**Giant Cell Tumors at the distal radius: *en-bloc* excision and arthrodesis of the translocated ipsilateral ulna**

**Abstract**

Distal radius is the third most common site of giant cell tumor of bone (GCTB). The local aggressive invasion of this rare neoplasm requires reconstructive solutions after wide excision.

 Authors present two cases of patients diagnosed with Campanacci grade III GCTB of the distal radius successfully treated with *en-bloc* excision and translocation of the ipsilateral ulna. Pre-operative application of denosumab was given for one year to both patients. At one-year follow-up, both patients are disease free and reported satisfactory results on Quick - Disabilities of the Arm, Shoulder and Hand (Quick-DASH) questionnaire and modified Musculoskeletal Tumor Society (MSTS) score. Although a challenge, this treatment for GCTB of the distal radius shows a successful oncological and functional outcome.

**Keywords**

Giant cell tumor of bone, distal radius, *en-bloc* excision, translocation, ipsilateral ulna, wrist arthrodesis

**Introduction**

 Giant cell tumor of bone (GCTB) is a benign but locally aggressive intramedullary bone tumor that was first described in 1818 by Cooper and Travers.1-3 Distal radius is the third most common site of GCTB after distal femur and proximal tibia.1,4-7 Local recurrences occur in 70% of the cases within 24 months after excision and lung metastasis in 2% of the patients.7-10

 Typically, local pain with an increased swelling is reported and a pathological fracture occurs in 10% of the patients because of its osteolytic nature.3,11

 The radiological system of 3 stages described by Campanacci et al. demonstrates a clinical-radiological correlation. In stage I, latent lesions have a well-marginated border and do not perforate the cortical bone. Stage II lesions are active, without a radiopaque rim or soft tissue involvement. Stage III tumors are aggressive, without well-defined limits, with rapid and permeated growth, with involvement of the surrounding soft tissue. For both stage I and stage II lesions, intralesional curettage and acrylic bone cement (or other substitutes) are the most reported treatment.3-8,10,12-14 Nevertheless, more aggressive treatment protocols are required to prevent recurrence of lesions at stage III. Although adjuvant agents decrease the recurrence rates of intralesional curettage, this primary option have higher recurrence rates (up to 27%) than wide resection (0 to 12%).6,8,15,16

 Denosumab, a human monoclonal antibody against RANKL (receptor activator of nuclear factor-kB ligand), contains tumor growth and makes surgery viable or facilitates resection without contamination when used as neoadjuvant therapy in large and aggressive lesions of complex locations.1,10

After resection of aggressive lesions of distal radius, surgeons must consider the pros and cons of the different reconstructive options already described. Despite the consensus in radical tumor excision the best wrist reconstructive option is not well defined.

 Authors describe two cases of patients diagnosed with Campanacci grade III GCTB of the distal radius treated with *en-bloc* resection and reconstruction with ulnar autograft and wrist fusion with good functional results.

**Case reports**

**CASE 1**

 A 35-year-old right hand-dominant male presented with a painful and enlarging mass on his left wrist, with six months evolution. The patient referred that, two months before mass detection, a pathological fracture was diagnosed after a minor trauma (Figure 1). On physical examination the distal forearm was tender and hypoesthesia in the ulnar nerve territory was present. Pre-operative anteroposterior and lateral radiographs, computed tomography (CT scan) and magnetic resonance imaging (MRI) revealed an expansible lesion located within the epiphysis of the distal radius, compatible with a Campanacci grade III GCTB (Figure 2). He underwent a CT scan guided core biopsy, and the histological report confirmed GCTB. The staging imaging verified no other lesions. The patient completed one year of neoadjuvant therapy with denosumab (120mg SC per 28 days, during 12 months) (Figure 2). The patient underwent an 8 centimeters dorsal *en-bloc* resection of the distal radius and an ulnar osteotomy at the same level of the radius osteotomy, retaining muscular attachments. The lunate was removed and the joint surface of the ulna as well as the remaining carpal bones were decorticated. Distal ulna was transposed and aligned with the remaining radius and the third metacarpal bone. An uneventful fixation was performed with a dorsal 3.5 mm locking compression plate (LCP) with a slight dorsiflexion and ulnar deviation (Figure 3). The histology report confirmed wide resection (R0).

The patient was immobilized with an above-elbow cast for three weeks and a below-elbow splint for two more weeks. The patient underwent an intensive program of physiotherapy during eight months. One year after surgery, there was no clinical or imaging signs of local recurrence and radiographs showed bone fusion at both ends of the ulna (Figure 4). The patient presented full flexion/extension of the fingers and full supination/pronation (SN/PN) (Figure 5). The modified Musculoskeletal Tumor Society score (MSTS) was 21 (compared to the pre-operative value of 9) and the Quick - Disabilities of the Arm, Shoulder and Hand questionnaire (Quick-DASH) was 22,7 (compared to the pre-operative value of 88,6). The mean hand grip value, evaluated with a Jamar dynamometer, for the operated side was 51,8 libras (lbs) compared to 93,9 lbs for the contralateral side. The patient is pain free.

**CASE 2**

 A 25-year-old right hand-dominant female presented with right wrist pain over an enlarging mass for one year. The patient reported a gradual increase in size over the last two months. On physical examination, the dorsal distal radius was tender and wrist motion was painful. The X-ray and CT scan revealed an expanded osteolytic lesion. MRI detected a huge osteolytic lesion and soft tissue extension with 4 x 3,3 x 2,3 cm, compatible with a Campanacci grade III GCTB (Figure 6). Staging imaging revealed no other lesions. The histology report of the imaging-guided core biopsy showed a GCTB. After one year of with denosumab therapy (120mg SC per 28 days, during 12 months) (Figure 6) the patient underwent the same surgery as Case 1. A 6 cm dorsal *en-bloc* resection of the distal radius and wrist arthrodesis with a 3.5 mm LCP plate were performed (Figure 7). There were no major complications related to the procedure. Histological report confirmed complete resection with free margins. An above-elbow cast was applied for three weeks, after which a below-elbow was used for two more weeks. After two months she had a full SN/PN. After six months the patient was able to perform the daily activities without restrictions (Figure 8). At six months the MSTS score was 24 (compared to the pre-operative value of 19), the mean handgrip strength value for the operated side was 33,1 lbs compared to 49,8 lbs for the non-operated side, and scored 27,3 in Quick-DASH questionnaire (the same value as in the pre-operative assessment). At one year of follow-up the patient has no clinical or imaging signs of local recurrence (Figure 9). The patient is pain free.

**Discussion**

 GCTB of the distal radius is the third most common site of this relative rare neoplasm, corresponding to 10%.2,4-7,17,18 Despite its benign label, distal radius is the most common primary site responsible for metastases and high focus on ruling out pulmonary metastasis is mandatory in the pre-operative assessment.9,10,12,19

 In well-marginated cortical borders, curettage with bone grafting/cement packing is acceptable despite the recurrence rates up to 50%.4,5,7,17,19 Campanacci grade, pathological fractures, tumor site and adjuvant therapy are recognized predictors of local recurrence.1,19 Studies have correlated the incidence of metastases with aggressive growth and local recurrence.20,21

 The treatment of the rare Campanacci III lesions is a much more arduous task. To avoid recurrence a wide resection should be performed, and surgeons should consider reconstructive options that preserve wrist function. The *en-bloc* resection is widely acceptable in expansive lesions, recurrent tumors and when the articular surface is largely damaged or collapsed.17,18,22 Due to the proximity with other bones (ulna and carpal bones) and other soft tissue structures, intralesional excisions, even when adjuvant therapies are used, have poor local control when compared to *en-bloc* resection.1,2 Reconstruction of the wrist by ulnar translocation after total resection was first described in 1982 by Seradge5,6,19,22 and several techniques to fixate the transposed ulna were described: Steinmann pins, T-shape plates, dynamic compression plates, clover leaf plates and K-wires.19 The ipsilateral ulnar translocation technique is a surgical procedure that avoids donor site morbidity and allows an adequate muscular cover with improved vascularity.5,7,9,17 Furthermore, the option of a single bone in the forearm avoids the complication of ulnar variants when other reconstruction techniques – fibular, iliac crest, allografts – are considered.6 Comparing all the fixation methods of the translocated ulna, Chobpenthai et al.19 concluded that distal radius plate technique is the less traumatic and achieves the best functional and cosmetic results.

 Despite the flaws pointed out to this technique (poor vascularity, proximal and distal nonunion and lack of motion), arthrodesis result in less post-operative pain and good to excellent results in grip strength.15,19 The most accepted wrist position after fusion is 10º dorsiflexion and 5-10º ulnar deviation.9

 Another possibility for reconstruction could be a custom-made mega prosthesis to preserve some motion in the sagittal e coronal planes. However, the literature is scarce and these patients were too young and with some functional demand, so the arthroplasty would be quickly condemned to fail.23

 Not less important, a great ally on dissection and resection is denosumab used as neoajuvant therapy. The massive cortical destruction and friable nature of GCTB benefit from this chemotherapeutic agent in reducing pain and suppressing the tumor.1,10

 In conclusion, treatment of Campanacci grade III GCTB of the distal radius remains a challenge, however neoadjuvant denosumab therapy and tumor *en-bloc* resection have good prognosis. The reported cases show a good functional and oncological outcome and patients are satisfied.