Journal of the Egyptian Nat. Cancer Inst., Vol. 15, No. 2, June: 163-168, 2003

Replacement of the Distal Radius after Resection of Primary Bone Tumors Using Nonvascularized Proximal Fibular Graft

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ABSTRACT

Back ground and purpose: The distal radius and its articulations clearly have a vital role in the functional ability of the hand and the wrist. The treatment of tumors of the radius, therefore, needs to achieve a satisfactory clearance of the lesions while also preserving as much wrist functions as possible.

Material and methods: The study included five patients with primary and recurrent giant cell tumors and one patient with malignant fibrous histiocytoma of the distal radius. Those patients were subjected to resection of the distal radius and replacement with osteoarticular autogenous proximal fibular grafts. The mean follow up period was 21 months.

Results: Bone graft healing occured at a mean of 6 months. The mean postoperative wrist flexion was 18 degrees, extension was 24 degrees, pronation was 62 degrees and supination was 46 degrees.

Conclusion: Resection of tumours of the distal radius followed by replacement with nonvascularized proximal fibular graft is an effective way to manage these tumours.

Key Words: *Bone tumor - Radius - Fibula.*

INTRODUCTION

The distal radius is a skeletal site frequently affected by primary bone tumors. It is a common site for occurrence of giant cell tumors. Giant cell tumors at the distal end of the radius can be treated by various methods. Lesions that are small and detected early can be treated by curettage and autogenous bone grafting or filling with bone cement **[1,2]**. Large expansile lesions can be treated by wide resection to minimize the chance of recurrence **[3]** but this often poses a dual problem, the first being that of bone reconstruction and the second is that of functional restoration. This problem of bone reconstruction and functional restoration can be solved by a custom-made prothesis **[4]**, allografts **[5]** or autogenous bone grafts **[6]**. The proximal fibula both vascularized and non vascularized has been used as a substitute of the distal radius. The ipsilateral fibula is favoured because its proximal shape and curvature best conforms to the convexity of the proximal carpal row **[7,8,9]**.

Vascularized fibular graft has the advantage of enhancement of healing at the proximal graft junction noted to be as early as 10 weeks and it is ideal for long defects that are larger than ten cms. However, this is associated with increased operative time to perform a microvascular anastmosis and some potential danger of recipient site vascular morbidity with anastmosis of peroneal artery to the radial artery **[10]**.

This prospective study assessed a group of patients who underwent replacementof the distal radius with ipsilateral nonvascularized autogenous fibular graft after resection of primary tumors of the distal radius.

PATIENTS AND METHODS

Between January 2000 and May 2003, six patients having primary bone tumors of the distal radius were subjected to resection and reconstruction of the radiocarpal joint with a nonvascularized autogenous fibular graft. One patient was treated for malignant fibrous histocytoma and the other five patients were treated for giant cell tumors (three primary and two recurrent after previous curettage). Those five cases had a large expansile lesions, so wide resection of the tumor was the method of choice (Fig. 1A,B). Their ages ranged from 30 to 51 (mean age, 31.1 years).

Preoperative investigations of each patient included, radiographs of the forearm and wrist, CT or MRI of the lesion, core needle or open biopsy and bone scan (Fig.1,C). Patients were selected only if preoperative imaging had shown that a satisfactory surgical margin could be achieved. Patients with expected defects larger than 10 cm are excluded from the study because vascularized fibular graft is a better option in such condition.

Under general anesthesia, the distal radius was resected through a standard dorsal longitudinal incision overlying the radius and including the previous biopsy site. The extensor tendons were freed from their sheaths. The dorsal retinaculum and the dorsal capsule overlying the radiocarpal and radioulnar joints were exposed and inspected for the presence of underlying tumor extension into the joint. If the radiocarpal joint appears free of tumor, the dorsal capsule is incised and the radiocarpal joint is entered. Tumour spread to the radiocarpal and radioulnar joints can be confirmed by preoperative CT or MRI studies. If so, resection should include the distal ulna or the proximal carpal row to obtain adequate margins. We did not require such a resection in our patients. The radius is osteomatised proximal to the proximal tumor margin as determined by the preoperative staging studies. The volar capsule is divided and the dissection carried volar to the pronator quadratus, which is divided close to the ulna. After removal of the distal radius and tumor mass, the remaining tissues are inspected for residual tumor; any suspicious margins are sampled and sent for frozen section (Fig. 1,D). In two patients resection was done through a ventral approach because they were referred to us with ventral scar. The lengths of the resected distal radius ranged from 6 to 9 cm.

The proximal fibula was approached by a lateral longitudinal incision as described by Gilbert [11]. The common peroneal nerve was identified and protected. The required length of the fibula including the head was denuded of its soft tissue attachments by subperiosteal stripping. The proximal tibiofibular joint was divided and then the fibula was divided distally with a saw to deliver the required length of the graft. The fibula was then implanted in the forearm to substitute the distal radius and fixed to the proximal radius by a dynamic compression plate and screws (Fig. 2A,B). Position of the distal graft is maintained with K-wire during the first 6 to 8 weeks. Additional stabilization for 6 to 8 weeks using a long arm cast is recommended until proximal radiographic union is complete.

Patients were followed up for an average period of 21 months. Postoperative assessment included, presence of pain, level of pain [12], range of movements of the forearm and wrist, power grip. The power grip was compared with the contralateral side. Radiographs were obtained on the operated forearm and wrist every one month to study radiographic union between the fibula and radius and to detect complications as subluxation of radiocarpal arthroplasty, nonunion, stress fracture and deformity. Assessment also included local and distant control of the disease.

RESULTS

Six patients were treated for primary tumors of the distal radius by wide surgical resection of the distal radius and reconstruction of the defect with ipsilateral autogenous nonvascularized fibular graft. Five cases had giant cell tumor (three recurrent, two primary) and one case had malignant fibrous histocytoma.

Surgery involved the right radius in four cases and the left in two cases. Patients were followed up for an average period of 21 months (range from 16 to 36 months). The operative time ranged from 3 to 3.5 hours and the average blood loss was 600 cc.

Union: Radiographic union was seen in all cases at an average period of 6 months (range from 5 to 8.5 months). Non of the transferred grafts had undergone nonunion, resorption, or stress fracture (Fig. 3A,B).

Functional results: The average range of movements at the operated wrist were; active extension 24° (range,12 to 55°), flexion 18° (range from 5 to 25°), radial deviation 13° (range 5 to 28°), ulnar deviation 14° (range, 0 to 30°), pronation 62° (range from 25 to 80°) and supination 46° (range from 5 to 80°). The average grip of the hand was satisfactory in comparison with the other hand. Movements and sensations of the fingers and thumb were normal in all patients.

Complications:

1- Recurrence: One patient with recurrent giant cell tumors developed a soft tissue recurrence after one year of resection. The recurrence

was amenable to surgical resection without amputation and the patient is now free of his disease. No patient developed distant recurrence.

Fig. (1-A): A 31 years old man presented with a slowly growing giant cell tumor at the distal end of the right radius over a period of three years.

2- Subluxation: One patient developed minor dorsal subluxation (Fig. 3,C).

3- Donar site morbidity: No donar site morbidity was seen in our cases **[13]**.

Fig. (1-B): Plain X ray showing a large expansile giant cell tumor.

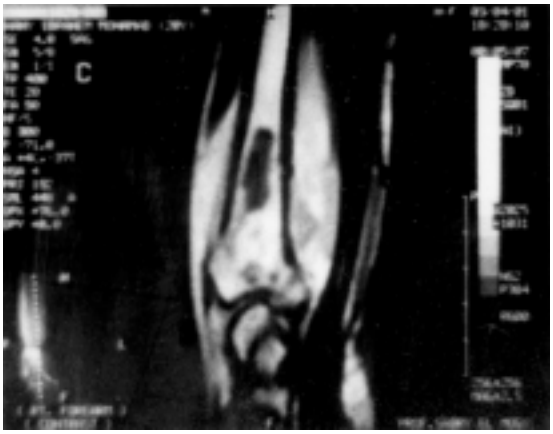

Fig. (1-C): MRI of a case of malignant fibrous histoicytoma of the distal radius.

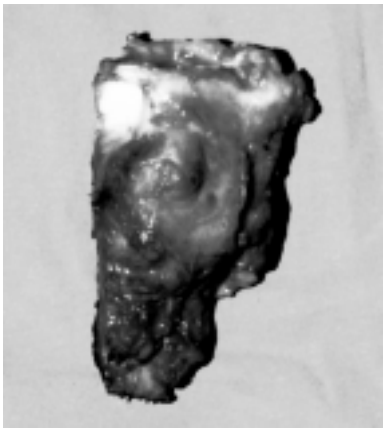

Fig. (1-D): Postoperative resected specimen.

Fig. (2-A): The distal radius has been removed (flexor tendons and median nerve are retracted).

Fig. (2-B): The fibula is implanted after resection of the distal radius and fixed with a 6 holes plate and screws.

Fig. (3-A): Post-operative radiograph after 5 months showing early union. The transferred fibula fixed proximally with DCP plate and distally with temporary K wire.

Fig. (3-B): Plain X ray after 13 months showing solid union at the fibulo-radial junction.

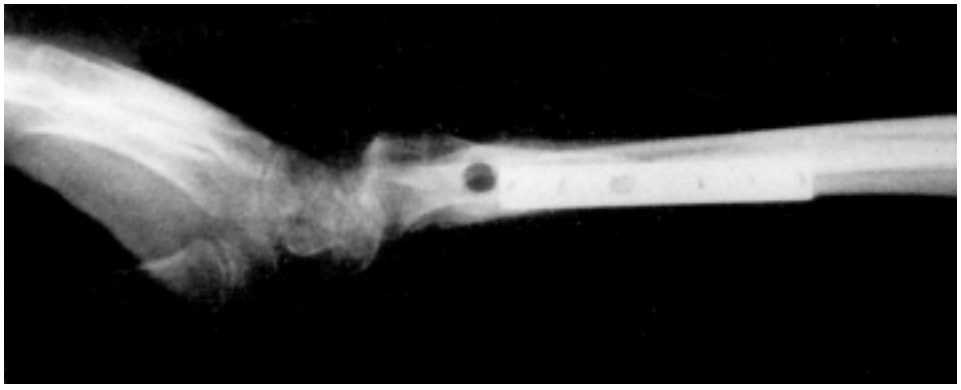

Fig. (3-C): Plain X ray, lateral view showing active extension. Note, minor dorsal subluxation.

DISCUSSION

The distal radius is a common site of giant cell tumor. Methods commonly used in the treatment of giant cell tumor of the radius include curettage which may be augmented by local ablative therapy such as cryosurgery and filling the resulting cavity with cancellous bone graft or bone cement. The reported recurrence rates of giant cell tumor are higher at the distal radius than other long bone sites, due to the complex anatomical structures surrounding the distal radius **[14]**. Recurrence rate of 50% has been reported following such treatment modality **[15]**. Large expansile tumor with extension into the soft tissue can be treated by wide resection of the distal radius and reconstruction to minimize the chance of recurrence **[3,2]**.

We performed wide resection of tumors of the distal radius in six patients having primary tumors of the distal radius, five cases had large expansile giant cell tumor, (three primary and two recurrent following curettage) and one case had malignant fibrous histiocytoma. On follow up of those patients for an average period of 21 months (range from 16 to 36 months), only one case of the recurrent giant cell tumors developed soft tissue recurrence. The recurrence was small and was amenable to surgical resection without amputation and this patient is now free of his disease.

Although the treatment of giant cell tumor at the distal radius by curettage preserves the radiocarpal articulation, this does not ensure preservation of full flexion. Restriction of the range of movement to 60% and power grip to 60% have been demonstrated **[16]**, of particular note is the relative preservation of supination and pronation with this technique.

Satisfactory functions of wrist extension, flexion and combined radial and ulnar deviation have been seen in our patients. These results are comparable to results reported by other authors using the same technique **[2,17,18]**.

Despite capsular repair, clinical and radiographic carpal subluxation can occur **[9]**. No attempt was made to reconstruct the wrist ligaments in our cases as none was left due to the radical excision of the tumor. Kirschner wires were used distally as a temporary fixation in addition to external support by plaster cast until sufficient fibrous tissue was formed around the reconstructed joint to permit a functional range of movement. One patients developed minor dorsal subluxation which was painless and did not affect the function of the wrist.

The described techniques for fixation of the fibular graft to the radius included the use of cortical screws, a Rush pin or a dynamic compression plate with screws **[2,8,19]**. Maruthain **[15]** reported that rigid fixation by step cut of fibula and compression plate as well as grafting the bone junction with cancellous bone are important factors to achieve rigid union. Although, we did not follow this policy, radiographic union was seen at the radius-fibula interface in all cases at an average period of 8 months. We think that rigid fixation by a compression plate and good approximation between the fibula and the radius are the most important factors to achieve union.

In a review of a large series of patients treated by a similar technique of osteoarticular allografting for tumors of the distal radius, allograft was revised or amputation was performed in 33% of cases **[20]**. Murray and Schlafly, **[8]** reported that some patients in whom arthroplasty of the distal radius had been fashioned with vascularized fibular graft required arthrodesis due to persistent pain. We did not require revision of the graft nor arthrodesis in our patients.

The results of this study suggest that a favorable functional outcome and local control can be achieved by the technique of radial resection of tumors of the distal radius and reconstruction using autogenous nonvascularized fibular graft. It can be done without the need to microvascular team and it is ideal when the bone defect is less than ten cm.

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