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Reconstruction of the distal radius by fibula following excision of giant cell tumor

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Abstract Thirty giant cell tumors of the distal radius were excised and reconstructed using a nonvascular fibular osteoarticular autograft. Four different surgical techniques for stabilization were used. There were ten recurrences, which could not be correlated with Campanacci's radiological or Jaffe's histological grading. Twenty cases without recurrence were followed up over 1.5–25.5 (average 8.5) years. Average time for incorporation of the graft was 5.2 months. The surgical technique using a radiofibular plate and K wire through the wrist had a low nonunion rate, no graft related complications, good range of movement, and good hand functions.

Résumé Trente tumeurs à cellules géantes du radius distal ont été excisées avec reconstruction par une autogreffe ostéo-articulaire fibulaire non-vascularisée. Quatre techniques chirurgicales différentes ont été utilisées pour la stabilisation. Il y avait 10 récidives non correlées avec la classification radiologique de Campanacci ou celle, histologique, de Jaffe. Vingt cas sans récidive ont été suivis de 1,5 à 25,5 années (moyenne 8,5 années). Le temps moyen pour l'incorporation de la greffe était de 5,2 mois. La technique chirurgicale utilisant une plaque radio-fibulaire et une broche de Kirchner trans-carpienne avait un faible taux de non-consolidation, aucune complications liée à la greffe, une bonne amplitude de mouvement et une bonne fonction de la main.

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Introduction

Juxtaarticular giant cell tumors of the distal radius are managed by intralesional curettage [2, 18, 21] or excision. Reconstruction of the distal radius after excision poses several problems [6, 9]. Options include osteoarticular grafts using nonvascularized proximal fibula [1, 4, 6, 8, 10, 20]; or vascularized fibula [5, 12, 13, 14, 15, 16], vascularized iliac crest grafting [5, 9], and wrist arthrodesis [12, 14, 21].

The main criticism for nonvascularized fibular autograft is that it is said to be associated with a higher incidence of complications like osteoporosis, progressive absorption, nonunion, and slow incorporation of the graft [15, 16, 19].

This study was undertaken to assess the long-term results of nonvascularized osteoarticular fibular autograft and the role of various methods of fixation, their functional status, and complications.

Material and methods

Thirty-one cases of giant cell tumors of the distal radius were treated between 1970 and 1997. Thirty of these underwent fibular osteoarticular autograft, 28 done primarily and two after a spacer was used for 3 months. All patients were categorized using Campanacci's radiological and Jaffe's histological grading methods (Table 1).

Fixation technique was evolved over time. The initial three cases had a Z-osteotomy and screw fixation, and one was fixed with an intramedullary Rush nail. Twenty-six cases had plate and screw fixation of which the last 21 had additional stabilization of the wrist with a K-wire inserted through the third metacarpal.

All patients were treated with an above-elbow plaster cast for 3–4 months. K-wires, when used, were removed at 3 months. After 3 months, a molded alkathene below-elbow splint was continued for a further 3 months, with intermittent mobilization of the wrist and forearm. No patient had chemotherapy or radiotherapy.

The follow-up ranged from 1.5 to 25.5 (average 8.5) years. Twenty patients who did not have recurrence were further evaluated. Range of movement was analyzed with a goniometer and was considered to be good if movement was greater than 65% of the opposite side, fair if between 35–64%, and poor if less than 34%. Hand functions were assessed independently by an occupa-

Table 1 Clinical data. *SN* Serial number, Rad. *grade* Radiological grade, *R* Recurrence, *Hist. grade* Histological grade, *A* Arthrodesis, *Z* Z-osteotomy and screw, *Amp* Amputation, *RN* Rush nailing, *NU* Nonunion, *P* Plate fixation, *Inf* Infection, *PK* Plate and K-wire, *Ref* Refused

S.N	Age	Gender	Rad. grade	Hist. grade	Treatment	Outcome	Wrist	Result	Follow-up (months)
1	23	F	2	2	Z		Good	Good	306
2	32	F	3	2	Z	R, A			
3	50	M	1	2	Z	NU	Poor	Poor	254
4	19	F	1	2	RN	R, Amp			
5	23	F	3	3	P	NU	Fair	Fair	207
6	36	M	2	2	P	R, A			
7	29	F	3	2	P	R, Amp			
8	39	M	2	2	P		Fair	Good	169
9	26	M	2	2	P	R, A			
10	29	M	3	3	PK		Fair	Good	123
11	32	M	2	2	PK	R, Amp			
12	36	M	2	3	PK		Fair	Fair	123
13	35	F	2	2	PK	R, A			
14	26	M	2	2	PK	R, Amp			
15	27	F	3	2	PK	NU	Poor	Fair	105
16	32	M	2	2	PK		Fused	Good	100
17	31	F	3	2	PK	R, Ref			
18	20	F	2	2	PK		Good	Good	90
19	28	M	1	1	PK		Fair	Fair	85
20	26	F	2	2	PK	R, A			
21	32	F	3	3	PK	Inf	Poor	Poor	79
22	33	M	2	2	PK		Good	Good	66
23	36	F	2	2	PK		Good	Good	60
24	24	M	3	3	PK		Fused	Fair	56
25	28	M	2	3	PK		Fused	Fair	50
26	28	F	2	2	PK		Fair	Good	45
27	34	M	3	2	PK		Good	Good	44
28	29	F	1	2	PK		Good	Good	32
29	31	M	2	3	PK		Fair	Fair	21
30	27	F	3	3	PK		Good	Good	17

tional therapist with a Jamar dynamometer for the grip strength and pinch meter. They were categorized good, fair, and poor, as per previous criteria.

Results

No significant intraoperative or immediate postoperative complications were noted. One patient who had fibula grafted after a spacer application had delayed onset deep infection with resultant graft resorption (Fig. 1). Recurrences were seen in ten patients, in whom radiological assessment showed one was Campanacci's grade I, six grade II, and three grade III. All recurrences were Jaffe histological grade II. The majority of recurrences were seen in the first 2 years after surgery. Four patients with recurrence underwent amputation. Five patients had wide excision and arthrodesis, and one of these had a second soft tissue recurrence that was treated by wide resection and is presently asymptomatic 7 years later. One patient refused further treatment and was subsequently lost to follow-up. The remaining 20 patients were further analyzed. The host-graft junction united between 4 and 6.5 (average 5.2) months. Host-graft nonunion was seen in three patients, one in each treatment group. One patient who had nonunion after Z-osteotomy and screw fixation refused bone grafting and eventually had a partial graft resorption (Fig. 2). Two others underwent bone grafting that united.

Fig. 1 Chronic osteomyelitis and partial sequestration of the graft

The best wrist movements were achieved in the rigidly fixed group, with 6/16 good and 5/16 fair results. In the group where K-wires were used to stabilize the carpus, three underwent spontaneous unintentional wrist

Fig. 2 Nonunion and partial resorption of the graft following Z-osteotomy and screw fixation

arthrodesis in functional position with a good range of supination and pronation. Evaluation of hand functions showed better hand function compared to range of movement: 9/16 had good, 6/16 fair and one had poor hand functions in the rigidly fixed treatment group.

Patients with infection (Fig. 1) and with host-graft nonunion (Fig. 2) refused further treatment and are happy to manage with an alkathene molded below-elbow brace. Wrist subluxation was seen in one patient who had Z-osteotomy and had a painful range of movement. Two who had plate fixation had fibuloulnar subluxation and experienced occasional discomfort on doing prolonged work. In the group who had stabilization of the carpus with a K-wire, none had subluxation at either joint.

Discussion

The roles of radiological and histological grading of giant cell tumors are controversial [1, 7, 17]. In this series, one patient with radiological grade I and six with grade II subsequently developed recurrence. All patients with recurrence were in histological grade II. Therefore, we agree with Enneking [3] that the use of either radiological or histological grading in isolation is of little help in prognosticating recurrence in giant cell tumors.

Recurrence rate after excision of the distal radius varies from 0–50% [2, 4, 5, 7, 12, 14, 17, 18, 21]. We report a recurrence rate of 33%. In general, the recurrence rates are lower than those treated by curettage [7, 17, 18].

Average healing time between the radius and fibula was 5.2 months. The vascularized fibula is reported to heal between 2 1/2 to 9 months [16] or before 10 months [11]. There was only one case of nonunion in our rigidly fixed group (6%), and it subsequently healed with bone grafting. Nonunion cannot be avoided by vascular graft [5]. It would be reasonable to presume that our understanding of the need for rigid fixation has contributed to the lower rates of nonunion in the recent series and, whatever be the nature of fibula used, rigid fixation is universally agreed upon as mandatory [6, 10, 15, 16, 18].

None of the nonvascularized fibulae fractured. In a few patients, the graft showed patchy physiologic osteoporosis at about 3 months, probably due to disuse and delayed vascularization, which eventually improved.

Range of wrist movements and stability improved in the group with stable fixation. Spontaneous unintentional wrist arthrodesis was seen in three patients. This has been reported once previously in a patient who had the vascular articular graft of fibula [5]. This problem in our patients possibly resulted from the use of a stabilizing K-wire for a period of 3 months. Earlier removal of K-wire with a hope of decreasing the rate of wrist stiffness will probably increase the chance of wrist subluxation [16]. Carpal subluxation is a common and occasionally disabling problem, and the incidence varies from 28 to 100% [5, 9, 12, 16]. Ligament reconstruction is technically inadequate [16], but functional results are good [10, 16]. Hence, it is important to ensure adequate support to the carpus and expect that stability be assured by fibrosis [16]. Vascular fibula ensures a viable articular cartilage, but it cannot avoid subluxation and degenerative arthritis due to the relative incongruity of the fibulocarpal joint [9, 12, 16].

It was also seen that a higher number of patients had good or fair hand functions than depicted by their wrist range of motion. We agree that most patients are happy with their functional status [2, 5, 6, 8, 9, 10, 14, 16, 20].

It has been stated that the fibula, being a long cortical bone placed in a relatively avascular bed, nearly always becomes osteoporotic, is progressively absorbed and becomes incorporated slowly [15, 16, 19]. Pho argued that despite prolonged immobilization the patient often ended up with a stress fracture, a deformity, and delayed or nonunion [15]. To overcome these problems, he recommended a vascularized fibular transplant but cautioned that it is a technically demanding surgery with prolonged operating time, requires extensive angiographic studies of the vascular pattern of the limbs, and two major vessels need to be sacrificed [15]. Occasionally, the nutrient artery pierces the fibula low down the bone, necessitating a long graft with subsequent extensive resection of the radius and affection of the flexor muscle function. Damage to the vascular pedicle by the fixation screws will result in the fibula functioning as a nonvascular graft. Also, the required expertise and equipment are usually unavailable in developing countries.

In our series, the rigidly fixed group had a significantly lower incidence of host-graft nonunion, better range of wrist movements, better hand function, and no wrist subluxation. Although earlier union can be expected with a vascularized graft, problems of the nonvascularized fibular graft can be minimized in the presence of rigid internal fixation.

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