THE PROXIMAL FIBULAR FREE FLAP - AN IDEAL MATERIAL FOR RECONSTRUCTING DISTAL RADIUS DEFECT AFTER GIANT TUMOR CELL RESECTION. A CASE REPORT

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Giant cell tumors (GCT) of the distal end of radius are relatively common tumors, representing approximately 5% of all primary bone tumors. It is the third most common location for GCT following distal femur and proximal tibia. In general, treatment includes thorough tumor excision, reconstruction of the defect, and wrist joint rehabilitation. The proximal fibular free flap is an ideal material for distal radius reconstruction after giant cell tumor excision. We present a case of a 57-year-old female, admitted to the hospital due to painful and limited proper wrist movement. Based on X-ray and Magnetic resonance imaging (MRI) images and histopathology findings, the patient was diagnosed with a stage 3 giant cell tumor of the distal radius. The patient underwent a one-step surgery of tumor excision and distal radius reconstruction by a vascularized proximal fibular free flap. 2 years follow-up post-surgery showed that the patient had no pain of the wrist, improved wrist joint function, no sign of recurrence, and good flap vitality and the knee joint remains normal. In conclusion, the surgery was successful with no further prolonged pain, improvement of the wrist joint function and overall improvement of the patient quality of life.

Keywords: Giant cell tumor, proximal fibular flap, distal radius defect.

The following case report has been reported in line with the SCARE criteria.[1]

I. INTRODUCTION

Giant cell tumors were first described by Cooper in 1818, accounting for approximately 5% of all primary bone tumors.[2,3] The distal radius is the third most common site affected, after the distal femur and the proximal tibia.[4] Giant cell tumor of bone is benign but has a high recurrence rate, and risk of malignant transformation.[5] Treatment includes complete tumor excision, reconstruction of the defect, and wrist joint rehabilitation. Distal radius reconstruction and wrist joint rehabilitation after giant cell tumor excision is a challenge for plastic surgeons. However, there are many materials for distal radius reconstruction such as artificial materials, bone autograft/allograft or microsurgical flap.

Bone allografts have the advantage of the ability of selecting the graft with the appropriate size and shape, not damaging the site where the material is taken. However, the disadvantages are slow healing, nonunion, high risk of infection, uncomplicated fracture due to mechanical trauma, and rejection. The most common bone

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autograft is the proximal fibula. The graft has the advantage of not being rejected, a simple grafting technique, but the vitality of the graft decreases when a large volume was harvested.

A proximal fibular flap is an ideal material for distal radius reconstruction. The flap has many advantages, such as the ability to reconstruct significant defects, rapid bone healing, reducing the rate of nonunion, reducing the risk of infection and fractures by mechanical trauma and not being rejected. Using the proximal fibular flap helps regenerate the wrist joint. The proximal fibula has cartilaginous tissue, so that it has a structure similar to the wrist joint that helps the wrist joint move easily, reduce pain and reduce the risk of joint stiffness. Our study reported the case of using the vascularized proximal fibular flap for patients with giant cell tumors of the distal radius. After a follow-up of two years, the patient had no local recurrence, no pain, and significant improvement in wrist joint function. In addition, movement of the knee joint where the flap was harvested was normal.

II. PRESENTATION OF CASE

A 57-year-old female was admitted to the hospital as swelling and pain of the right wrist and reduced range of motion. X-ray image showed an osteolytic lesions grade III following Cappanacci classification at distal radius (Figure 1). MRI images illustrated the distal radius with an osteolytic lesion adjacent to the radiocarpal joint, ill-defined margin bubble shape. The size of the lesion was 21 x 33mm, with cortical break to the soft tissue at the lateral wrist. CT scanner of the chest did not detect metastasis images. Histopathological results with Hematoxylin-Eosin staining method showed that the tumor proliferated stromal cells with rhomboid or circular nuclei, narrow cytoplasm, numerous mitotic nuclei but no typical mitotic nucleus. The standing stromal cells are interspersed with many multinucleated giant cells with round, relatively regular nuclei, wide and active cytoplasm, scattered areas with bone-like substances. The patient was diagnosed with giant tumor cell grade III at distal radius based on clinical and paraclinical symptoms; subsequently, she experienced an en-bloc resection along with distal reconstruction radius by a vascularized proximal fibular flap in one step surgery.

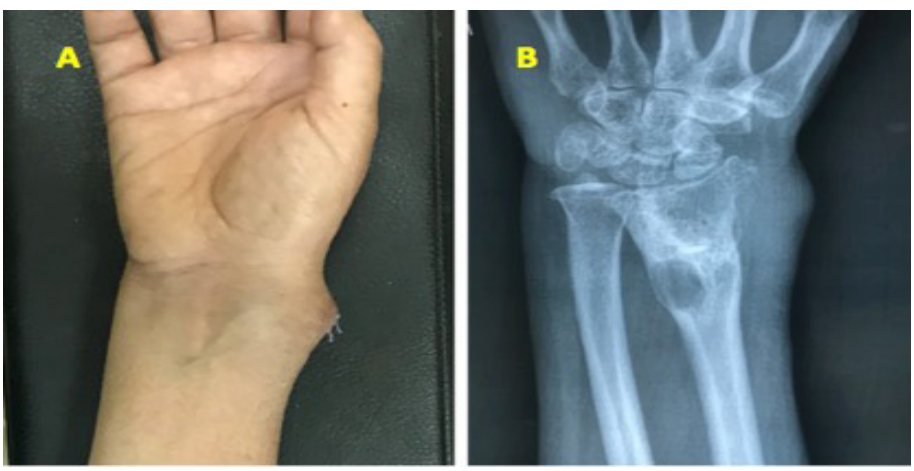

Figure 1. Pre-operation: (A) the right wrist is swollen and red on the radial side. (B) X-ray film: The right wrist demonstrating the osteolytic lesions of the distal radius

1. Operative technique

En-bloc resection of the distal radius

Safe resection of the tumor was defined as the distance from the tumor margin to surgical excision greater than 2.5cm, radial artery and cephalic vein were exposed and protected throughout the procedure. To maintain the flexibility of the wrist joint, we tried to remain the distal radioulnar joint capsule and radiocarpal ligament. 12cm of the distal radial bone was removed, from 7cm above the tumor margin (Figure 2A).

Harvesting of the proximal fibular free flap

The contralateral proximal fibular was chosen for reconstruction. The surgical incision line was parallel with the fibular, above the proximal fibular head 7cm and behind the posterior border 1cm, expanded to one-third inferior of the fibular. The peroneal vessels and their intermuscular septum branches were determined and protected. Biceps femoris tendon, fibular collateral ligament, fibular joint capsule, common fibular nerve, deep and superficial fibular nerves, and genicular vessels were also located and meticulously preserved. The flap included the proximal fibular peroneal artery and veins with a total length of 15cm (Figure. 2B). After harvesting the flap, the biceps femoris tendon, collateral fibular ligament, and proximal tibiofibular joint were reconstructed to maintain the stability of the knee joint.

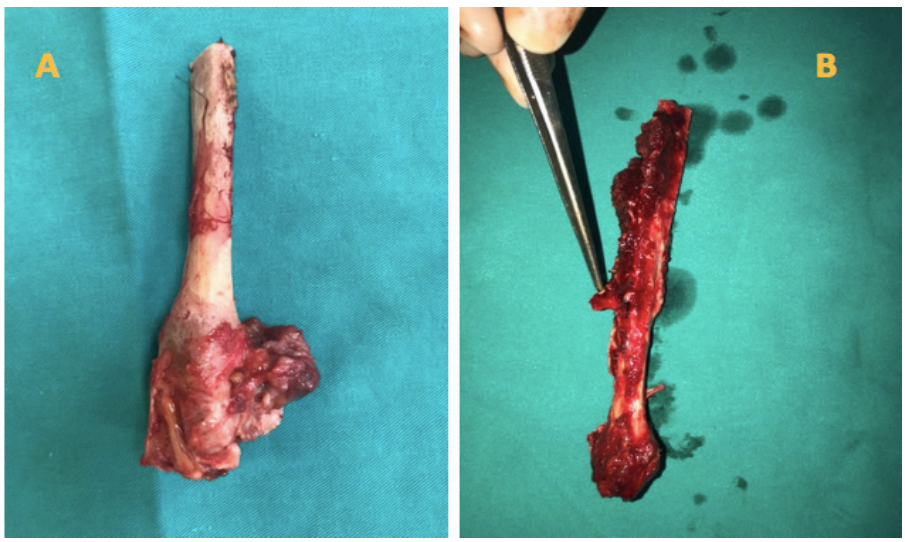

Figure 2. (A) Photographs of operative specimens after en bloc resection of the distal radius. (B) Harvesting of the vascularized proximal fibular flap

Anastomosis and reconstruction

The vascularized proximal fibular flap was transferred to the defect of the distal radial bone after removing the GCT. A plate and eight screws were utilized to fix the bone flap after confirming that the length of the fibular flap was appropriate to the defect of the distal radius. The proximal head of the fibular flap is connected with ulnar and carpal bone by employing two Kirschner wires. Next, we cut the radial artery into two separate portions, the distal one was carefully fastened and the proximal one connected with the peroneal artery via end-to-end anastomosis. Similarly, peroneal veins were anastomosed with a cephalic vein by an end-to-side method utilizing nylon 9/0 suture. Finally, the

upper extremity was stabilized by employing an arm cast plaster with 90^0 flexions of the forearm, 20^0 extensions of the palm.

2. Postoperative evaluation

Bone union was followed up by comparing the X-ray images. Plaster splint and Kischner wires were removed at eight weeks post-operation. During this time, the patient was instructed to conduct rehabilitation of wrist joint and forearm muscles.

To evaluate the result of reconstructive surgery after 24 months, we employed the musculoskeletal tumor society functional evaluation scale (upper limb data).

Table 1. Musculoskeletal tumor society functional evaluation scale

	Pain	Function	Emotional	Hand positioning	Manual dexterity	Lifting ability	Overall functional rating (%)
Preoperation	2	1	0	5	3	2	43
3 months	5	2	4	5	3	3	73
6 months	5	3	5	5	4	3	83
2 years	5	3	5	5	4	4	87

The patient experienced a significant improvement of the wrist function after six months and two years of follow-up. Pain was gradually relieved postoperatively and completely vanished at three months follow up. Manual dexterity showed slow development, but the patient can flex the wrist two years after the operation. There were no signs of local recurrence or distant metastasis.

At the donor site, the knee and ankle joint were stable with none of no pain, normal joint rotation range, no sign of osteoarthritis or deformity of tibial bone were observed at the anterior, posterior leg X-ray.

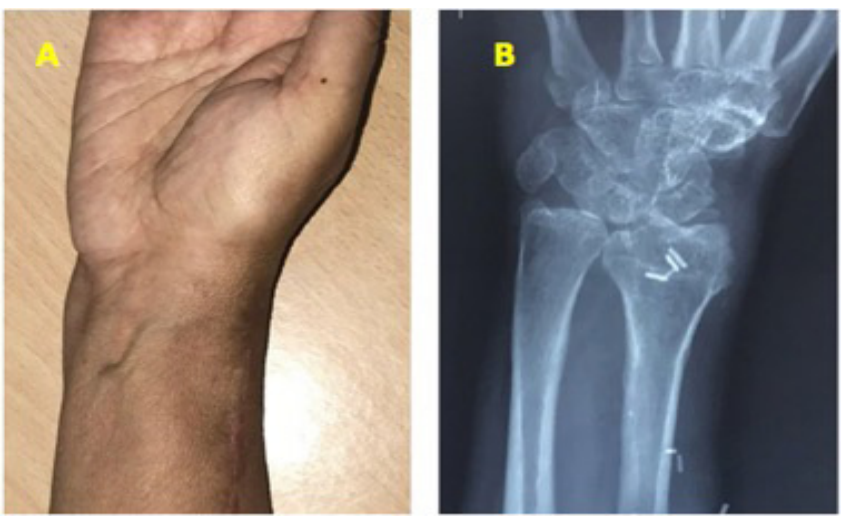

Figure 3. Two years after operation: (A) the right wrist looks normal. (B) The proximal fibular has a surprising fit to the distal radius reconstruction

III. DISSCUSSION

A giant cell tumor is a uncomplete benign tumor with a high rate of local recurrence and lung metastasis.[6] Distal radius is the third position after distal femur and proximal tibia. Treatment goal includes tumor resection, preventing recurrence, and preservation of wrist function. Intralesional curettage with bone graft or cement injection is the standard treatment method with stage I.[7,8] Stage II, III with a high incidence of local recurrence require en - bloc resection.[9,10] Reconstruction distal radius is the compulsory indication after surgery, posing a challenge for reconstructive surgeons as large tissue defect along with anatomical and functional preserve demand.

There are many materials such as artificial materials, bone autograft/allograft, or microsurgical flap. The advantages of artificial materials are no requirement to harvest the tissue itself, no damage to the donor site, unlimited quantity, not absorbed over time, and produced distinctly for each specific case. However, the artificial materials have a risk for being unsuitable for the host bone; therefore, they should not be used for the long term. Bone allografts have the advantage of choosing the graft with the appropriate size and shape, not damaging where the material is taken. Nevertheless, the main disadvantages of allograft are hypoperfusion, immune response, low level of osteoblast, and risk of osteolysis. The fibula on its own is an ideal material for reconstructing distal radius defects. It can be used in two forms: bone graft or bone flap. The graft has the advantage of not being rejected, a simple grafting technique, but the vitality of the graft decreases when harvesting a large volume. Vascularized fibular auto flap with a bone healing rate of 67 - 100% is superior to fibular autograft.[11,12] The vascular pedicle increases blood perfusion and osteoblast for the flap.

Some surgeons use the fibula body flap rather than the proximal fibular flap for distal radius reconstruction due to concerns of damaging the tibiofibular joint and common fibular nerve. However, the fibula body is exposed to damage the cartilage of the causing joint pain and joint stiffness. The proximal fibular flap is suitable for reconstructing the wrist joint because of its similar structure to the wrist joint which will allow the wrist joint to move easily, reduces pain, and reduces the risk of joint stiffness, thus help to improve both the anatomy structure and function of the wrist joint.

In our report, the patient was diagnosed with giant tumor cell at distal radius stage III and underwent en-block resection and reconstruction of the tissue defect with vascularized proximal fibular flap. The flap with its plentiful blood supply lessened complications involving wrist function as osteoarthritis, secondary bone collapse caused by the hypoperfusion characteristic of graft. O'Donnell proposed that subluxation is caused by the incompatible shape of proximal fibular and carpal bones.[5] We did not observe the complications in our case as soft tissue was appropriately reconstructed and the compatibility of proximal fibular head and carpal bones.

Several authors proposed that choosing donor flaps from left and right fibular have a similar outcome. Innocenti and most authors advocated vascularized proximal fibular flap harvesting from contralateral fibular since it is compatible with radius although, Mack had the opposite result in his research.[13,14] Therefore, we choose contralateral proximal fibular with satisfactory outcome after two years of follow-up. There were a normal range of motion, stable knee and ankle joints.

IV. CONCLUSION

Reconstruction distal radius after treating giant cell tumor stage III by en–block resection method with vascularized proximal fibular flap is an effective technique. Although entailing intricate skills, it brings outstanding results of anatomical compatibility, wrist joint function recovery and maintains normal function at the donor site.

Conflicts of interest

None.

Funding

No source to be started.

Ethical approval

The study was approved by our research committee, Vietnam National Cancer Hospital, Hanoi, Vietnam.

Consent

The publication of this study has been consented to by all relevant patients.

Registration of research studies

Not applicable.

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