Distal Ulna Giant Cell Tumor Resection with Reconstruction using Distal Ulna Prosthesis and Brachioradialis Wrap Soft Tissue Stabilization

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Abstract This is a surgical technique report concerning the treatment of a 32-year-old male who had a giant cell tumor of distal ulna with suspected metastatic disease to the lungs. Three curettage procedures and a Darrach procedure were performed at an outlying facility. Upon the fourth reoccurrence, the patient was referred to our facility. It was established that the patient needed a distal ulna en bloc resection. To accommodate his activity requirements, reconstruction of the sigmoid notch and distal ulna was undertaken using a prosthesis. Soft tissue stabilization of the prosthesis was a challenge due to his previous procedures. This was accomplished using a brachioradialis tendon wrap.

Keywords Brachioradialis · Distal ulna prosthesis · Giant cell tumor · Ulna · Sigmoid notch · Stability system

Introduction

In the treatment of giant cell tumors of the distal ulna, many surgeons try to retain the ulna and perform only curettage and packing with polymethylmethacrylate [2, 5, 11]. Unfortunately, there is a high recurrence rate of up to 40% when treated in such a manner [5]. With this disease, a surgeon must also be cognizant of the potential for

metastasis. The risk of metastasis is thought to increase six-fold with a recurrence [7]. The overall risk for metastasis ranges from 1% to 9% [6, 7, 14] with the largest series showing a rate of 2.6% [7]. The mortality of lung metastasis from giant cell tumor ranges from 14% to 23% in studies with follow-up longer than 8 years [2, 14]. These thoughts have prompted surgeons to be more aggressive in treating distal ulna giant cell tumors with en bloc resection [12, 16]. The functional reconstruction of the defect after resection has been a challenge [11, 12, 16].

Resection of the distal ulna has been shown to lead to forearm instability with dynamic radioulnar convergence. This may lead to pain, weakness, and loss of grip strength as the ulnar stump may impinge upon the distal radius [1, 3, 12]. Not only does the distal ulna prevent convergence but reports indicate that the ulna also carries about 20% of the load of the hand [10, 12]. Loss of the distal ulna and surrounding structures has also been shown to cause radiocarpal instability and even rupture of digital extensor tendons [8, 9]. Darrach-type resections and allograft reconstructions have been employed with varying results [3, 16]. With the emergence of the distal ulna prosthesis, another option for distal ulna reconstruction became available [12, 15]. Gordon et al. showed the ability of ulnar head arthroplasty to at least provide the mechanical stability necessary to prevent convergence [4].

Soft tissue stabilization of the distal ulna prosthesis has been emphasized for the success of the implant [4]. This has usually been accomplished by repairing the triangular fibrocartilage along with an ulnar-based capsuloretinacular flap. The brachioradialis wrap (Gupta, Brachioradialis Wrap presented at the American Hand Society 2007) revealed a novel option for prosthesis stabilization. Excessive scar tissue and violation of the native capsule and triangular fibrocartilage during previous procedures make

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Figure 1 Preoperative radiographs.

the brachioradialis wrap an ideal soft tissue stabilizer in a wrist in which multiple resections have been attempted.

Case Report

A 32-year-old male presented initially with pain in his non-dominant left wrist. Radiographs revealed a tumor in his distal ulna. The patient underwent a curettage procedure and packing with bone substitute. Pathology reports revealed findings consistent with a giant cell tumor. Upon recurrence, a Darrach resection was performed. The patient

Figure 2 Intraoperative fluoroscopy.

Figure 3 a–c Intraoperative photographs.

required two more resections and after a fourth recurrence was referred to our facility. At the age of 32, 6 years and four surgeries after the tumor was discovered, the patient still had a large tumor of his distal ulna with the desire to stay active and play golf (Fig. 1). Full oncologic evaluation identified a lung mass. Follow-up imaging has shown this lesion to be stable. After collaboration of the hand surgeon and the orthopedic oncologist, it was determined that the patient required an en bloc resection of his distal ulna to best treat his aggressive tumor. To reconstruct the defect to accommodate the patient's activity demands, the patient was scheduled to undergo reconstruction with a custom-made distal ulna prosthesis (Small Bone Innovations, NY, USA), STABILITY sigmoid notch replacement system (Small Bone Innovations), and soft tissue stabilization with a brachioradialis wrap.

Procedure

The patient was administered sedating medications and peripheral block along with preoperative antibiotics. The orthopedic oncologist conducted the resection. The prior incision over the ulna laterally was used and sharp dissection was carried down between the flexor and extensor carpi ulnaris. Careful dissection was continued leaving at least a 1-cm cuff of soft tissue around the bone. Fluoroscopy was then used to determine the proximal extent of the tumor radiographically. A bony cut was made

with a micro-sagittal saw 1 cm proximal to this margin and a marrow specimen was sent for frozen sections (Fig. 2). Intraoperatively, a pathologist reviewed the slides and saw no evidence of tumor. So, the resection continued with sharp dissection of the interosseous membrane. A 1-cm margin was taken around any grossly malignant tissue or the ulna. A portion of the flexor and extensor carpi ulnaris muscle bellies had to be sacrificed to maintain the desired margin. Again specimens from all six sides of the resection were sent for frozen sections and found to be clear of malignancy. After the specimen was removed en bloc, attention was paid to obtaining excellent hemostasis (Fig. 3a, b). The wound was irrigated and then the hand surgeon began with the reconstructive portion of the case.

The incision was extended proximally and distally. The dorsal sensory branch of the ulnar nerve was found and retracted. The distal ulnar medullary canal was reamed and broached to accept a size #3 uHead implant (Small Bone Innovations). Attention was then paid to harvesting the brachioradialis tendon. A 4-cm longitudinal incision was made over the first dorsal compartment, carefully retracting the dorsal sensory branch of the radial nerve. By retracting the tendons of the first compartments, the brachioradialis tendon was found. A more proximal 4-cm incision was made over the musculotendinous junction of the brachioradialis and the muscle was gently teased off of the tendon. The tendon was then sharply incised and using a tendon passer was pulled into the radial wrist incision. The tendon was then

Figure 4 a, b Postoperative radiographs.

passed between the pronator quadratus and the radius and secured with a clamp.

The ulnar side was then prepared. A trial size #3 stem was impacted in and tried with a #2 size trial head. These components were found to be satisfactory. So, the custom-made uHead distal ulna implant and sigmoid notch implant (Small Bone Innovations) were placed. The polyethylene was placed and the uHead (Small Bone Innovations) snapped onto the stem of the ulnar implant yielding a reconstruction of not only the distal ulna but also the distal radial ulnar joint. Two bioabsorbable suture anchors were placed on the dorsal aspect of radius and the brachioradialis tendon was pulled tight and sutured to these anchors. The rest of the brachioradialis was passed under the extensor tendons and sutured tightly to the insertion of the

brachioradialis at the radial styloid using #2 Ethibond sutures (Fig. 3c). The implant was tested for stability and range of motion. The wound was then again irrigated and the remnants of the capsule were approximated with #2 Ethibond sutures. The skin was closed with vicryl and nylon. Postoperative radiographs are shown in Fig. 4a and b.

Postoperative Care

Postoperatively, the patient was placed into a sugar tong splint, which was removed on postoperative day number 9. The patient was noted to have some numbness in the distribution of the radial sensory nerve at his first appointment. He was placed back into a sugar tong splint at this time. He was seen 4 weeks postoperatively and had return of

Figure 5 a–d Photographs of patient range of motion.

sensation on the dorsum of his hand. The sugar tong splint was removed and changed to a wristlet and the patient was started on gentle range of motion exercises of the wrist. The wristlet was discontinued 2 months postoperatively. He had full supination, pronation, flexion, and extension (Fig. 5a–d). Through short-term follow-up, the patient is doing remarkably well and is quite pleased with his result. Nine months postoperatively, the patient has resumed all desired activities including golf without complaint. However, longer-term follow-up is certainly needed to best assess his overall outcome.

Discussion

It is difficult to characterize distal ulna giant cell tumors with certainty because they are not common. It seems that they act as or more aggressive than those tumors of the distal radius [5]. Surgeons must keep in mind that, although touted as a benign tumor, giant cell tumors have the capability of killing. Even when lung metastases were resected, 17% of patients died due to tumor-related complications [13]. High rates of local recurrence and the high morbidity associated with metastasis has led surgeons to search for more treatment options. Aggressive resections have been limited in the past due to a void of reconstructive options that provided a stable, pain-free, functional outcome.

To our knowledge, the brachioradialis wrap along with a prosthesis has never been used in an oncology case. Roidis et al. described a giant cell tumor resection with distal ulnar arthroplasty with promising 2-year follow-up. Stabilization was achieved using the triangular fibrocartilage and the extensor carpi ulnaris subsheath. These were sutured to the stem of the prosthesis [12]. In a wrist in which the soft tissues have been violated by multiple procedures, a capsular and triangular reconstruction may not be possible. The brachioradialis wrap provides a reliable soft tissue stabilization option in such a situation.

In this case, the utilization of the soft tissue reconstruction, the brachioradialis wrap combined with the STABILITY system (Small Bone Innovations) provided the freedom to perform the required resection to excise a

recurrent giant cell tumor, yet provided the patient with a functional, pain-free wrist.

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