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Case Report

Prevention of Post Traumatic Radioulnar Heterotopic Ossification Recurrence Using Acellular Human Dermal Matrix: A Case Report and Review of Literature

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Abstract

Post-traumatic radioulnar synostosis is a challenging condition to treat due to its rarity and high recurrence rate. It represents only 2% of all distal forearm injuries. It is complicated by significant impairment of function due to restricted wrist pronation and supination. Risk factors include open fractures, severe soft tissues injury and high energy injuries. Physical therapy can help improve the function of the wrist, but it may not always prevent the recurrence of synostosis. We describe the successful treatment of a patient with distal radioulnar heterotopic ossification using the human ADM. ADM interposition is a new technique for the treatment of distal radioulnar heterotopic ossification. After heterotopic ossification resection, ADM is inserted between the radius and ulna in a cigar-shaped construct. Patients are monitored clinically and radiographically. We treated 1 female patient with recurrence of heterotopic ossification. The range of motion in supination and pronation of the affected wrist improved significantly postoperatively, at the 12 weeks follow up. No postoperative complications occurred and there was no recurrence. The ADM provides a barrier between the radius and ulna to prevent reformation of heterotopic ossification. The use of ADM results in no morbidity at the harvest site and is theoretically more resistant to infection compared to non-biologic barriers such as silicone and Integra. This technique is a simple, safe and effective procedure to treat and prevent the recurrence of heterotopic ossification at the radioulnar joint.

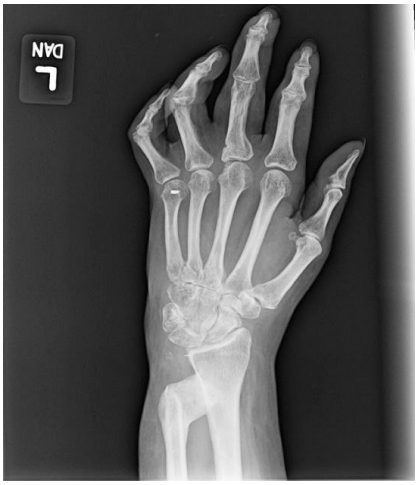
Introduction

Post-traumatic radioulnar synostosis is a challenging condition to treat due to its rarity and high recurrence rate. [1] It represents only 2% of all distal forearm injuries. It typically leads to a loss of pronation and supination movement, resulting in significant disability. Risk factors for radioulnar synostosis are a high degree of soft tissue injury, comminuted fractures, both bones at the same level, Monteggia fractures, delay of surgical intervention, traumatic brain injury, and prolonged immobilization with late rehabilitation. (2) Surgical resection with interposition graft is recommended for most types of synostoses. Resection of the heterotopic ossificationwithout interposition is another option but may lead to other complications such as recurrent synostosis, scarring at the removal site and infection.

Overall, the management of post-traumatic radioulnar synostosis requires a multidisciplinary approach that involves the expertise of Orthopedic or Hand surgeons, physical therapists, and rehabilitation specialists. (3)

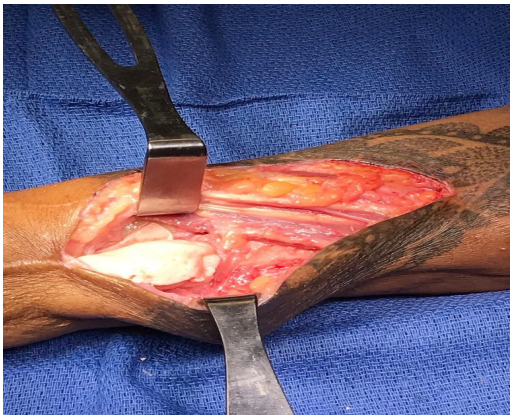
We report a 46-year-old woman who presented with traumatic amputation of the left distal ulna after being attacked with a machete. She also had multiple extensor tendon injuries at two levels, to the hand and mid-forearm. The injured tendons were extensor digitorum of all fingers, extensor carpi ulnaris, extensor carpi radialis, and extensor carpi brevis Figure 1.

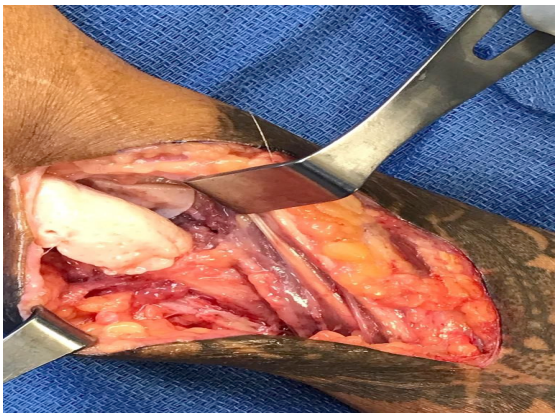
During exploration, all injured tendons underwent primary repair. The distal ulnar head was found to be completely amputated and without any soft tissue attachment in the wound, so it was excised. The patient did well postoperatively and was discharged with a splint. At the first follow-up, all wounds had healed well and range of motion had improved. She continued to wear the splint and followed with occupational therapy for the hand therapy. However, she subsequently developed severe stiffness despite being on physical therapy. She had lost extension of the fingers and wrist and had limited pronation and supination of the wrist. Her radiographs showed radioulnar synostosis after resection of the ulnar head. This explained the lack of pronation and supination of the forearm, which, along with extensor muscle adhesions and hand stiffness, resulted in significant hand function impairment (Figure 2).



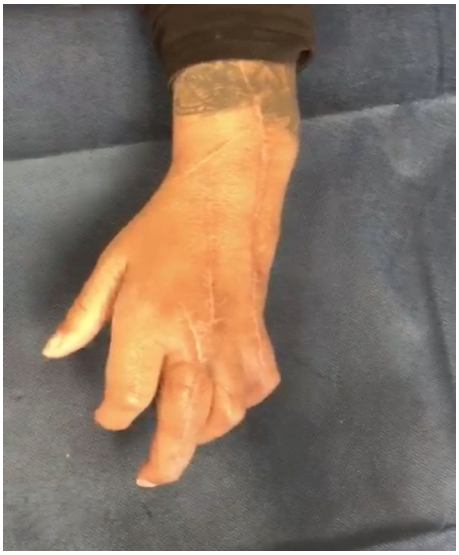
She was taken to surgery for excision of the radioulnar synostosis and interposition of the Acellular Dermal Matrix (ADM), tenolysis of the extensor muscles, and arthrolysis of the metacarpophalangeal joints. Through an incision at the dorsal wrist and a ligament-sparing approach to the dorsal wrist capsule, the synostosis was resected using an osteotome and a rongeur under intraoperative fluoroscopy. A 2x4x2cm sheet of ADM was interposed between the ulnar stump and the distal radius with the dermis facing out. It was rolled in a cigar shape by suturing one edge to the other with 3/0 Tycron suture. Then the roll was fixed distally to the radioulnar joint.

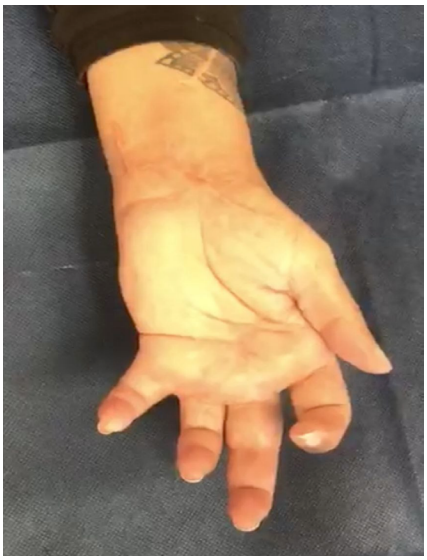
Drill holes were made in the radius and the intervening ADM was further fixed to the bone with K-wires. An additional smaller piece was used to cover the bare ulnar stump and was also fixed with drill holes and sutures. The ADM spanned the entire area of the excised synostosis. The range of pronation and supination was confirmed along with the stable position of the two ADM sheets. The Patient had almost full range of passive wrist pronation and supination of the wrist on the table (Figure 3).





The patient was placed in a splint for 3 weeks for protection. She then underwent physical therapy to improve range of motion and perform strengthening exercises. Follow-up at 12 weeks showed significant improvement in range of pronation and supination with 50' and 60', respectively. Her radiographs showed no signs of recurrence. (Figure 4).





Discussion

Radioulnar heterotopic ossification is a well-known condition. It can lead to chronic pain and significant loss of function due to limited pronation/supination of the forearm. The risk factors for the occurrence of radioulnar synostosis described by Vince and Failla [4] in their series are: Traumatic: Monteggia fracture, fracture of both forearm bones at the same level, open fracture, significant soft tissue injury, comminuted fracture, high-energy kinetic fracture, or bone fragments on the interosseous membrane. The diagnosis is made with a total pronosupination block a few months after a forearm fracture. On clinical examination, pronosupination is found to be completely absent during both passive and active mobilization. In total synostosis, the patient is pain-free, with the forearm completely blocked. In incomplete synostosis, on the other hand, the clinical aspect is limited painful pronosupination. [5] Medical treatments alone are ineffective in treating this condition but are often used in conjunction with surgical management. These include the use of NSAIDs and postoperative radiation. [6] Adjuvant therapy is not considered necessary in all cases but may be beneficial in patients with high risk

factors such as recurrence or traumatic brain injury.

The primary treatment remains surgical. Recurrence rates vary from 5% to 60%. Many methods have been proposed to prevent recurrence after surgical excision, but no single method has been shown to be consistent. Successful treatment requires effective preventive measures by establishing interposing barriers with low morbidity and high persistence. Unfortunately, there are no comparative studies demonstrating the importance of one method over the other. However, current data support the trend that providing an effective barrier can significantly reduce recurrence rates. Acellular Dermal Matrix (ADM) is developed from human skin (e.g, FlexHD, AlloMax, AlloDerm) or animal skin (e.g, SurgiMend), removing the cells and retaining the support structure. ADM is derived from the decellularization of human dermal matrix through a controlled sterilization process that removes the epidermis and cells from the dermis while leaving intact the components of the dermal matrix such as collagen fibers, elastin, proteoglycans, and the vascular scaffold. ADM is safely used for various hand reconstruction methods. ADM is known to neovascularize in the human body. [7] This property makes ADM more resistant to infection, so ADM is recommended for repair of contaminated abdominal hernias. Some ADMs have been approved by the FDA for use in certain surgical procedures, such as hernia surgery, to reinforce tissue at weak sites.

Many studies have demonstrated the efficacy of autogenous tissue interposition. Fernandez and Jones child successfully used proximally based pedicled brachioradialis flap to treat recurrent radioulnar synostosis in 5 patients who experienced no recurrence over an average of 8 years. Friedrich et al reported a series of 13 cases with interposition of fascia lata grafts (autograft in the first three cases, then allograft in the other 10 cases because of the observed risk of donor site morbidity after synostosis resection); at an average follow-up of 30 months, there were two moderate, two good, and nine excellent results. There was a single postoperative complication of scar dehiscence which required surgical revision.

Sonderegger et al [8] described the use of a pedicled adipofascial flap based on either the radial artery or the posterior interosseous artery in 6 patients, five patients with proximal radioulnar synostosis whereas, one patient had a distal radioulnar synostosis. At a follow-up after 32 months, all patients had good pronation and supination range of motion which averaged 70° in pronation and 70° in supination without evidence of radiographic recurrence. One complication was transient posterior interosseous nerve palsy. Autogenous tissue harvesting prolongs operative time and increases the risk of complications at the harvest site.

Friedrich et al. [9] reviewed 13 patients with radioulnar heterotopic ossification who had undergone treatment tensor fascia lata interposition after synostosis resection and showed good results. Two of the 13 patients had purely distal disease. There was one complication in the form of wound dehiscence, but no case of recurrence. Interestingly, 3 patients had autologous fascia lata grafts, whereas the subsequent 10 patients received a cadaveric source to prevent a large donor site. More dissection was required because the graft was wrapped around the bone, whereas in this article the graft was interposed. Numerous techniques have been described, none of which has been clearly shown to be optimal.

Jupiter and Ring [10] interposed a free fat flap after eight forearm synostosis resections, with no graft interposed in an additional 10 cases; adjuvant therapy was not prescribed. Outcomes in both groups were functionally equivalent. One case had a recurrence related to initial head trauma. Other complications included fat flap migration, ulnar fracture, and fracture of a humeral pin in the dynamic external fixator used in some cases. Sugimoto et al. [11] reviewed a case of proximal radioulnar synostosis treated by resection and interposition of a vascularized fat flap taken from the distal third of the forearm, sparing the posterior interosseous artery; they found that ROM at 1 year was 10◦ in pronation and 55◦ in supination.

Bell and Benger [12] reported a series of three patients who underwent resection of proximal synostosis with vascularized anconeus muscle interposition; there were no postoperative complications and pronosupination ROM at 12 months was 100°, 110°, and 150°, respectively. Sugimoto et al reported a case of proximal radioulnar synostosis treated by resection and interposition of a vascularized fat flap from the distal third of the forearm with sparing of the posterior interosseous artery; ROM was 10° in pronation and 55° in supination after 1 year. In summary, there is currently no consensus on the benefit of interposition after synostosis resection or on the material used (fat flap, whether vascularized or not, muscle, fascia lata, cellophane, silicone, etc.), although fascia lata autograft has shown to provide the best results [13]. In this article, ADM was preferred over the autologous graft because the patient had multiple scars from the machete injuries and also to avoid donor site morbidity. Interestingly, most radioulnar synostosis are secondary to injuries to the distal radius or both bones, but in our patient, only the ulna which was injured.

Conclusion

Radioulnar synostosis is the fusion of the radius and ulna bones in the forearm, which can occur as a result of injury or trauma to the forearm. In such cases, the bones may heal in an abnormal position, leading to the formation of a single bone instead of two separate bones. The treatment is surgical, and the procedure depends largely on the location of the synostosis as categorized by Hastings. Interposition and adjuvant treatment to prevent recurrence, on the other hand, have yet to be demonstrated,

as posttraumatic radioulnar synostosis itself is rare. The ADM forms a barrier between the radius and ulna and helps to prevent recurrence of heterotopic ossification. ADM does not result in morbidity at the harvest site and is theoretically more resistant to infection compared with nonbiologic barriers such as silicone and Integra. In conclusion, prompt and proper treatment of forearm fractures, along with proper rehabilitation and physical therapy, can help to prevent radioulnar synostosis and maintain the normal function and movement of the wrist and hand.

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