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Repair of Achilles tendon segmental gap defect in a dog using bioactive xenograft and collagen gel

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The Achilles tendon is the strongest tendon in dogs formed by the various muscle tendon units. Its rupture in dogs is relatively uncommon and often due to trauma (Shani and Shahar, 2000). Surgical treatment involves debridement of fibrous and necrotic tissue and attachment of ruptured ends with or without augmentation. Tendon healing is a challenging task for a veterinary surgeon since tendons are relatively acellular and take a long time to heal. Many times, the healed tissue is inferior in terms of mechanical strength and adhesions with the surrounding soft tissues, and hence becomes partially nonfunctional. The damaged, torn tendon or overstretched tendon has to be cut and supported with a graft material. Excessive tension by apposition of the ruptured end or extensive damage to the tendon can be corrected by augmentation techniques to reduce gap formation and suture failure. It also increases the mechanical strength of the injured tendon. The current case, reports the Achilles tendon full gap defect repair and augmentation by bubaline derived acellular tendon graft and bioactive collagen gel for tissue engineering of a large tendon gap defect in a dog.

A 9-month-old female Indian mongrel dog weighing 20 kg was presented with a history of trauma to the hind limbs 20 days prior. On examination, the animal exhibited a plantigrade stance and non-weight-bearing lameness in the left hind limb (Fig. 1). Clinical and orthopedic evaluation revealed hyperflexion of the left hock joint. Orthogonal radiographs of the affected limb showed a depression in the soft tissues above the tarsal joint, suggestive of a discontinuity in the soft tissue structures. Ultrasonographic examination revealed a type IIb tendon rupture, characterized by multiple anechoic regions at the ends of the ruptured Achilles tendon. Based on these findings, a diagnosis of type IIb Achilles tendon rupture was made (Corr *et al*., 2010), and surgical repair of the tendon was planned.

Fig. 1: Typical plantigrade stance of the dog.

The dog was premedicated with atropine sulphate (0.04 mg/kg body weight, s.c.), xylazine HCl (1 mg/kg body weight, i.m.), and diazepam (0.5 mg/kg body weight, i.v.). Anaesthesia was induced with ketamine HCl (5 mg/kg body weight, i.v.) and maintained with isoflurane. Following aseptic preparation of the surgical site, an incision was made on the medial aspect of the Achilles tendon to expose the injured area. A 3.5 cm segment of the partially ruptured Achilles tendon was resected and reconstructed using a ready-to-use bubaline-derived acellular tendon graft of appropriate length and diameter, overlaid with a thick bioactive collagen gel. The graft ends were sutured to the host tendon using Vetafil in a modified Kessler suture pattern. The paratenon was apposed using 1-0 polyglactin. Subcutaneous tissue and skin were closed following standard procedure. The limb was immobilized with external coaptation (fiber cast), incorporating a window at the surgical site. Postoperatively, the animal received ceftriaxone–tazobactam (50 mg/kg body weight, i.v.) for 7 days, and meloxicam (0.2 mg/kg body weight, i.m.) for 5 days. Skin sutures were removed on the 14th postoperative day.

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Fig. 2: Xenograft in resected site and secured with sutures.

Fig. 3: Normal gait and weight bearing on 45th postoperative day.

Partial weight-bearing was allowed from the 7th postoperative day. By the 30th postoperative day, the dog's gait had nearly returned to normal, and follow-up ultrasonography and radiography showed excellent graft incorporation into the host tendon. By the 45th postoperative day, the animal demonstrated strong weight-bearing and a near-normal gait.

The prognosis of tendon rupture repair depends on the severity of the injury and the time elapsed between the rupture and treatment (Spinella *et al.*, 2010). Surgical apposition of chronic or delayed tendon ruptures often results in varying degrees of gap formation or excessive tension at the repair site, both of which can compromise healing. Postoperative gap formation greater than 3 mm significantly reduces the mechanical strength of the repaired tendon due to scar tissue development, which is particularly susceptible to rupture within the first six weeks after surgery (Gelberman *et al*., 1999). Augmentation techniques- such as the use of autografts, allografts, synthetic materials like polypropylene or polyglycolic acid mesh, and xenografts- can enhance mechanical strength, minimize the risk of gap formation, and reduce the likelihood of suture failure. Tendon lengthening procedures are sometimes not feasible when a significant increase in tendon length is required. In such cases, tendon grafts capable of integrating with the host tendon should be considered.

In the present report, a bubaline-derived acellular tendon graft combined with bioactive collagen gel was successfully used to repair an Achilles tendon gap defect, resulting in a favourable clinical outcome. The acellular tendon graft was prepared from the Achilles tendon of a buffalo, which was decellularized and sterilized to create a ready-to-use xenograft material. Decellularization eliminates antigenic components, enhancing biocompatibility and reducing the risk of immune rejection across species. The bioactive collagen gel was prepared from decellularized tendon using an optimized in-house protocol (IPR). In a previously reported study, a similar decellularized tendon graft with bioactive collagen gel was successfully employed for the tissue engineering of an Achilles tendon gap defect in a horse (Pathak *et al.*, 2023). The bioactive gel promotes soft tissue healing by facilitating cellular migration and integration with the graft material. Previous experimental evaluations have demonstrated that the graft is non-antigenic, non-toxic, bioactive, mechanically strong, and biodegradable. Its application in the current case resulted in successful tendon reconstruction and excellent functional recovery. The findings of this case suggest promising clinical potential for the use of acellular xenogenic tendon grafts combined with bioactive collagen gel in the tissue engineering of tendon gap defects in dogs.

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