. In a partial avulsion the one or two of these anatomical portions of the foot can be affected by the pathology. In full-thickness lesions the horny layer, the corium and the subcutis are completely detached from the underlying structures (e.g. third phalanx). In partial-thickness lesions the horny layer is separated from the underlying structures (Parks 1999).

Sometimes complications such as a fracture of the distal phalanx, osteomyelitis, septic arthritis and degenerative joint disease have been reported (Stashak 2002). Avulsion, generally, may be treated by daily cleaning to allow removal of any necrotic debris (Jackson 1969); bandaging is essential to protect the healing digit and to avoid secondary contamination. Nevertheless in case of a large defect and especially when it is incomplete, cast application is recommended (Stashak 1991), because limiting motion at the affected site and hoof stabilisation are essential to obtain a good hoof regeneration (Stashak 1991). Casts are also excellent in case of complete avulsion to improve weightbearing, maintain alignment of the distal limb, or restrict growth of exuberant granulation tissue (Parks 1999). Normally the first cast is left in place for 2–3 weeks and needs to be changed frequently before the wound is healed (Stashak 1991; Parks 1999).

This case report reviews the clinical features including diagnostic techniques and outcome of a Quarter Horse filly that presented with a complete and full-thickness traumatic hoof capsule avulsion complicated by an open fracture of the third phalanx.

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Clinical details

Clinical history

A 4-year-old Quarter Horse filly was referred to our centre after a trauma occurred about 12 h before. While galloping clockwise in a horse corral, a foot became stuck between a side board and the floor. Once the horse pulled the limb back a complete full thickness avulsion of the left hind hoof was achieved. On presentation to the referring practitioner, 2 h after trauma, the horse demonstrated a nonweightbearing lameness and the hoof was completely exungulated and bleeding. The traumatised tissues were cleaned with sterile solutions and a sterile compressive dressing was applied to protect the hoof and control haemorrhage. Systemic procaine benzylpenicillin (20,000 iu/kg bwt) and dihydrostreptomicin sulphate (25 mg/kg bwt) treatment was started and tetanus antitoxin administered.

Clinical examination

Examination at our centre, about 12 h after trauma, revealed a nonweightbearing lameness on the left hindlimb and as the bandage was removed the foot showed spontaneous bleeding. *Corium coronae* and *corium cunei* were still recognisable but on the dorsal surface of the third phalanx, some islands of *stratum germinativum* instead of a conserved *corium paretis* were visible. The surface was covered by debris, sand and other foreign material. Moreover the sensitivity of the tissues was conserved. A deeper lesion was detected on the dorso-lateral portion of the foot; the bone surface of the third phalanx was yellow-brown in colour (**Fig 1**).

During inspection of the inner part of the avulsed hoof, a fragment of the lateral portion of the third phalanx was recognised (**Fig 2**). Radiological examination and venography were performed respectively in order to assess the exact fracture conformation of the third phalanx and assess the vascularisation of the foot. Radiographic findings were consistent with a diagnosis of a complete major fracture of the dorso-lateral solar portion of the third phalanx (**Fig 3**). The venogram showed interruption of the contrast medium at the level of the anastomotic plantar and lateral dorsal rami of proximal and middle phalanx, lateral digital cushion and coronal vein. A complete lack of vascular pattern was seen in the terminal arch while a partial pattern reduction was noted in the parietal and solar plexus. Venogram findings were compatible with a suspect of post traumatic thrombosis of the lateral plantar digital vein. Furthermore a conserved vascularisation of the medial compartment was attested (**Fig 4**).

Treatment and follow-up

For the first 12 days the foot was treated by daily cleaning and bandaging to allow passive drainage of the exudate produced by injured and septic tissues and removal of necrotic debris (Stashak 1991; Parks 1999). The antibiotic therapy was continued as above for 20 days. Once lack of sepsis of the bone and of the surrounding tissue had been established and since it is very expensive and time consuming to change dressing every day, we adopted the technique suggested by Redden (2002) in the management of high grade scale laminitis. This technique is based on the use of a transcortical cast. The transfixation casting technique has been previously described by Nemeth and Back (1991). In the present case three 6 mm Ø pins were inserted and the cast padding was made with Gore-Tex bands. This technique allowed use of the affected limb, while this waterproof and breathable material avoided the necessity for frequent change of the cast. A rounded steel-cup was applied distally to the cast to promote an easier rolling motion of the cast's foot. The cast was left in place to help the healing of the digit long enough to allow primary epithelialisation as suggested by Stashak (1991). On the other limb a Redden Modified Ultimate[1] support was applied to reduce the risk of a supporting laminitis.

The pins and the first cast were removed after 4 weeks (6 weeks after injury) when the horse showed a sudden decrease in weight load on the affected limb and radiological examination revealed osteolysis around the pins, especially the proximal one. The extraction of the pins was carried out with the horse under general anaesthesia and a completely restored vascular supply was attested by a second control venogram (**Fig 5**). A good, compact layer of granulation tissue covered the deeper structures of the foot and a small discoloured area was still present at the level of third phalanx fracture surface (**Fig 6**).

Subsequently, in order to obtain a progressive load on the affected limb and to protect the healing digit, 2 additional short limb casts were maintained with Gore-Tex bands and were left in place for 8 weeks each. After the second cast (10 weeks after injury), a compact layer of granulation tissue covered the foot and an incomplete cornification of the hoof wall was still present (**Fig 7**). After the third cast (14 weeks after injury), total cornification of the hoof wall and the sole was observed (**Fig 8**). The foot was trimmed and shod with a 4-point rail shoe. This type of shoe was adopted because the breakover point is located in the centre, which allows the horse to self-adjust the plantar angle (Redden 2007); it offers continuous self-adjustment that the horse needs to initially unload the DDFT and progressively exercises the DDFT. Finally a progressive load was permitted on the affected limb. Nevertheless, 10 months after injury the horse suddenly presented with a worsening of the lameness.

Radiographic findings were consistent with a diagnosis of rotation of the third phalanx and a plantar angle of 20° was noted (**Fig 9**). A tenotomy of the deep digital flexor tendon at the pastern region was performed with the horse under general anaesthesia as previously described by Fackelman *et al.* (1983). Pastern region tenotomy was chosen instead of tenotomy at the metatarsal region because this technique is easier and avoids the risk of complications such as iatrogenic transection of the vascular and neural bundles (O'Grady 2006). On a radiographic control a partial realignment (plantar angle 10°) of the third phalanx was achieved (O'Grady 2006) (**Fig 10**). The horse was shod with an egg-bar shoe to allow loading weight on the heel and to keep a normal plantar angle. An improvement in the lameness was immediately noticed.

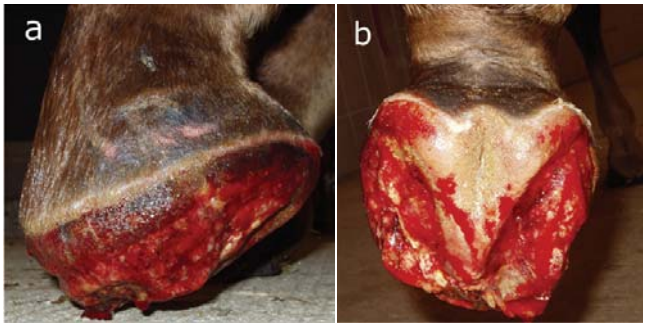

Fig 1: Lateral (a) and plantar (b) views of the left hind foot at time of presentation. The dorso-lateral aspect of the fracture of the third phalanx is visible. **Corium coronae *and* corium cunei *are still recognisable.***

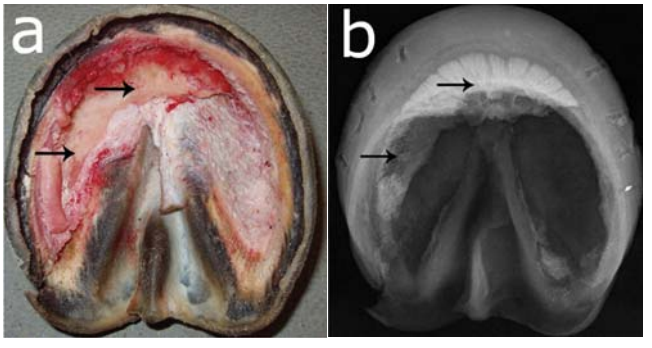

Fig 2: Gross examination (a) and radiograph (b) of the avulsed hoof at time of presentation. The dorso-lateral fragment of the third phalanx (arrows) is embedded in the avulsed hoof.

Fig 3: Latero-medial radiograph of the left hind foot at time of presentation shows the absence of the tip of the third phalanx.

Several months later (16 months after injury), the horse suddenly presented with a severe lameness and an examination of the sole revealed a softening of the lateral quarter. A painful reaction was achieved with a hoof tester and the area was explored until an exudate pocket was hit. A nonputrid, yellowish fluid was detected, leading to a diagnosis of seroma. The pocket was flushed and a protective bandage applied. Each time the horse was trimmed and shod, past the recommended 50 days, the seroma had the tendency to reform. Twenty-four months after trauma the foot had completely regrown but some alterations were still present. From a cosmetic point of view, the dorsal aspect of the hoof wall appeared to be remarkably shorter compared to the heels (**Fig 11**). From a functional point of view, the horse was grazing free on the pasture. At walk the lameness was still recognisable and worse at trot (3/5 AAEP degrees; Anon 1999). Radiographically the lateral aspect of the left hind foot showed diffuse bone remodelling and a deformed distal phalanx (**Fig 12**).

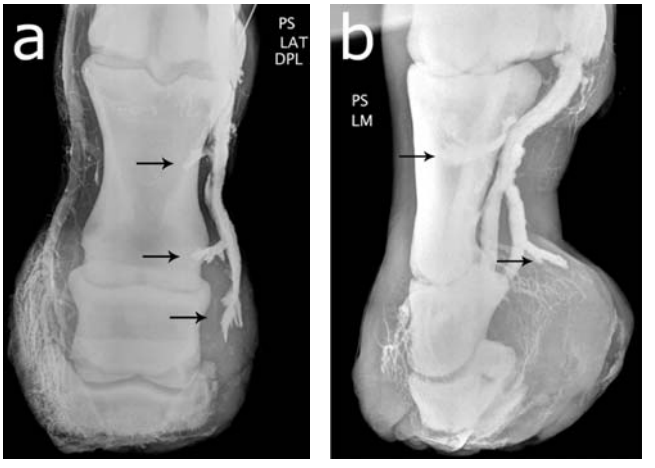

Fig 4: Dorso-plantar (a) and latero-medial (b) venograms at time of presentation. Note the interrupted vascular pattern of the lateral plantar digital vein, compatible with a post traumatic thrombosis (arrows).

Fig 5: Dorso-plantar (a) and latero-medial (b) venograms one month after presentation. A restored vascular supply of the lateral plantar digital vein is recognisable.

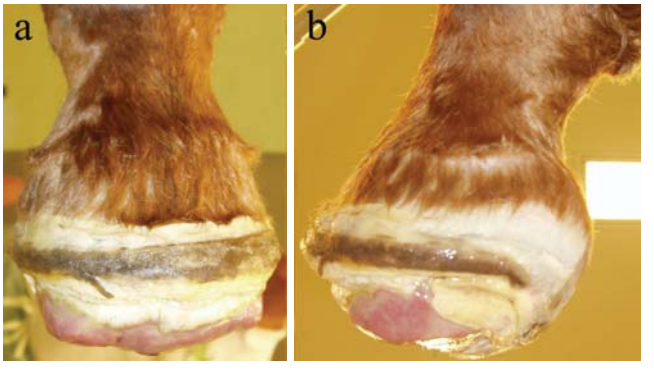

Fig 6: Dorsal (a) and lateral (b) views of the left hind foot 6 weeks after the injury. A good, compact layer of granulation tissue covers the deeper structures of the foot.

Discussion

Total and complete full-thickness traumatic hoof avulsion is an unusual condition in horses. Despite most popular veterinary medicine text books considering total avulsion (Stashak 1991, 2002; Ross 2003; Auer 2006), only 2 cases have been reported (Jackson 1970; Stanek and Brkic 1980), both affecting one hind foot. Normally this type of lesion needs daily cleaning and bandaging and considerable professional care: therefore the treatment is very expensive. Stanek reported the use of a cast for the first 2 weeks in order to protect the healing digit (Stanek and Brkic 1980). Jackson (1969) adopted a plaster of Paris cast for a period of 72 h but only to provide an haemostatic effect.

In the treatment of high grade scale laminitis a surgical partial and/or total ablation of the hoof wall may be considered as the last rescue therapy and in these cases the use of a transcortical cast is recommended (Redden 2002). This technique allows immediate clinical relief and sufficient use of the affected limb to diminish the risk of developing an overload laminitis on the contralateral limb, especially in hindlimbs. To reduce this possibility we decided in this case to apply a Redden

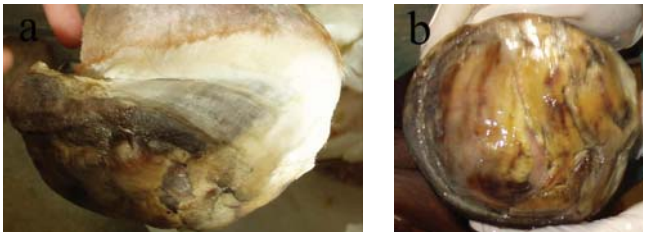

Fig 7: Lateral (a) and solar (b) views of the left hind foot 10 weeks after the injury. A compact layer of granulation tissue covers all the foot and an incomplete cornification of the hoof wall is still present.

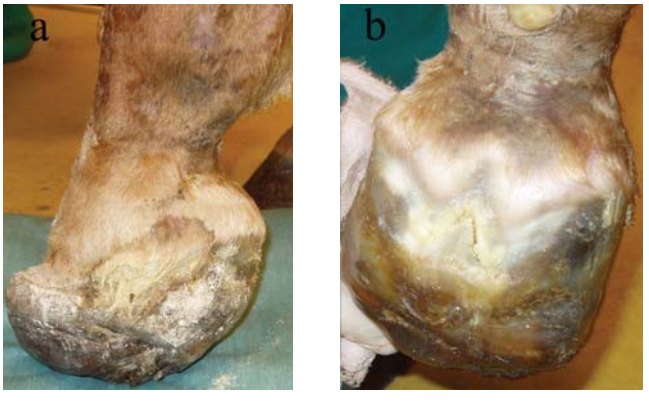

Fig 8: Lateral (a) and plantar (b) views of the left hind foot 14 weeks after the trauma. Total cornification of the hoof wall and the sole is observed.

Fig 9: Latero-medial radiograph at 12 months after trauma when rotation of the third phalanx and plantar angle of 20° were noted.

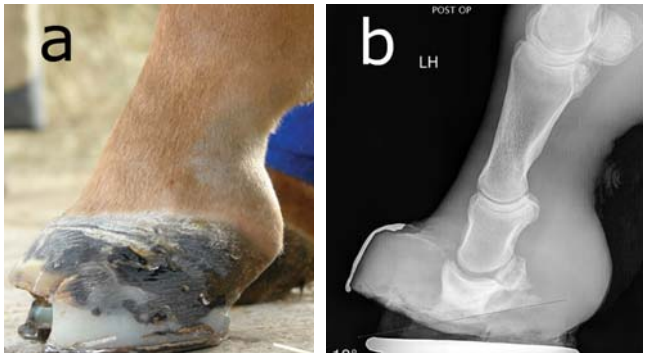

Fig 10: Gross examination (a) and latero medial radiograph (b) of the left rear foot after tenotomy of DDFT and realignment of the third phalanx.

Fig 11: Dorsal (a) and lateral aspect (b) of the left rear foot after trimming 24 months after trauma. Note that the dorsal hoof wall is remarkably shorter compared to the heel.

Fig 12: Latero-medial radiograph at 24 months after trauma. Note the diffuse bone remodelling of the third phalanx that appears severely deformed.

Modified Ultimate support on the contralateral limb. Moreover, the use of a waterproof, breathable material such as Gore-Tex bands makes it possible to maintain the cast *in situ* for a long time with a drastic reduction in the total number of medical treatments and professional care time. In the present case the use of a transcortical cast allowed immediate use of the affected limb and the support on the contralateral limb avoided the development of laminitis.

In cases of laminitis, as with traumatic avulsion cases, a venogram is recommended to assess the state of vascularisation. A lack of blood supply to the digit could affect the healing process interfering with the regrowth of the new hoof (Parks 1999). In the present case the first venogram was performed about 16 h post trauma, with the second about one month later when the first cast was changed. The first venogram revealed a lack of blood supply to the lateral aspect of the foot, while the second revealed the complete restoration of vascularisation. The venograms were performed as developed by Pollitt and Molyneux (1990) and described by Redden *(*1993) through injection of 40 ml of Iohexol (300 mg/ml) into the lateral plantar digital vein after application of a tourniquet on the fetlock area. The block in blood flow observed in the first venogram, in our opinion, was likely to be secondary to thrombosis. We decided to apply a cast in the hope that the lateral vascular supply would be restored by recanalisation of the thrombosed vessels. In fact after about one month the control venogram attested a completely restored blood supply. The time necessary to repair this pathological alteration is compatible with the fibrinolysis process and the formation of new capillary sinuses as observed in the evolution of deep vein thrombosis (DVT) in human medicine (Sarcina and Bavera 1999).

Jackson reported that the time necessary for a new completely regrown horn was about 4 months and that the use of a sling for 10 h each day alleviates the fatigue on the opposite limb (Jackson 1969). Stanek also reported a time of about 4 months to obtain complete regrowth of the horn (Stanek and Brkic 1980). In the present case the growth of new hoof took about 6 months. The transcortical cast was used to unload the weightbearing and immediately alleviate pain. The healing process included 30 days of complete suspension followed by progressive loading of the foot with 2 further short limb casts. The new tissue was very hard compared with the contralateral foot. The initial shape of the new foot was bowled and a careful examination revealed faster growth of the heel portion with respect to the dorsal part. The horn tubuli of the dorsal hoof wall were oriented outwards (plantaro-dorsal) and not along the force lines directed towards the ground. Therefore, we can speculate that the reduced weight of force transferred to the cast's foot could be the reason of the final shape of the foot. Complete cornification can be assumed to have taken 6 months because of the missing portion of the solar and *paretis corium* of the third phalanx. The high energy necessary to remove a healthy hoof capsule can also be sufficient to provoke lesions of the deeper structures such as a fracture of the third phalanx. Fracture of the wings of the third phalanx is cited in a previous report (Stanek and Brkic 1980). Unfortunately in the present case the fracture also extended to the lateral portion of the third phalanx at the level of the terminal arch. After several months a partial reabsorption of the remaining portion of the third phalanx was observed. These radiographic changes were interpreted as bone remodelling and were compatible with the vascular impairment of the terminal arch. These conditions resulted in a guarded prognosis for lameness-free use of the limb.

Acknowledgements

The authors thank Luisa De Ponti for the interesting case, and Antonia Elizabeth Zorat for editorial support.

Manufacturer's address

[1]Nanric, Versailles, Kentucky, USA.

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