Fracture Prosthesis in Giant Cell Tumor of Distal Radius: Precautions and Management

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Abstract

Introduction: Distal radius is one of the common locations for giant cell tumor (GCT) in the second to the fourth decade of life. Based on the extent of the tumor, various treatment options are available such as curettage and bone grafting or use of bone cement, various ablation techniques, excision, and vascularized or non-vascularized fibular graft. However, when subchondral bone and articular surface are involved and the patient is not ready for the fibular grafting, one of the methods described is excision and use of custom-made acrylic prosthesis, of which fracture prosthesis is a complication. Here, we are reporting a case who presented with a fractured prosthesis, the way we managed it and the precautions that can be taken while use of the prosthesis.

Case Report: We are presenting a case of a 42-year-old male who came back after 2 years of implantation with a fractured prosthesis, which happened during a routine activity. There was no evidence of recurrence of the tumor. A discussion about the cause, the management done, precautions to be taken while implanting acrylic prosthesis, and a follow-up of the patient for 3 years is also done.

Conclusion: Acrylic can be used as a cost-efficient material for a prosthesis in both primary excision and revisions in distal radius GCT with good functional results if specific precautions are taken preoperatively and intraoperatively.

Keywords: Acrylic prosthesis, broken prosthesis, fractured prosthesis, radius giant cell tumor.

Introduction

Giant cell tumor (GCT) was not formally classified from other bone tumors such as aneurysmal bone cyst, chondroblastoma, and non-ossifying fibroma until 1940 [1]. Amputation was a routine for giant cell tumors in the 19th century. Later on, Joseph Bloodwood, who also holds the credit of naming it, showed that simple curettage was usually sufficient [2]. Although GCT of bone was first described by Cooper and Travers, it was described in depth by Jaffe and Lichenstein [3].

GCT are locally aggressive tumors and notorious for a higher rate of recurrence (about 50%) following simple curettage. However, with the dawn of better techniques and increased understanding, the current recurrence rates have decreased to 10–15% in most published series [4]. Campanacci et al. showed that the risk of recurrence was unrelated to the stage of the lesion but to the inadequacy of treatment and inappropriate removal of the tumor [5, 6, 7].

The reported recurrence rates of GCT are higher at the distal radius than at other long bone sites due to the anatomical structure of the distal radius [8, 9]. Primary curettage with filling of the defect has a recurrence rate of 25–80% and is particularly high when the tumor has breached the cortex [10]. Hence, excision of the tumor and replacement with a vascularized or non-vascularized fibula graft or custom-made prosthesis is usually beneficial in these cases. Acrylic is a common material used in dentures and fracture prosthesis is not an uncommon occurrence, due to the stress it sustains. Acrylic, when used as prosthesis, also causes tissue reaction and fibrosis around [11]. Although fracture of the prosthesis is a common occurrence, there is no literature introspecting the cause or the precautions to be taken during implantation or the surgery to deal with a broken prosthesis. We are presenting one such case discussing these aspects.

Case Report

A 46-year-old male presented in 2014 with dull pain and swelling of the right wrist of 6 months duration, which was insidious in onset and gradually progressive. Clinicoradiologically, it was suspected to be a GCT. On MRI, a cortical breach was noted without the involvement of the surrounding tissues (Fig. 1). He was given the option of resection and autologous fibular bone grafting, which he refused. Hence, an acrylic prosthesis was placed and fixed with an eight-holed plate. The histopathology report came out to be GCT Campanacci Grade 2. He was followed up after a month, and the dorsiflexion and palmar flexion were both noted to be around 0–20°. He was followed up regularly at 1, 3, and 6 months and was confirmed to have an uneventful recovery with improvement in movements and return

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Figure 1: X-ray and magnetic resonance imaging images showing cortical breach

to his daily activities (Fig. 2).

After 2 years, the patient came back with complaints of pain and deformity of the wrist of acute onset after the alleged history of slinging a hammer which was a routine activity for him. The wrist was radially deviated. All movements were painfully restricted.

Orthogonal X-rays of the wrist and forearm were done, and it was noted that the prosthesis was fractured and the ulna had subluxed dorsally (Fig. 3). Relevant blood investigations were noted to be normal.

The patient was again given the option of fibular autograft, which he refused. Hence, custom-made acrylic prosthesis had to be used again, but certain amends were made in each step.

Figure 4: (a) Broken prosthesis and removal of the proximal end, (b) distal end of the prosthesis and fibrosis of tissues around, (c) removal of the distal end of the prosthesis, and (d) new Barium sulfate impregnated prosthesis fixed with a plate.

Figure 2: One-year post-excision of the tumor and fixation of the prosthesis which is radiolucent.

Surgical technique and prosthesis

Pre-operative A pair of the acrylic prosthesis was made, one extra in case of cracking of the prosthesis while fixing. The prosthesis was impregnated with barium for radio-opacity to track any minute cracks on imaging intraoperatively. An eight-holed plate was used, and the holes were marked on the prosthesis. Drill holes were made using 2.5 mm drill bit and were tapped. 3.5 mm screws were passed and removed and the prosthesis was checked for any cracks from the screw sites. The same was done with the other prosthesis and they were autoclaved.

Intraoperatively The old surgical incision was extended. Extensive fibrosis was noted around the prosthesis. The prosthesis was noted to have broken at the distal screw site which was the site of origin of the break and the distal part had displaced dorsally. The prosthesis was removed. Five mm of the distal end of the radius was removed and sent for biopsy with some surrounding tissue. Due to extensive fibrosis, ulna could not be relocated. Hence, Darrach's procedure was done. The tendons were released and the new prosthesis was fixed with the trialled plate and checked for any minute cracks visually and by imaging (Fig. 4 and 5). The histopathology report showed no recurrence of tumor and the post-operative X-ray was noted (Fig. 6).

Figure 5: Barium sulfate impregnated prosthesis made from a demographically matching specimen.

Figure 3: X-ray showing breakage of the prosthesis and radial deviation of the hand.

He was followed regularly until 3.5 years during which period he got back to his normal activities with some restriction of movements in the wrist (Fig. 7). Later in the year, he had another fall when he had an L1 burst fracture and a proximal tibia fracture, for which he underwent stabilization and

Figure 6: Post-operative X-ray with new prosthesis fixed and Darrachs' procedure done.

Figure 7: Three years post-implantation of the new prosthesis.

Table 1: Previous distal radius giant cell tumor studies and complications

Study	Number of cases	Curettage	Excision	Complication
McGough*et al* . 2005 [14]	10	4	6	Nil
			Arthrodesis	
Renard*et al* . 1994 [1]	1	Nil	1 Arthrodesis	Nil
Goel*et al* . 2005 [15]	42	Nil	42	Recurrence 6
			Fibula reconstruction	Non-union 8
				Instability 6
				Infection 2
Chadha*et al* . 2010 [16]	10	1	9	Recurrence 1
			Fibula reconstruction	Graft fracture 2
				Subluxation 2
				Tourniquet palsy 1
				Graft resorption 1

Table 2: Various treatment options available

Treatment option	Advantages	Disadvantages
Intralesional curettage and bone grafting	Articular surface retained, better functional outcome of joint, less damage to nearby structures.	High chance of recurrence up to 36% [13], donor site morbidity for graft
Curettage with adjuvant therapy (PMMA, phenol, cryotherapy, and burr)	Lesser chance of recurrence than only curettage [13], articular surface can be retained	Difficult to use in distal radius due to neighboring structures.
Fibular grafting after wide excision(vascular or non-vascular)	Radical excision of involved tissues, low chance of recurrence [13], low cost considering an autologous transfer	The suboptimal functional result, donor site morbidity, patient factors, problems with integration, resorption, and fracture
Arthrodesis	Radical excision of involved tissues, low chance of recurrence, low cost	Poor function, donor site morbidity if graft required after excision

fixation and started walking with a walker with no complaints as such in the wrist.

Discussion

GCTs account for 8% of all bone tumors seen in metaphyseoepiphyseal junction between the second and fifth decades [1]. They constitute three types of cells: Multinucleated giant cells, round cells, and spindle cells which secrete stroma as well as cytokines and other factors which cause activation of osteoclasts, and hence lysis of the bone [12].

The location of the tumor is an important determining factor of the prognosis. The aggressiveness and rate of recurrence are quite high in distal radius when compared to other locations [13]. Complications are quite frequently noted in distal radius GCT as per previous studies (Table 1) [1, 14, 15, 16].Although there are numerous treatment options described for distal radius GCT, its close proximity with tendons, neurovascular bundles, and skin limits the usage of quite a few of them such as radical excision of the tumor tissue or the use of adjuvant therapies such as phenol, cryotherapy, and burr [17]. Furthermore, the limited eggshell covering the tumor will lead to a breach in the bone quite easily, leading to the spilling of the tumor cells, and hence higher chances of recurrence.

In case of breach of the bony compartment, excision of the tumor becomes a better option than curettage for the eradication of the disease. Articulation of the radius with three bones helps in the versatile movements of the wrist and hand. Although the current treatment options available post-excision may not be able to recreate this function, they are far worse when chances of recurrence are considered.

While arthrodesis of the wrist causes significant functional impairment, non-vascularized or vascularized fibular bone graft used to reconstruct the distal end of the radius is also not one without serious complications, as observed by Goel et al [15]. Custom-made prosthetic reconstruction is a viable option in patients who refuse to undergo a fibular autografting procedure (Table 2) [13].

When low-cost custom-made prosthesis are considered, acrylic is being used quite extensively to replace the lunate, scaphoid, vertebral body, and major articular surfaces of the joints with quite good function. After the custom-made acrylic prosthesis replacement of our patient, he had an uneventful return to daily activities for 2 years without the evidence of recurrence. The fracture in the acrylic prosthesis commenced from the last screw hole, probably from a microfracture that occurred during implantation and propagated to the surface, leading to failure of the prosthesis during his routine daily activity over the years. It has also been shown that acrylic dentures will have lower fatigue failure strength after using since acrylic resorbs some fluid in vivo [18].

Despite being a good material for low-cost custom-made prosthesis, the problems of brittleness and low fatigue failure have to be dealt with while using acrylic. Being extensively used to make dentures, specific modifications have been brought up to improve the durability which was used while making the prosthesis:

- Good processing technique which avoids surface defects and inclusions.
- Usage of higher strength polymers [18, 19].
- Surface roughening [20].
- Addition of fibers such as glass and aramid to increase the strength of the acrylic polymer [19].
- Addition of Barium sulfate to make it radio-opaque so that microfractures can be checked for by imaging intraoperative.
- Certain precautions also advisable during their use so as to limit microfractures are as follows: To make a pair of the prosthesis as a backup. To make the drill holes in the prosthesis preoperatively.Holes to be made slowly and serially without much force using a sharp drill bit. Holes to be tapped and the implant to be used to be trialled preoperatively.
- To check for microfractures near all holes made.

Conclusion

- Acrylic can be used as a cost-efficient material for a prosthesis in both primary excision and revisions in distal radius GCT with good functional results.
- Certain modifications can be made in acrylic with minimum cost to make it more durable.
- Specific precautions taken preoperatively can decrease the possibility of microfractures during implantation.

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