



Clinical Management of Achilles Tendon Injury with Tendon Gap Defect in a Horse Using Tissue Engineering: A Case Report

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DOI: 10.31080/ASVS.2023.05.0690

Received: May 29, 2023

Published: June 14, 2023

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Abstract

A 3 years old horse was presented to Referral Veterinary Polyclinic I.V.R.I with history of traumatic injury on left hind limb with lameness. The case was examined and diagnosed as lacerated and crushed rupture of Achilles tendon with tendon gap defect. With suitable anaesthetic protocol and aseptic measures, the tendon grafting was performed using a tested tissue engineered bubaline derived tendon grafts to reconstruct the tendon. Postoperatively the limb was immobilized with fiberglass cast and antibiotic coverage along with anti-inflammatory and routine dressing. However, infection developed after few days, which might have been due to open wound presented, resulting in the removal of the graft. Hence, the treatment of the tendon gap defect wound was attempted with bubaline tendon derived collagen gel application resulting in a progressive healing. The fiberglass cast with splint were also removed 25 days post-surgery. Thereafter, a moderate weight bearing while standing on the affected limb was noticed post collagen gel treatment. The animal regained normal weight bearing and made an uneventful recovery after three months.

Keywords: Horse; Achilles Tendon; Tendon Injury; Decellularized Tendon Graft; Collagen Gel

Introduction

The Achilles' tendon is made up of multiple tendons from several different muscles of the hind limb. When this tendon is affected by certain cause it leads to severe limp with the collapse of the limb. Traumatic injuries like (lacerations, blunt force trauma, severe stretching/pulling, cut by agricultural appliances) are major cause of Achilles tendon injury. The crushed injuries or damage of the lacerated tendons demands for the segmental removal of necrosed tendon leaving a large gap defect and affected flexion and extension of the hock joint. Repair of large tendon defects are a challenge to the orthopaedic surgeons. Tissue engineering techniques using novel scaffolds materials offer potential alternatives for management of tendon disorders [9]. It helps to restore, maintain and improve tissue function; thus provides an option for

repair of large tendon defects. The present case reports the use of tissue engineered decellularized tendon graft and collagen gel to repair large tendon injury in a horse with successful outcome. The result of the present case report may encourage a larger clinical application of the tissue engineering techniques for tendon repairs.

Materials and Methods

Acellular tendon grafts were developed from bubaline tendon by processes including combination of physical and chemical treatment [4]. Terminal sterilization was done by UV irradiation. The decellularized tendon grafts were washed with normal saline solution prior to application. Collagen gel was prepared from the developed decellularized tendon by an optimized protocol (IPR).

History

A 3 years old stallion was presented to Referral Veterinary Polyclinic (RVP), IVRI with severe limping/lameness of the left hind limb and blood dripping from the wound on the posterior aspect of the upper limb around the hock joint. The wound was tied with a cloth on presentation. The owner reported the wound to be caused by a sharp object when the horse accidentally jumped over a sharp agricultural appliance on the day of presentation of the case.

Clinical observation

Clinical examination revealed the sharp traumatic injury with skin and soft tissue defect of the posterior aspect of the left hind limb extending from the proximal aspect of the hock joint to the caudal end of the thigh (Figure 1). Exploration of the wound revealed deep Achilles tendon lacerations with a large gap defect relevant between the two lacerated ends of the tendon tissue stump. At rest, the horse exhibited severe postural irregularities (Figure 1). The hoof was off the ground at most of the time during the weight bearing phase/walking with abnormal flexion of metatarsophalangeal joint. The hock joint was observed to flexed abnormally indicating failure of the Achilles tendon function.



Figure 1: Horse presented with traumatic injury of the left hindlimb with no weight bearing on the limb.

Treatment (Surgical Technique)

Deep tendon laceration results in loss of mobility in addition to acute pain, thus immediate surgical intervention was made to prevent further damage to the limb. The horse underwent surgical repair of the tendon gap defect which remain the best treatment option for tendon loss, under general anaesthesia and with proper aseptic procedures. The horse was positioned in lateral recumbency with the affected limb upward and supported at the fetlock joint. The wounded area was washed repeatedly with normal saline solution and flushed with povidone iodine solution to remove any dirt and debris. The wound was extended upward by surgical incision for better exposure of the underlying tissues. The two ends of the tendon were exposed and brought close by extending the limb (Figure 2a). The tendon gap defect of the affected limb was pre-measured while making the animal stand on ground and measuring the angle of hock of the normal contralateral limb, thereafter the two limbs compared. The ruptured ends of the tendon with tendon gap defect were reconstructed using the decellularized graft developed. An appropriate size tissue engineered tendon graft was used to repair the gap defect. The host ends and the tendon graft were sutured using four strands of monofilament polyamide No. 1 by Bunnell-Mayer suture pattern. First, the decellularized graft was sewed using suture material polyamide to hold the graft, later the sewed graft along with the suture ends were sutured into the proximal and distal stump of the host tendons (Figure 2b). On tightening the sutures, the margins of the graft and the host tissue ends were well apposed (Figure 2c). The muscle and fascia were sutured with polygalactin 910 No. 1 (vicryl) in simple continuous suture pattern. The wound edges were trimmed off and the skin incision and the wound were apposed by cross mattress suture pattern using polyamide No. 1 (Figure 2d).

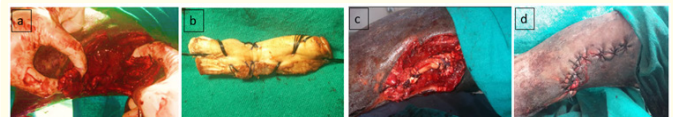


Figure 2: a) The ruptured ends of the Achilles tendon leaving a large gap defect; b) Decellularized tendon graft used for the reconstruction of the gap defect; c) reconstruction of the tendon gap defect using Bunnell Mayer suture pattern; d) Skin closure with Polyamide suture in cross mattress pattern.

Immobilization

To support the repaired limb and counteract large tensile force during healing process, the limb was immobilized from tibio-tarsal joint/hock joint. A well-padded cotton bandage was applied around the incision side leaving a window for dressing from the end point of the tibia to the hoof to avoid any soft tissue trauma. An Aluminium bar used as splint, was curved to the angle of the hock joint and applied to the limb as short limb cast. The limb was then immobilized using fiberglass cast over the aluminium bar. The cast was given sufficient time for setting and the stallion underwent assisted recovery after general anaesthesia. The purpose was to provide early weight bearing and augment early healing of the tendon tissue reducing the risk for ischemic injury while allowing to perform wound care through the window. Padding under the splint protects the skin and bony prominences and accommodates swelling of the injured extremity.

Post operative management

The post operative management included, antibiotic therapy (intramuscular) Moxel 3500 mg for 5 days, NSAIDs (Meloxicam) @ 0.5 mg/Kg for 5 days, and multivitamin inj. every alternate day for 10 days with regular wound dressing using povidone iodine as antiseptic solution. The horse was advised to keep under stall rest for three months while allowing gradual outdoor walk on leash.

Wound management

The wound was monitored and daily dressing was done. However, wound dehiscence was present and the surgical site got infected after 10 days of postoperative period. The skin sutures opened up and exudate and discharge was noticed between the skin edges (Figure 4a, b). All the sutures were removed immediately along with the remnants of the tendon grafts after infection developed. The skin edges were cleaned/irrigated properly with povidone iodine solution. The extensive wound and a large tendon gap defect are a great challenge. So, to bring the healing process (aimed at soft tissue and tendon both) back on track it was compulsory to have a tissue filler, which would bridge up the gap defect of tendon edges and also skin edges. The tendon gap defect was filled and packed with thick viscous biomimetic, bioactive pre-validated (preclinical and clinical) collagen gel (biological dressing) and bandaged. The dressing was changed every 3 days interval and the wound was monitored for progressive healing (Figure 4 c, d, e, f).



Figure 3: Immobilization of the limb using Aluminium bar curved to the angle of the hock joint and fixing with fiberglass cast.

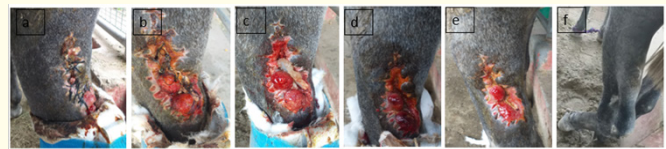


Figure 4: a) Weakening of /Rupture of the skin suture and exposure of the underlying tissue after 10th post-operative day; b) exposure of the tendon graft material which appears to be dissolved; c) removal of the remnants sutures and grafts and treatment with viscous collagen gel; d) the wound shows healthy granulation tissue after 3 days post collagen gel application; e) progressive healing of the site with granulation tissue and wound contracture after 10 days; f) complete wound healing of the site with minor scar tissue after regular dressing.

Results

The horse was able to bear weight on the affected limb supported with splint immediately after surgery (Figure 3). After the infection the animal again started to show the lameness which progressively improved upon the gel application in the gap defect. During the post-operative period immediately after the removal of the fiberglass cast the horse showed lameness, pain with abnormal gait which improved gradually with physiotherapy and regular exercise for normal weight bearing. The wound healed completely af-



Figure 5: The appearance of the left hindlimb 3 months postoperatively, with the affected limb bearing weight (near to normal) showing successful repair of the Achilles tendon.

ter proper wound management leaving a minor scar. Three months postoperatively, slight lameness was still present while walking on the left hind limb while the abnormal flexion of the hock joint had recovered. A slight atrophy of the gluteus muscle had developed in the immobilised limb. At rest, the horse was able to bear full weight on the limb except for a slight flexion of the tibiotarsal joint was evident (Figure 5). However, the horse was judged to have acceptable locomotion and the owner reported that the horse returned to normal activity on ground.

Discussion

The Achilles tendon is a vital reciprocal apparatus of the hind leg which allows lower limb locomotion and propulsion in actions in horses. The clinical case described in this report had an uncommon laceration on the posterior surface of the limb around the hock joint resulting in Achilles tendon rupture. The present case shows marked dropping of the tuber calcanei, an abnormal angle of the tibiotarsal joint and abnormal flexion of the metatarsophalangeal joint, the hoof was found to be frequently lifted from the ground while walking. Similar signs were also found in earlier reports of Achilles tendon injuries [3] and disruption of the superficial digital flexor muscle [12] in horses. This postural dysfunction results from the rupture of the tendon which anchor the gastrocnemius and other muscles of hind limb to the bony prominence of tuber calcanei resulting in failed ability to resist tensile forces in addition to acute pain due to the injury. Tendon injury requires immediate attention so that further damage to the tendon can be prevented. The V-Y technique, local tissue augmentation, turn-down flaps, tissue transfer, free tissue transfer, and use of synthetic materials are some of the techniques performed when tendon gap defects

are present [11]. A segmental loss of the tendon tissue was reconstructed with different procedures using synthetic materials, such as suturing the tendon extremities with nonabsorbable plaited terylene [13], carbon fiber [7] or PLLA [5]. But artificial materials has certain drawbacks such as increased inflammatory responses, antigenic reactions, failure at the fixation sites, and lack of long-term biocompatibility [2]. Autografts have limited availability and cause donor site morbidity while allo- and xenografts have the chance to be acutely or chronically rejected by the host [10]. In the present case, there is formation of a gap between the ruptured tendon ends, due to loss of the tendon and the high contractility of the associated muscles, which also prevents bringing together the cut ends by simple tenorrhaphy. Therefore, surgical procedures to repair and reconstruct the ruptured tendon with gap defect was attempted using tissue engineered tendon graft to regain the functionality of the injured limb. Available nonabsorbable, synthetic fibers that are relatively strong was use for the tendon repair. Immediately after a tendon repair, the tendon contributes nothing to the strength of repair. During this time, the suture itself and suture technique are the sole contributors to the strength of repair [6] and also immobilization contribute to support the newly repaired tendon. However, a few days later, due to wound contamination all the sutures and grafts from the site were removed immediately. The contamination might be due to late presentation of the open wound to the hospital, without any prior treatment. The wound was lavaged with antiseptic solution, left open and the tendon gap defect was bridged with viscous collagen gel. The bioactive gel might have kept the two tendon ends connected and might have lead to early endotendinous and peritendinous healing in the present case (might have led to the functional recovery in the present case). It is also attributed to the early wound healing. Immobilization for a prolonged duration of tendon decreases the total weight of the tendon, and reduces its stiffness and tensile strength [14]. Therefore, exercise and mobilization therapy is generally found to be beneficial, with stretching and strengthening activities being the most common place [1]. This was accomplished in the present case too. When this unorganised tissue was subjected to weight bearing the organisation of tendon fibers into smooth parallel structure might have occurred. Under special observation there was no proud flesh formation nor was there any abnormal reaction of the host tissue for the collagen gel/graft. The was no post gel application exudation/swelling etc, but rather an enhanced healing was observed. The incomplete extension of the tibiotarsal joint after healing of the wound might be due to fibrotic scar formation of the healed tendon which might improve by physiotherapy and stretching and extension/flexion exercises. Tendon tissue generally heal by scar formation so healed tendon is less stiff and less flexible from before [8]. The animal

remained alert throughout with normal activity. After a period of three months the animal was discharged from the polyclinic with uneventful recovery.

Conclusion

Tendon injuries are serious concern in equine which may cause a crippling lameness. Treatment of tendon injuries in horse is a significant clinical challenge. The present case report shows that decellularized tendon graft failure occurred due to infection and subsequently the gap defect filled with thick collagen gel can be used as a bioactive dressing material to repair and reconstruct the loss of tendon tissue in horse with successful outcome. The result of the present case report encouraged a larger clinical application of the tissue engineering techniques for tendon repairs.

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