Chronic Achilles tendon injuries require more time to heal due to limited local blood supply and reduced availability of cytokines and growth factors necessary for healing.[10] Consequently, methods to improve healing of such injuries have been under development to accelerate the improvement of active ROM.

Non-operative and operative treatment are both options for the management of torn Achilles tendons, however operative repair is held in higher regard due to significantly lower re-rupture rates [1.7 to 5.6% of cases] in comparison to cast immobilization [6,7]. Despite these advantages, surgical repair is known to have a higher risk potential for other complications such as delayed healing, dehiscence, scarring and infection [7]. The pooled rate of these complications was reported to be 27-33%, with an overall rate of 2%-4% specifically for wound infection [8,9].

Unlike injuries to other tendons or tissues, injury to the Achilles tendon requires more time to heal due to limited local blood supply and reduced availability of cytokines and growth factors necessary for healing.[10] Consequently, methods to improve healing of such injuries have been under development for quite some time. One potential adjunctive treatment modality is cryopreserved amniotic membrane and umbilical cord tissue. Placental tissue is known to have anti-scarring and anti-inflammatory properties [11,12]. In pre-clinical models, placental tissue was shown to promote faster healing process, reduce inflammation, and promote organization of collagen fibers in an acute Achilles tendon injury model in rats [13-15].

In the present report, we report a case of a 25-year-old male who underwent surgical repair for Achilles tendon rupture twice, once due to sport injury and the second due to a fall relatively early in the post-operative course of treatment. Cryopreserved Umbilical cord tissue (cUC) was used as adjunctive treatment in both instances to promote faster healing, reduce inflammation, and accelerate the improvement of active ROM.

**CASE PRESENTATION**

A 25-year-old patient presented with acute severe pain, a slight limp, and a swollen right ankle (Figure 1) after he felt a sharp pop in his ankle area while lunging for a volleyball. Physical examination revealed loss of active plantar-flexion and a positive Thompson Test. Imaging revealed a rupture at the myotendinous junction, approximately 7 cm proximal to the insertion with concurrent edema and retraction of tendon proximally and distally (Figure 2). Open surgical repair of the right Achilles tendon was performed. An incision was made over the right Achilles tendon

The Achilles tendon is the strongest tendon found in the human body, yet is injured or torn in healthy, active individuals [1-3]. Annually about 11-18 per 100,000 people suffer from torn Achilles tendons [4], with about 25% of these cases being misdiagnosed on initial presentation to the clinician [5]. Upon rupture, severe pain and complete or partial loss of foot plantar-flexion is commonly experienced [1].

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exposing the injury site. The tear upon inspection was deemed repairable without the bone anchor placement into the calcaneus. Proximal and distal sutures were passed in Krackow fashion through the respective soft tissue fragments and then passed through the opposite stump in modified a Kessler Fashion. Suture material used was 2-0 Orthocord® (Depuy-Synthes, West Chester, PA). A 6x3cm cUC graft (Clarix Cord® 1k, Amniox Medical, Miami, FL) was then implanted and wrapped over the Achilles tendon. The peritenon was closed with 1-0 vicryl suture material and the incision was closed with 3-0 nylon suture material placed in “near-far / far-near” fashion to allow for soft tissue swelling. The sutures were maintained for 2-weeks PO without evidence of erythema or drainage but there was concern for the wound edges so the sutures were maintained for an additional week (Figure 3A). At 3-weeks PO, there was concern for wound dehiscence and possible superficial infection, so the patient was placed on antibiotics and Santyl® (Smith & Nephew, Andover, MA) was applied over the area of concern. Due to continued poor healing in the area, the patient was taken back to the operating room for incision and drainage (I & D) at 4 weeks; the sutures were removed and necrotic tissue debridged leaving a 3x1cm wound. Santyl® and an Adaptic® foam dressing (Acelity, San Antonio, TX) were also used to cover the wound. At 6-weeks PO, there was a 1.5 x 1.5cm area of granulation and fibrinous exudate noted posterior to the Achilles wound, however no active drainage was observed. A 2.5x2.0 cm cUC graft (Neox® Cord 1k, Amniox Medical, Miami, FL) was then placed on the wound (Figure 3B). A week later, there were no signs of infection or necrosis. An Adaptic® 4x4cm dressing was placed over the graft and a removable fiberglass cast was placed. At 20-days post superficial cUC graft placement the patient was seen in the office; the wound was healing with a yellow cap (Figure 3C) and active assistive ROM was initiated. The next day the patient fell in his bathroom with a dorsiflexion load at the Achilles tendon. The patient was taken to the operating room that day. At the time of evaluation there was areopening noted at the incision site and a new tear of the Achilles tendon at the calcaneal insertion distal to the original repair site (Figure 3D).

A complex revision Achilles tendon repair with a repeat I&D was performed using a Mitek Healix Advance®BR 4.5mm triple loaded anchor (Depuy-Synthes, Chester, PA) (Figure 4A). To continue the healing at the proximal superficial wound a 2.0x2.0cm cUC graft (Neox Cord 1K, Amniox) was placed at the superior segment of the incision (Figure 4E and 4F). Accelerated wound healing with progressive closure is shown at day 13, 33, and 56 following revision Achilles tendon repair as demonstrated in Figures 5A, 5B, and 5C respectively. Three weeks following the final procedure, the patient was a “household ambulator” (Stage 2) and exhibited a lower extremity functional status (FS) score of 27 [16]. The patient was also able to accomplish plantar-flexion and dorsiflexion at 4 weeks (Supplementary File 1). Ten weeks following the final procedure, the patient was a “community ambulator” (stage 4) with a FS score of 61 and was able to achieve active plantar-flexion and dorsiflexion (Supplemental File 2).
[16]. Furthermore, the patient was also able to stand and perform a single-leg heel raise on the involved side (Supplemental File 3).

**DISCUSSION**

The healing of the Achilles tendon is more complex and protracted due to poor local blood supply. Typically following surgical repair of a ruptured Achilles Tendon, patients are placed in a splint or cast for about two weeks followed by weight-bearing in a walking boot or cast variably between two to six weeks. At this point, patients are generally allowed to fully bear weight as tolerated without a cast or boot. The final step is to restore ROM via physical therapy and a home exercise program achieving a release to full activity level by 6-10 months [17].

The patient had a cUC graft placed at initial surgical repair. Despite a wound complication, the original repair demonstrated clinical healing at the time of incision and drainage 4 weeks postoperatively. This allowed a removal of the braided sutures placed at initial surgical repair; the goal of suture removal was to limit any bacterial load at the wound site. At nine weeks following the initial repair (20 days following the second superficial cUC graft application) the patient was allowed to perform active plantar-flexion and dorsiflexion. Note should be made that a repeat traumatic event the next day with a forced dorsiflexion load tore the Achilles tendon at a new distal region, the Achilles tendon insertion site. The area of greatest weakness should have still been the original repair site 9 weeks following a repair. This did not occur suggesting tissue healing at the initial tear site. As a result, a bone anchor was required to repair the new tear site actually using the previously repaired proximal tissue fragment to complete the procedure. The repeat application of a cUC graft at the time of the second repair was to assist in wound closure. There were understandable concerns for the exposed Achilles tendon tissue with a continued proximal wound issue at that time. The interesting aspect of this case is the rapid recovery following a complicated post-surgical history. The cUC graft placed at 9 weeks allowed for simultaneous healing of the revision repair and the superficial wound simplifying the patient’s recovery.

In this case study, we demonstrate the safety and effectiveness of using cUC in promoting wound healing during open repair of the Achilles tendon, minimizing inflammation and rapidly restoring ROM. This patient was able to achieve full active plantar-flexion and dorsiflexion one month after a revision repair; a function that typically would occur after 8-12 weeks. The patient was able to bear weight at a household level and achieve normal activities of daily living despite a fall.

![Figure 3](image1.png)

**Figure 3** Wound Healing after Initial Surgical Repair. Nylon sutures were in-place at 2-weeks but wound healing was concerning (A). Sutures were removed by 4 weeks. Dehiscence and delayed wound healing led to wound debridement, followed by cUC application at 6 weeks following the initial surgical repair (B). Healing was progressing 20-days following initial cUC application to the dehiscence site (C). The patient fell a day after this assessment demonstrating repeat wound dehiscence at the wound site and a new tear of the Achilles tendon distal to the original injury site.

![Figure 4](image2.png)

**Figure 4** Revision Surgery of Ruptured Achilles Tendon. Intra operative photos of the complex revision repair after re-injury demonstrating suture anchor placement in the calcaneus (A and B). Revision suture repair at the distal repair site (C) and incision closure (D). A new Neox graft was applied proximally to the same area of previous wound dehiscence (E).
daily living (ADLs) as a community ambulator within 2 ½ months of the final procedure. In most circumstances, with the complex clinical picture presented here, this level of function would be expected to occur at a later time point. Hanada et al., reported two cases of open re-ruptures of surgically repaired Achilles Tendons [6]. The re-ruptures occurred at four and 13 weeks in the post-operative period. They reported that both patients had almost full range of motion by 4 months after the secondary repair.

In the initial repair, there were concerns for a possible infection; a known complication that affects 2–4% of cases [8,9]. Infection can lead to poor wound closure and loss of functional outcomes [18]. Although there is no defined treatment strategy for infections, [19] the patient was placed on systemic antibiotics along with local mechanical and enzymatic debridement to stabilize the wound dehiscence. In addition, a cUC graft was placed to promote expeditious wound healing and this was demonstrated one day prior to a repeat traumatic event with no signs of inflammation or infection. Secondary application of a cUC graft over the wound at revision surgical repair promoted a rapid complete wound healing process in a poorly vascularized area by 4 weeks. The clinical effectiveness resembles what has been reported for using cryopreserved UC allograft as an adjunct with systemic antibiotics and/or negative pressure to heal complex diabetic foot ulcers with bone exposure and biopsy-proven osteomyelitis to avoid amputation [20-22]. In addition, this case presents a complicated revision Achilles Tendon repair with return to full active range of motion and single-leg heel raise by 2.5 months, which is comparable to primary injuries treated either surgically or non-operatively [23]. This case report demonstrates the preliminary effectiveness of adjunctive cUC to accelerate the healing of Achilles tendon repair. The original repair site withstood a severe dorsiflexion load at 9 weeks postoperatively. This same graft showed the ability to accelerate tissue healing of tendon material while healing and protecting a superficial wound directly over an exposed surgical procedure. This allowed the patient to return to normal ADLs and regular ambulation at an earlier time point than would be expected in this complex clinical scenario. Other options available to clinicians include repeated wet to dry dressing changes with or without collagen graft application, negative pressure wound VAC placement and/or plastic surgical intervention. These treatments all necessitate slower more limited physical therapy with less passive and active ROM, prolonged immobilization in a splint, cast or fracture walker boot and limitations on weight-bearing. The application of a cUC graft in this case allowed the therapist to treat this with a normal post-operative Achilles tendon protocol. The demonstrated timetable to community ambulation and single-leg heel raise ability clearly shows the positive impact of the umbilical graft in this case.

CONCLUSION

This case report illustrates how cryopreserved umbilical cord (cUC) can be safely and effectively used to augment repair and accelerate wound healing following Achilles tendon repair in the setting of wound complications and revision intervention. The demonstrated early recovery of active muscle function and community ambulation encourages further use of this tissue in this clinical setting.

REFERENCES


