



OPERATIVE TECHNIQUE FOR RECONSTRUCTION OF DISTAL ULNA AFTER GIANT CELL TUMOUR RESECTION

Katarina Barbarić Starčević¹ and Ivan Bohaček²

¹Department of Orthopaedic Surgery, University Hospital Centre Zagreb, Zagreb, Croatia

²School of Medicine and Department of Orthopaedic Surgery, University Hospital Centre Zagreb, Zagreb, Croatia

SUMMARY – Giant cell tumour (GCT) is a rare, benign tumour, but it has a locally aggressive nature and a high rate of recurrence. A wide en-bloc resection of the distal part of the ulna, with or without stabilisation of the ulnar stump, is the recommended treatment option. Functional results after that kind of surgery are mostly satisfying but, in some cases, it can result in wrist instability, causing pain and weakness of grip strength. That is why when it comes to young people, with high functional demands, we prefer reconstruction of distal ulna and distal radioulnar joint after an en-bloc resection of the distal ulna. The distal ulna is reconstructed with an autologous free fibular graft and the distal radioulnar joint is stabilised with an autologous palmaris longus tendon graft. We present our operative technique and good functional results of three young patients treated with this procedure. Our results confirm the hypothesis that the reconstruction of the distal ulna and the distal radioulnar joint leads to a satisfactory functional result in young and active patients with higher functional demands.

Keywords: *giant cell tumour, ulna, resection, reconstruction, operative technique*

Introduction

Giant cell tumour (GCT) is a rare, benign tumour, but it has a locally aggressive nature¹⁻⁴. It accounts for 3 to 5% of all primary bone tumours, and affects adult people at the age of 20 to 40 years^{2,4}. The distal ulna represents an extremely rare localization of this tumour, occurring in only 0.45-4,5 % of all GCT cases^{1,3}. There are different treatment options for GCT of the distal ulna described in literature: curettage with or without bone grafting, cryotherapy of the cavity or application of phenol, radiation, insertion of bone cement in the cavity

after curettage, en-bloc resection with or without reconstruction of the distal ulna with bone graft or reconstruction of the distal ulna with endoprosthesis³. Today, en-bloc resection of the distal ulna performed with or without additional stabilisation of the ulnar stump is the recommended treatment option^{1,5-7}. Functional results after that kind of surgery are mostly satisfying^{3,7,8}. However, in some cases with excessive resection of the distal ulna, the radiocarpal joint loses its ulnar support which can result in DRUJ instability, causing pain and weakness of grip strength^{1,3}.

This is the reason why in young people with high functional demands we prefer a reconstruction of the distal ulna and a stabilisation of the distal radioulnar joint after an en-bloc resection of the distal ulna. The distal ulna is reconstructed with an autologous free fibular graft and the distal radioulnar joint (DRUJ) is stabilised with an autologous palmaris longus tendon

Correspondence to: *Barbaric Starcevic Katarina*
Department of Orthopaedic Surgery, University Hospital Centre Zagreb
Kispaticeva 12, 10000 Zagreb, Croatia
e-mail: katarina.barbaric@hotmail.com
phone: +38512368911

graft. We present our operative technique and functional results of three young patients treated with this procedure.

Methods

Since 2014, three young male patients aged 21, 23, and 40 years have been surgically treated in our department because of GCT of the distal ulna. They were all physically active, with jobs that required hand strength or were active in sports. In two of the cases the dominant arm was operated on whereas in the third case, it was the non-dominant arm. In all three cases, diagnostic work-up included wrist, forearm, and elbow radiograms and magnetic resonance imaging followed by an open tumour biopsy. Pathohistological findings confirmed the diagnosis.

In all three cases, we decided to perform a wide en-bloc resection of the distal ulna. Because of the size of the tumour and the high functional demands of our patients, we decided on a reconstruction of the distal ulna and the distal radioulnar joint to achieve as much stability as possible. In one case, we decided on two-stage surgery because of the unclear margins of the tumour. In the first stage, the en-bloc resection of GCT was done, and with bone cement, it was moulded to resemble a normal ulna so the space for the second stage of reconstruction was maintained. The second stage surgery was done 6 weeks after the first one. In two other cases, everything was done in one procedure.

Surgery was performed with general anaesthesia. First, a wide en-bloc resection of the distal ulna through a standard approach between tendons of the extensor and flexor carpi ulnaris was done. The length



Figure 1. Resected distal ulna.

of the resection was planned according to the magnetic resonance images. The resection was performed cranially, two centimetres from the edge of the tumour, and the ulna was removed distally without resection, via exarticulation in the distal radioulnar joint (Figure 1.).

After the resection of the tumour, the autologous bone graft was harvested. A non-vascularised fibular shaft graft from the patient's contralateral lower leg, in the length equal to the resected distal ulna, was prepared in a standard manner from the middle third of the fibula. Further on, the palmaris longus tendon graft was harvested through two separate incisions, one at the level of the wrist and the other one 12 cm proximally on the forearm volar surface. Such a tendon graft was later used for the reconstruction of the distal radioulnar joint.

The fibular graft was matched and oriented to best fit the ulnar stump and the place for the 3.5 mm dynamic compression plate was determined. As fibular bone is very firm, because it is mainly composed of cortical bone in the middle third, we performed the drilling and plating of the fibular graft on a back table (Figure 2.). Then the bone graft with the plate was placed on the distal part of the ulnar stump and the osteosynthesis was finished. The DRUJ was reconstructed with the palmaris longus tendon with a modified Adams procedure¹². With a cannulated drill bit size



Figure 2. Plating of the fibular graft on the back table.

4,0 mm bone tunnels were made in the distal radius and the distal part of the fibular bone graft. A tunnel in the distal radius was made from volar to dorsal, located 5 mm proximally to the radiocarpal joint and 5 mm radially to the sigmoid notch. A tunnel in the bone graft was made from its central distal end to the lateral side of the graft, one centimetre distally from the end. Then, the palmaris longus tendon was passed through the hole in the radius, and both ends of the tendon were passed through the hole in the fibular graft and



Figure 3. Reconstruction of the distal ulna with free fibular graft and stabilisation of distal radioulnar joint with palmaris longus tendon.

around it and finally sutured to itself (Figure 3.). After wound closure, the wrist and forearm were immobilised for 6 weeks in a Sarmiento forearm cast. It was made in supination of the forearm and allowed flexion and extension in the elbow joint but blocked rotations of the forearm.

Results

This operative technique provided a good functional outcome in all three cases. All our operated patients are feeling well, declare no major difficulties and show a satisfactory range of motion on the control follow-up examinations (Table 1.). The grip strength of the operated arm is similar to the contralateral side in all cases. “The disabilities of the arm, shoulder, and hand score“ (DASH)⁹ show improvement during the follow-up (Table 1.) They have returned to work and have no major disturbances in performing daily activities. Control X-rays show adequate integration of the fibular graft at the site of osteosynthesis, with no signs of tumour recurrence (Figure 4.). The DRUJ is stable and pain-free in all cases.

Discussion

The main finding of this report is that the distal ulna affected with a GCT can be successfully resected

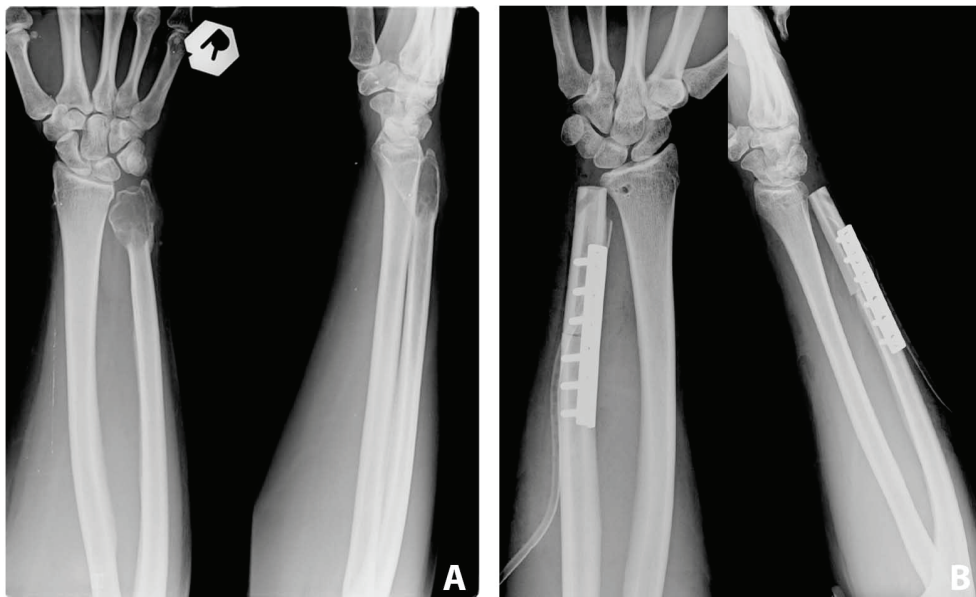


Figure 4. Preoperative (A) and postoperative (B) radiograms of the wrist and the forearm.

Table 1. Patient data, postoperative range of motion, grip strength, and functional score results following the resection of the distal ulna and reconstruction with a fibular autograft coupled with distal radioulnar joint stabilisation using an autologous palmaris longus tendon graft.

| PATIENT | 1 | 2 | 3 |
|--------------------------------------|----------------|----------------|--------------------|
| AGE (years) | 21 | 23 | 40 |
| PATHOHISTOLOGICAL FINDINGS | GCT grade 1-2 | GCT grade 2 | GCT grade 1 |
| OPERATED ARM | Dominant/right | Dominant/right | Non-dominant/right |
| FOLLOW UP (months) | 17 | 18 | 98 |
| POSTOPERATIVE ROM (°) | | | |
| DORSAL FLEXION | 90 | 75 | 48 |
| PALMAR FLEXION | 60 | 75 | 48 |
| RADIAL DEVIATION | 25 | 30 | 24 |
| ULNAR DEVIATION | 45 | 45 | 36 |
| PRONATION | 90 | 90 | 64 |
| SUPINATION | 90 | 90 | 54 |
| POSTOPERATIVE STRENGTH (psi) | | | |
| OPERATED ARM | 11 | 16 | 11 |
| NON OPERATED ARM | 14 | 18 | 15 |
| Percent of non-operated arm strength | 78,5% | 88,8% | 73,3% |
| DASH score preop | 54,2 | 81,7 | 64 |
| DASH score postop | 10,5 | 0 | 33 |

and reconstructed with a free-fibular autograft, coupled with a DRUJ reconstruction using an autologous palmaris longus tendon graft. Such reconstruction provides optimal functional results, fast recovery, and a return to everyday activities.

GCT represents a locally aggressive tumour with a high recurrence rate. Although the distal ulna is considered a rare localization of this bone tumour, there are different treatment options described in the literature³. So far, the most commonly used procedure was curettage of the tumour lesion and filling the defect with cancellous bone or bone cement and retaining the distal ulna^{5,10}. Unfortunately, a high recurrence rate was described after this procedure, up to 40%¹¹.

Today, the recommended treatment option for the GCT of the distal ulna is a wide “en-bloc” resection with or without an ulnar stamp reconstruction and/or stabilisation^{1,5-7}. Namely, some authors have reported good functional outcomes after only a wide resection

of the distal ulna without any kind of reconstructive procedure^{5,12,13}. Darrach reported that the distal ulna can be excised without any functional limitations and this procedure was successfully used in the treatment of degenerative conditions². But the failure rate of that procedure has been documented to be 10–50%^{14,15}. Excessive resection of the ulna, where the osteotomy was localised cranially from the distal oblique band of the interosseous membrane, can lead to ulnar stump instability with consequent dorsal migration, causing impingement with the radius, pain, and sometimes even a rupture of the extensor tendon. This unwanted biomechanical cascade represents the main reason why numerous authors suggest stabilisation of the ulnar stump using the tendon graft^{4,7,8,15,18}. One half of the extensor carpi ulnaris tendon (ECU) is the most commonly used graft for such a procedure, while some authors combine both flexor and extensor carpi ulnaris tendon grafts in order to obtain more stability^{4,7}.

Another problem related to wide resection of the distal ulna is wrist instability, with pain, weakness, and loss of grip strength. That is caused by the loss of ulnar support of the carpus, causing an abnormal force distribution.^{16,17} That is especially important in young people with high functional demands. In this population of patients, a reconstruction of the distal ulna and the DRUJ represents a preferred option. For that purpose, some authors use distal radioulnar prosthesis with satisfactory functional results^{1,10,18}. Others prefer biologic reconstruction using a bone graft and some kind of DRUJ stabilization. Some authors perform so-called “ulnar buttress arthroplasty” by fixing the autologous iliac crest bone to the ulnar side of the radius in order to provide support for the carpus and additionally stabilize the ulnar stump with the ECU tendon^{14,19}.

Considering all of the aforementioned reasons, in young active patients with high functional demands we always perform a reconstruction of the distal ulna with free fibular shaft graft and stabilization of the DRUJ. Our technique was initially reported in 2014., when our first patient was surgically treated in this way, and we published good functional results in the case report three years after the surgery²⁰. Here, we are reporting altogether three cases treated with this method, all of them showing satisfactory functional results, good ROM, and grip strength.

Mariappan et al² have published a similar technique except they used the proximal part of the fibula as a free graft and for stabilization of the DRUJ, and they used a palmaris longus graft with the sling of the extensor carpi ulnaris. Although the proximal part of the fibular graft could potentially suit better since it has cartilage cover on its surface, we believe that anatomically it cannot replace the ulnar head and the donor site may be significantly disturbed since important lateral knee structures are inserted into the fibular head.

The distal ulna and the DRUJ play an important role in the function of the wrist and the forearm. They are important for load transfer in relationship with the carpal bones and the distal end of the radius, and allow pronation and supination of the forearm. In young, active patients with high physical demands, salvage surgery like en-bloc resection of distal ulna should not be an option. In these patients, a reconstruction of the distal ulna and a stabilization of the distal radioulnar joint is necessary for satisfactory functional results.

Disclosure of conflict of interest

All authors declare no conflict of interest.

References

1. Gracia I, Proubasta IR, Trullols L, Peiró A, Moya E, Cortés S et al. Distal radioulnar joint prosthesis for the treatment of giant cell tumor of the distal ulna: a case report and literature review. *Strategies Trauma Limb Reconstr.* 2011;6(2):103-6. doi: 10.1007/s11751-011-0113-4.
2. Mariappan E, Mohanan P, Moses J. A newer technique of distal ulna reconstruction using proximal fibula and TFCC reconstruction using palmaris longus tendon following wide resection of giant cell tumour of distal ulna. *Case Rep Orthop.* 2013; 2013:953149. doi: 10.1155/2013/953149.
3. Blackley HR, Wunder JS, Davis AM, White LM, Kandel R, Bell RS. Treatment of giant-cell tumors of long bones with curettage and bone-grafting. *J Bone Joint Surg Am.* 1999;81(6):811-20. doi: 10.2106/00004623-199906000-00008.
4. Solichin I, Martika W, Wikanjaya R. Giant cell tumor of distal ulna treated using en-bloc resection combined with extensor carpi ulnaris and flexor carpi ulnaris tendon stabilization: A case report. *Int J Surg Case Rep.* 2021;79:362-367. doi: 10.1016/j.ijscr.2021.01.065.
5. Cooney WP, Damron TA, Sim FH, Linscheid RL. En bloc resection of tumors of the distal end of the ulna. *J Bone Joint Surg Am.* 1997;79(3):406-12. doi: 10.2106/00004623-199703000-00014.
6. Wolfe SW, Mih AD, Hotchkiss RN, Culp RW, Keifhaber TR, Nagle DJ. Wide excision of the distal ulna: a multicenter case study. *J Hand Surg Am.* 1998;23(2):222-8. doi: 10.1016/s0363-5023(98)80117-2.
7. Sharma V, Sharma K, Sharma S, Kanwar S, Soni RK, Katoch P. Resection and stump stabilization in giant cell tumor distal ulna: A case report. *J Orthop Case Rep.* 2020;10(4):45-48. doi: 10.13107/jocr.2020.v10.i04.1796.
8. Mujaddid I, Pamudji U, Savero I, Handry T, Brian W. Wide resection giant cell tumor of distal ulna and stabilization ulnar stump with extensor carpi ulnaris tendon (2 case reports). *Int J Surg Case Rep.* 2020;74:58-62. doi: 10.1016/j.ijscr.2020.07.071.
9. Hudak PL, Amadio PC, Bombardier C. Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand). The Upper Extremity Collaborative Group (UECG). *Am J Ind Med.* 1996;29(6):602-8. doi: 10.1002/(SICI)1097-0274(199606)29:6<602::AID-AJIM4>3.0.CO;2-L.
10. Burke CS, Gupta A, Buecker P. Distal ulna giant cell tumor resection with reconstruction using distal ulna prosthesis and brachioradialis wrap soft tissue stabilization. *Hand (NY).* 2009;4(4):410-4. doi: 10.1007/s11552-009-9192-9.
11. Harness NG, Mankin HJ. Giant-cell tumor of the distal forearm. *J Hand Surg Am.* 2004;29(2):188-93. doi: 10.1016/j.jhsa.2003.11.003.
12. Harish, R. Giant cell tumor of the distal end of ulna: a case report with review of literature. *Eur Orthop Traumatol* 2011; 1:253–255. doi:10.1007/s12570-011-0046-x.

13. Archuk S, Tripathi SK, Nanda SN, Choudhari A. Giant cell tumour of distal ulna. *J Can Res Ther.* 2017;13:586-8. doi:10.4103/0973-1482.174190
14. Hashizume H, Kawai A, Nishida K, Sasaki K, Inoue H. Ulnar buttress arthroplasty for reconstruction after resection of the distal ulna for giant cell tumour. *J Hand Surg Br.* 1996;21(2):213-5. doi: 10.1016/s0266-7681(96)80101-x.
15. Kayias EH, Drosos GI, Anagnostopoulou GA. Resection of the distal ulna for tumours and stabilisation of the stump. A case report and literature review. *Acta Orthop Belg.* 2006;72(4):484-91. PMID: 17009832.
16. Minami A, Iwasaki N, Nishida K, Motomiya M, Yamada K, Momma D. Giant-cell tumor of the distal ulna treated by wide resection and ulnar support reconstruction: a case report. *Case Rep Med.* 2010;2010:871278. doi: 10.1155/2010/871278.
17. Singh M, Sharma S, Peshin C, Wani IH, Tikoo A, Gupta SK et al. Wide resection and stabilization of ulnar stump by extensor carpi ulnaris for giant cell tumor of distal ulna: two case reports. *Cases J.* 2009;21;2:8617. doi: 10.4076/1757-1626-2-8617.
18. Jones NF, Graham DJ. Radical resection of a recurrent giant cell tumor of the distal ulna and immediate reconstruction with a distal radio-ulnar joint implant arthroplasty. *Hand (NY).* 2020;15(5):727-731. doi: 10.1177/1558944719895779.
19. Naik MA, Sujir P, Rao SK, Tripathy SK. Ulnar buttress arthroplasty after enbloc resection of a giant cell tumor of the distal ulna. *Indian J Orthop.* 2013;47(2):211-4. doi: 10.4103/0019-5413.108933.
20. Barbarić Starčević K, Starčević D. Reconstruction of distal radioulnar joint after resection of giant cell tumor of distal ulna. *J Orthop Skeletal Med* 2017;2(1):102.

Sažetak

REKONSTRUKCIJA DISTALNE ULNE NAKON RESEKCIJE GIGANTOCELULARNOG TUMORA

K. Barbarić Starčević i I. Boháček

Gigantocelularni tumour distalnog dijela ulne je izrazito rijedak, lokalno agresivan tumour sa velikom vjerojatnošću recidiva. Danas preporučena i najčešće korištena metoda liječenja ovih bolesnika je široka resekcija ulne sa ili bez stabilizacije proksimalnog dijela ulne tetivom. Funkcionalni rezultati ovakvog načina liječenja su uglavnom zadovoljavajući, ali se neki slučajevi kompliciraju razvojem nestabilnosti ručnog zgloba i značajnim smanjenjem snage šake. Zato u mladih osoba sa visokim funkcionalnim zahtjevima preferiramo nakon resekcije tumora učiniti rekonstrukciju distalne ulne i distalnog radioulnarnog zgloba. Distalnu ulnu rekonstruiramo pomoću slobodnog koštanog presatka dijafize bolesnikove fibule, a distalni radioulnarni zglob stabiliziramo koristeći presadak bolesnikove tetive mišića palmaris longusa. Ovim radom prikazujemo našu operativnu tehniku i dobre funkcionalne rezultate troje mladih bolesnika operiranih na ovaj način. Naši rezultati potvrđuju pretpostavku kako rekonstrukcija distalne ulne i distalnog radioulnarnog zgloba dovode do zadovoljavajućeg funkcionalnog rezultata u mladih i aktivnih bolesnika sa većim funkcionalnim zahtjevima.

Ključne riječi: gigantocelularni tumor, ulna, resekcija, rekonstrukcija, operativna tehnika